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When cognate status produces no benefits:

Investigating cognate effects during the processing of code-switched sentences

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Experimental studies examining the production and comprehension of language switches have provided evidence for a subtle but significant "switch cost:" switched words take longer to process than non-switched words (e.g., Altarriba, Kroll, Sholl, & Rayner, 1996; Gollan & Ferreira, 2009; Gollan, Montoya, & Werner, 2002; Meuter & Allport, 1999). However, bilingual speakers produce code-switches seamlessly and effortlessly (Myers-Scotton, 2002) and do not experience disruptions during the comprehension of naturally occurring code-switches (Guzzardo Tamargo, 2012). These two observations suggest that bilinguals make use of particular sources of information to seemingly alleviate the challenges associated with switching between two languages. In the work presented here, we ask whether the cognate status of switched words may be one such source of information. To examine this question, the eye movements of Spanish-English early and late bilinguals were recorded while they read

sentences on a computer screen. The experimental stimuli consisted of 4 versions of the same sentence, corresponding to 4 experimental conditions. Conditions 1 and 2 were code-switched conditions with a progressive verb. In Condition 1 the switch occurred immediately before the verb (...*los instructores are preparing*) and in Condition 2 it occurred at the verb (…*los instructores están preparing*). Conditions 3 and 4 were analogous to Conditions 1 and Conditions 2 but involved a verb in the perfect form (...*los instructores have prepared* and *los instructores han prepared*). Critically, half of the verbs (48) were cognates ('prepare'/ 'preparar') and half were non-cognates ('ship'/ 'enviar'). Bilinguals demonstrated an asymmetry in how they process code-switched sentences with the perfect structure vis-à-vis code-switched sentences with the progressive structure, and how cognate status impacted the integration of code-switch.

Introduction

One uncontroversial finding in the bilingual literature is that bilinguals activate words from both languages in parallel even when they intend to use one language only (e.g., De Groot & Nas, 1991; Dijkstra, De Bruijn, Schriefers, & Brinke, 2000; Dijkstra, Van Jaarsveld, & Brinke, 1998; Duyck, Van Assche, Drieghe, & Hartsuiker, 2007). The parallel activity of the two languages reported in much of the bilingual literature is observed most reliably during the processing of cognate words (e.g., Dijkstra, 2005; Morford, Kroll, Piñar, & Wilkinson, 2014; Schwartz, Kroll, & Díaz, 2007; Van Hell & Dijkstra, 2002; Wu & Thierry, 2010). Cognates are words that share form and meaning between two languages, such as 'doctor' in English and Spanish. Empirical

work investigating how bilingual word recognition is affected by the presence of cognates has consistently shown that the cognate status of words in the bilingual lexicon affects speech planning, speech production, and speech processing. Generally speaking, cognate words are named faster than non-cognates in both single-word naming and picture naming tasks; during reading, cognates are read significantly faster than non-cognate words (e.g., Costa, Caramazza & Sebastián-Gallés, 2000; Hoshino & Kroll, 2008; Sherkina-Lieber, 2004), and because of their phonological and orthographic overlap, cognates allow bilinguals to overcome lexical access failures (Gollan & Acenas, 2000). Cognate facilitation effects have been observed when words are presented in isolation (Dijkstra, Van Hell, & Brenders, 2015), but also when they are embedded in sentence contexts (e.g., Schwartz & Kroll, 2006; Van Assche, Duyck, & Brysbaert, 2013) and have been reported in early stages of processing (Duyck, Van Assche, Drieghe, & Hartsuiker, 2007; Libben & Titone, 2009). The processing advantage for cognates over non-cognates is typically accounted for by assuming a language-nonselective activation process in which word candidates from both languages are activated in parallel (e.g., Van Hell & Dijkstra, 2002). Interactive models of bilingual word recognition, such as the BIA+ model (Dijkstra & Van Heuven, 2002), propose nonselective access at different levels of representation in the bilingual's two languages. One assumption of the BIA+ model is that word recognition will be affected by orthographic, phonological, and semantic overlap. Because cognate words share the same or similar spelling and pronunciation and the same meaning, the prediction is that during lexical access, cognates will reach a stable state of activation earlier than non-cognates, resulting in their overall faster recognition over non-cognates (Van Hell, 2005).

Most studies examining the effect that cognates have on processing have done so while bilinguals are reading or speaking one of their two languages, thus privileging unilingual

approaches to bilingualism. However, for many proficient bilinguals, code-switching between two languages is a natural feature of language use and a hallmark of proficiency in two languages (e.g., Myers-Scotton, 2002; Miccio, Hammer, & Rodríguez, 2009). In bilingual discourse, proficient bilinguals move in and out of their two languages seemingly effortlessly, even in the middle of a sentence (Poplack, 1980; Torres Cacoullos & Travis, 2015). This phenomenon is commonly known as code-switching, and can occur inter-sententially (between sentences) and intra-sententially (within sentences). The choice of when to switch languages intra-sententially has been the subject of extensive inquiry because it is governed by complex grammatical (Di Sciullo, Muysken, & Singh, 1986; Lipski, 1985; Muysken, 2000; Myers-Scotton, 1993; Poplack, 1980) and sociolinguistic factors (Milroy & Wei, 1995; Moyer, 1995; Myers Scotton, 1982, 1988, 1995, 2002)[1]. Muysken (2000) classifies types of code-switches into three categories: insertions, alternations and congruent lexicalizations. Insertion happens when individual lexical items from one language (the guest language) are embedded within the grammatical structure of another language (the host language), and presupposes a base or matrix language (e.g., Myers-Scotton, 1993). Insertions do not presuppose a high command of the two languages; indeed, even beginning second language learners readily insert words from the second language into the structure of their more dominant language (see also Poplack, 2013). Alternation occurs when syntactic phrases from the two languages juxtapose within the same constituent. As might be expected, alternational switching presupposes a high degree of proficiency in the two languages (Poplack, 1980). Finally, in congruent lexicalization "the grammatical structure is shared by languages A and B, and words from both languages *a* and *b* are inserted more or less randomly" (Muysken 2000, p. 8).

[1] Consult Bullock and Toribio (2009) for an extensive review of these complex factors that are beyond the scope of this chapter.

Within the code-switching literature, some research has examined the role that cognate words play during bilingual language production. One finding is that cognates can act as 'triggers' to initiating a code-switch. For example, in a corpus study of naturally occurring code-switched speech produced by German-English bilinguals and Dutch-English bilinguals in Australia, Clyne (1967) reported that a large proportion of cognate words appeared in anticipation of a code-switch, suggesting that code-switching into the other language could be boosted by the presence of cognates. The presence of cognates is thought to create a propitious environment for code-switching because their tightly linked representations lead to higher activation of both languages at the lexical level, increasing the opportunities for lemma selection in a language different from that which has recently been spoken (Broersma & De Bot, 2006). Since Clyne's study, lab-based production experiments (Kootstra, Van Hell, & Dijkstra, 2012) and studies examining code-switching corpora (Broersma 2009; Broersma & De Bot, 2006; Broersma, Isurin, Bultena, & De Bot, 2009) have corroborated the idea that cognates increase the opportunities for selection of items in the other language. However, the presence of cognates in sentence contexts has not always produced facilitatory effects. In a recent study, Dijkstra, Van Hell and Brenders (2015) asked Dutch (L1)-English (L2) bilinguals to perform a lexical decision task under varying conditions. In a mixed-language condition, participants sometimes viewed a sentence in Dutch but were required to do a lexical decision task in English, or viewed a sentence in English, but were required to do a lexical decision task in Dutch. In half of the cases, the word was a cognate and in the remaining half, it was a non-cognate. Dijkstra et al. also manipulated the semantic constraint of the sentence, such that in some cases the target word was highly predictable (e.g., The devil does not live in heaven but in …TARGET → HEL; Dutch word for HELL) and other times it was not (e.g., The carpenter hurt himself with a…TARGET → MES;

Dutch word for KNIFE). When participants were performing the lexical decision task in the L2 English, reaction times for English cognates appearing after Dutch sentences were faster relative to non-cognates in both high- and low-semantic constraint sentences. However, when performing the lexical decision task in the L1 (i.e., when Dutch cognates were preceded by English sentences), an inhibitory effect was observed. The effect was also larger for low-constraint sentences than for high-constraint sentences. The findings from Dijsktra et al. are significant because the facilitatory and inhibitory effects observed during cognate processing provide strong evidence that in mixed-sentence contexts, cognate words are highly co-activated (see also Brown, 2015 for evidence from phonology). However, the implications of these results for real-world code-switching are limited. First, cognate effects in lab-based code-switching studies have been reported almost exclusively in contexts where a single-word other language insertion appears in an otherwise unilingual sentence. Although insertional patterns are attested in the code-switching literature (e.g., Muysken, 2000), because fluent code-switching involves the integration of two linguistic systems at the level of the lexicon and of the grammar (Torres Cacoullos & Travis, 2015), there is a need to examine the processing of cognates in alternational contexts, where several elements from each of the two languages appear in succession, and where the grammatical constraints of each language must be respected. Second, cognate facilitation effects have largely been studied in the context of nouns (but see Bultena, Dijkstra , &Van Hell, 2013; Van Asshe, Duyck, & Brysbaert, 2013), and overwhelmingly in nouns that refer to concrete objects. We know that nouns are particularly accessible words (Gentner, 1982). Nouns are conceptually more basic than predicative concepts (such as verbs), a fact that has often been invoked to explain why the comprehension of verbs lags well behind that of nouns in children (e.g., Goldin-Meadow, Seligman, & Gelman, 1976), and why in early productions,

nouns greatly outnumber verbs. Nouns are also morphologically more transparent and less complex than verbs. In English, for example, noun inflections are restricted to singular-plural distinctions and the possessive; however, verb inflections include tense, person, number, and aspect. One hypothesis derived from these properties of nouns is that the facilitatory effect of cognates reported in the code-switching literature might be a result of two factors that conspire to make nouns more accessible during processing: (1) the morpho-syntactic simplicity of nouns relative to other types of words, such as verbs; and (2) the transparent semantic mapping that nouns have to the conceptual world. A better understanding of the processing of mixed-language input requires the investigation of structures involving more than single noun switches and of manipulations of the syntactic locus of the switch point. The work presented here tries to do just this. We examine whether the presence of a cognate verb in code-switched contexts affects its processing; our main goal is to understand how lexical and grammatical variables interact during the comprehension of code-switched language.

Syntactic asymmetries in the production of Spanish-English code-switches For several decades, code-switching was regarded as random interference of one language upon the other (e.g., Lance, 1975). We now know that code-switching is rule-governed (e.g., Deuchar, Muysken, & Wang, 2007; MacSwan, 2000; Myers-Scotton, 2002; Toribio, 2001), although there is little agreement on the precise nature of the rules involved. There is consensus, however, as to the observation that code-switching is a remarkable feat of bilingual communication that gives language scientists the potential to understand how humans negotiate the boundaries of two languages (e.g., Kroll, Dussias, Bice, & Perrotti, 2015; Kroll, Dussias, Bogulski, & Valdés Kroff, 2012).

Corpus studies on intra-sentential switching involving a variety of language pairs have revealed that syntactic boundaries are permeable to intra-sentential shifts and that certain types of syntactic junctures are more prone to undergo code-switching than others (Clyne, 1987; Halmari, 1997; Lipski, 1986; Myers-Scotton, 1993; Pfaff, 1979; Poplack, 1980; Sankoff & Poplack, 1981; Timm, 1975; Zentella, 1997). Of particular relevance for our purposes, several studies examining the production of Spanish-English code-switches (e.g., Lipski, 1978; Pfaff, 1979; Poplack, 1980) have documented a production asymmetry involving alternations at the auxiliary phrase—the locus under investigation in the current study. Specifically, switches between the progressive auxiliary ESTAR (the Spanish auxiliary *be*) and an English present participle are comparatively more frequent than switches between the perfect auxiliary HABER (the Spanish auxiliary *have*) and an English past participle. To illustrate, Pfaff's (1979) analysis of conversational code-switching data from 200 Spanish-English bilinguals points to the statistical predominance of switches between the progressive auxiliary ESTAR and its corresponding verbal participle relative to switches involving the perfect auxiliary HABER. An examination of the code-switches that occurred within the verbal phrase (44 in the corpus) revealed that 45% involved the progressive form and about 1% involved the perfect form. Examples (1) through (3), drawn from different Spanish-English code-switching corpora, illustrate the two types of switches (code-switching juncture underlined; code-switch in italics):

(1) Mi marido está *working on his Master's* (Lipski, 1978, p. 252)

'My husband is working on his Master's'

(2) Siempre está *promising* things. (Poplack, 1980, p. 596)

'(He) is always promising things.'

(3) Yo creo que se había *washed out*. (Pfaff, 1979, p. 300)

'I think that she/he had washed out.'

The preponderance of switches involving progressive constructions over perfect constructions illustrates the differential behavior of these two switches in bilingual production. In the experiments presented here, we capitalize on these production asymmetries in code-switched discourse to examine whether the presence of a cognate verb modulates the processing of different types of intra-sentential code-switches. Our logic for including the two structures is to identify whether cognates exert a similar effect regardless of structure or whether cognate status and structure interact. Based on the differential status of the two types of switches in production, one prediction is that switches involving the auxiliary "HABER +English participle" would incur greater processing cost than switches involving ESTAR +English participle. Given the vast literature reporting cognate facilitation effects, one additional prediction is that any differential processing cost between the two types of code-switches would be modulated by the presence of cognates such that codeswitched sentences with cognate verbs would be expected to incur less processing cost than codeswitched sentences without cognate verbs. To anticipate the results, although switches involving the progressive structure were processed faster than switches involving the perfect structure, we did not find the predicted cognate facilitation effect.

The Present Study

Participants Two groups of Spanish-English bilinguals were recruited. One group (early exposure group, n=42) had acquired Spanish and English in early childhood and had been exposed to Spanish-English code-switching since childhood by virtue of being born, being raised, and living in an established Spanish-English bilingual community in Harlem, New York (NY; see Poplack, 1980; Zentella, 1997). The second group of participants (late exposure group,

n=27) was comprised of speakers from Hispanic countries who had immigrated to the United States (US) later in life (mean age of arrival = 18). The majority (n = 17) of participants in the late exposure group were living in the same code-switching community in Harlem. Additionally, we included ten participants in this group who were not part of this community, but whose linguistic profile and experience with code-switching was similar to the NY late exposure group (self-reported ratings and proficiency measures, all *p*s > 0.307). Although they had been living in the US for less time, the participants in the second group had been exposed to Spanish-English code-switching from the moment of arrival in the US. The purpose of including this group, then, was to determine if the results obtained with the early exposure group could be replicated with a group of participants who had been exposed to code-switching in the same community, but for less time.

Participants completed an online Language History Questionnaire (LHQ) designed to determine their relative proficiency in English and Spanish by self-report (10-point scale; 1 corresponded to "very low" and 10 corresponded to "perfect"). They also answered open-ended and multiple-choice questions about their history with both languages, their language acquisition experiences, and their daily exposure to and use of both languages (e.g., Did you begin to speak both English and Spanish before age 5?; In general, which language do you prefer to use?; Code-switching means using both Spanish and English in the same sentence when you are talking to someone else. Do you ever code-switch?; Why do you think you code-switch?).

Results of the language history questionnaire revealed that the participants were proficient in English and Spanish and used both languages regularly in the oral and written modes. Participants also reported code-switching frequently with other bilinguals, both in the spoken and the written modalities (e.g., emails, instant messages, text messages, chats). More

specific participant characteristics are displayed in Table 1. Participants were paid $10 per hour for their participation in the study.

Table 1. Participant characteristics

Characteristics	Early exposure participants (n = 42)	Late exposure participants (n = 27)
Age	21 (18-33)	22 (18-32)
Self-ratings for English proficiency (/10)	9.0 (5.75-10)	8.5 (5.75-10)
Self-ratings for Spanish proficiency (/10)	8.3 (5.75-10)	9.4 (7.5-10)

* Means are displayed with ranges in parentheses.

Table 1 shows that both groups are very similar in terms of mean age. Within-group comparisons were conducted to explore differences between the participants' proficiency levels in both languages. Paired-samples *t* tests for the early exposure participants revealed higher self-ratings for English (self-ratings: $t(41) = 3.62$, $p < .001$). Conversely, results for the late exposure bilinguals displayed higher self-ratings for Spanish (self-ratings: $t(26) = 5.43$, $p < .001$). The results of an independent-samples *t* test showed a significant difference between both groups (self-ratings for English proficiency: $t(67) = 2.33$, $p = .023$; self-ratings for Spanish proficiency: $t(67) = -4.53$, $p < .001$), indicating that the early exposure group was English-dominant while the late exposure group was Spanish-dominant—a finding that is expected given that the early group had been immersed in an English-speaking environment since birth, whereas the late group had lived in a Spanish-speaking environment and had received schooling in Spanish before coming to the US. In all, however, the high scores provided by both groups suggest that participants were

proficient in both languages and display differences that are expected given their language histories and language dominance.

Materials and Design The experimental stimuli comprised 48 item sets (see the Appendix) for a total of 192 experimental sentences. Each item set consisted of four different versions of the same sentence corresponding to four experimental conditions. Conditions 1 and 2 were code-switched conditions with the progressive structure. In Condition 1, the switch occurred at a phrasal boundary (that is, at the auxiliary) and in Condition 2, it occurred at the participle. Conditions 3 and 4 were analogous to Conditions 1 and 2, but involved the perfect structure instead. Additionally, we manipulated cognate status such that in half of the cases (i.e., 24 item sets), the participle comprised a Spanish-English cognate (…*los diseñadores* are/*están* ORGANIZING / have/*han* ORGANIZED…) and in the remaining half, the participle was a non-cognate (…*los turistas* are/*están* ENJOYING / have/*han* ENJOYED…). In each experimental sentence, the critical region under examination was part of an embedded phrase to ensure its appearance in the middle of the sentence and, thus, in the middle of the computer screen. Table 2 displays a sample item set (the critical region is underlined; cognates and non-cognates are capitalized).

Table 2. Example of experimental item set

Condition	Participle status	Sample sentence
(1a) ESTAR -Switch at auxiliary	cognate participle	*La estilista confirmó que los diseñadores* are ORGANIZING their collections for the fashion show.
(1b) ESTAR -Switch at auxiliary	non-cognate participle	*El chef piensa que los turistas* are ENJOYING the food at his gourmet restaurant.
(2a) ESTAR -Switch at participle	cognate participle	*La estilista confirmó que los diseñadores* están ORGANIZING their collections for the fashion show.
(2b) ESTAR -Switch at participle	non-cognate participle	*El chef piensa que los turistas* están ENJOYING the food at his gourmet

		restaurant.
(3a) HABER -Switch at auxiliary	cognate participle	*La estilista confirmó que los diseñadores* have ORGANIZED their collections for the fashion show.
(3b) HABER -Switch at auxiliary	non-cognate participle	*El chef piensa que los turistas* have ENJOYED the food at his gourmet restaurant.
(4a) HABER -Switch at participle	cognate participle	*La estilista confirmó que los diseñadores* han ORGANIZED their collections for the fashion show.
(4b) HABER -Switch at participle	non-cognate participle	*El chef piensa que los turistas* han ENJOYED the food at his gourmet restaurant.

In addition to the experimental items, 32 filler sentences were added. The fillers were similar to the experimental items in terms of overall length, but differed from them regarding the syntactic structures and the code-switch types included. Three examples of the fillers are provided below.

(4) Switch between the verb and the direct object

Laura estaba limpiando the kitchen before going out with her friends.

'Laura was cleaning…'

(5) Switch between the definite article and the noun

Tomás y su esposa ya habían visto el movie that their friends had recommended.

'Thomas and his wife had already seen the…'

(6) Switch between clauses

Como la maestra ha sospechado, the students have not studied for the exam.

'As the teacher has suspected…'

Five practice items were included at the beginning of the experiment to familiarize participants with the requirements of the task and the type of stimuli.

The experimental sentences were tightly controlled in several ways to ensure that

extraneous factors were not responsible for the predicted pattern of results. First, the experimental stimuli were controlled for word length (mean word length 13 [range 11-14]). In addition, the verb of the main clause was always a sentential complement-biased verb or an equi-biased verb, but never a direct object biased verb; this was done to facilitate processing of the following embedded clause. Also, the grammatical subjects of the verbs in the embedded clause (mean character length 10 [range 5-14]; mean lexical frequency 27.64 [range 1-162][2]) were always a cognate noun in Spanish and English (e.g., *diseñadores* and *turistas* in the examples in Table 2) in order to maximize cross-linguistic lexical activation. The cognate and non-cognate participles in the critical region (mean character length of the present participles 9 [range 6-11]; mean lexical frequency of the present participles 16.03 [range 1-76]; mean character length of the past participles 8 [range 5-10]; mean lexical frequency of the past participles 51.68 [range 3-401][3]) were from regular-ending verbs in order to keep the spelling of the participles as uniform as possible. In addition, there were no significant differences in lexical frequency between the cognate and non-cognate verbs in the progressive forms ($t = 0.40$), and the cognate and non-cognate verbs in the perfect form ($t = 0.82$).

All the sentences were followed by a comprehension question (e.g., for the items with cognate participles in Table 2, it was 'Is there going to be a fashion show?'; for those with non-cognate participles, it was 'Do the tourists seem unsatisfied?'). This was done to guarantee that participants were performing the reading task as expected. Because the sentences always began in Spanish and ended in English, the comprehension questions were presented in English to

[2] Lexical frequencies for the Spanish grammatical subjects of the embedded clauses are from the Alameda and Cuetos (1995) two-million-word corpus, available through Normas e índices de interés en Psicología Experimental (NIPE) website (Díez, Fernández, & Alonso, 2006).
[3] Lexical frequencies for the participles of the embedded clauses are from the Hal frequency norms (Lund & Burgess, 1996) and they were obtained through The English Lexicon Project website (Balota et al., 2007).

avoid introducing an inter-sentential code-switch while participants were processing the question. Half of the questions required a "yes" answer and the other half required a "no" answer. Questions were distributed evenly such that half required a response that referenced the beginning of the sentence and the other half required a response that related to the end of the sentence. Four item lists were created, each containing the experimental items (eight in each condition; four with cognate participles and four with non-cognate participles), 32 fillers, and the five practice sentences. Each list contained exactly one version of each experimental sentence (i.e., one version of a sentence within an item set). Within each file, eight item blocks were created, each containing eight sentences (four experimental items and four fillers). The blocks as well as the experimental items included in each block were presented in random order to each participant with the constraint that no two sentences representing the same condition were presented immediately following one another. This resulted in the items being presented in a different order to each subject, yet the items belonging to each stimulus type were evenly distributed throughout the duration of the experiment.

Results

Error analysis We conducted four 2x2 repeated-measures ANOVAs in which we test the difference across conditions in comprehension question errors. Mirroring the analysis design used for the eye-tracking measures, we included Switch Position (at auxiliary, at participle) and Cognate Status (cognate, non-cognate) as two within-subjects factors. Additionally, we conducted separate analyses between code-switches involving the progressive and perfect structures and tested the bilingual groups separately.

Early Exposure Group The error analysis for code-switched sentences involving the progressive structure did not reveal any significant main effects or interaction (Switch Position: $F(1,40) = 1$, $p = 0.32$, $\eta^2 = 0.004$; Cognate Status: $F(1,40) = 0.69$, $p = 0.41$, $\eta^2 = 0.004$; Switch Position x Cognate Status: $F(1,40) = 0.23$, $p = 0.63$, $\eta^2 = 0.002$). In contrast, a significant interaction between Switch Position and Cognate Status was found in code-switched sentences involving the perfect structure ($F(1,40) = 6.86$, $p = 0.01$, $\eta^2 = 0.039$) with no other main effects (Switch Position: $F(1,40) = 0.29$, $p = 0.59$, $\eta^2 = 0.002$; Cognate Status: $F(1,40) < 0.001$, $p = 1$, $\eta^2 < 0.001$). Post-hoc paired *t* tests did not reveal any further significant effects when corrected for multiple comparison (all corrected *p*s > 0.16). Numerically, however, the early exposure bilinguals produced more errors on the cognate trials when the code-switch occurred at the participle (mean=0.41, SD= 0.59) compared to the auxiliary (mean= 0.24, SD = 0.49).

Late exposure Group The late exposure group did not reveal any main effects or interactions for the progressive (Switch Position: $F(1,26) = 0.83$, $p = 0.37$, $\eta^2 = 0.01$; Cognate Status: $F(1,26) = 0.33$, $p = 0.57$, $\eta^2 = 0.002$; Switch Position x Cognate Status: $F(1,26) = 0.2$, $p = 0.66$, $\eta^2 = 0.002$) nor the perfect structures (Switch Position: $F(1,26) = 1.06$, $p = 0.31$, $\eta^2 = 0.011$; Cognate Status: $F(1,26) = 1.95$, $p = 0.17$, $\eta^2 = 0.019$; Switch Position x Cognate Status: $F(1,26) = 0.1$, $p = 0.752$, $\eta^2 = 0.001$).

Eye-tracking results We report on the results of two eye-tracking reading measures for three regions of interest. In (7)-(10) below, "/" marks indicate where the sentences were segmented for analysis:

(7) *La estilista confirmó que*	*los diseñadores*	are,están /	ORGANIZING/	their/	collections/
			Region 1	Region 2	Region 3

(8) *La estilista confirmó que*	*los diseñadores*	have,han n	ORGANIZED/	their/	collections/ …
			Region 1	Region 2	Region 3
(9) *El chef piensa que*	*los turistas*	are, están	ENJOYING/	the/	food/…
			Region 1	Region 2	Region 3
(10) *El chef piensa que*	*los turistas*	have, han	ENJOYED/	the/	food/…
			Region 1	Region 2	Region 3

Region 1, the (cognate or non-cognate) participle, was selected as the critical region because it is the point in the sentence at which the participants have processed the complete auxiliary phrase. It is also the point at which all code-switches, both the code-switches at the auxiliary and the code-switches at the participle, have occurred. We also analyzed the two words after the critical region (Region 2 and Region 3, respectively). Because processing is not always completed by the time the eyes move, time processing a word (or region) can spill over to the next word (Rayner & Duffy, 1986). Therefore, analyses on Regions 2 and 3 were carried out to determine whether effects not observed on the critical region surfaced at a later point in the sentence or if results detected on the critical region were transient or continued to affect post-critical regions.

We extracted two eye-tracking measures for analysis: first-pass reading time and total time. First-pass reading time is defined as the sum of all the fixations within an interest area starting with the first fixation into that interest area until the first time the participant's gaze leaves the region either to the left or to the right (Rayner, 1998). On single-word regions, first-pass reading time is equivalent to the commonly reported *gaze duration* (Liversegde, Paterson, & Pickering, 1998; Traxler, Morris, & Seely, 2002). Total time represents the sum of all fixation durations in the critical region, including all regressive fixation durations on it (Rayner & Duffy, 1986).

We analyzed the two reading time measures using linear mixed-effects models as implemented by the lme4 package version 1.1-7 (Bates, Maechler, Boker, & Walker, 2014) in the R Environment for Statistical Computing program, version 3.1.2 (R Core Team, 2014). Because the participle form differs between progressive (e.g., *organizing*, *enjoying*) and perfect (e.g., *organized*, *enjoyed*) structures, we conducted separate analyses between these two structures. Fixations shorter than 80 ms were combined with a previous or subsequent fixation if they were within one character of each other. Additionally, trials for which participants incorrectly answered the comprehension question were excluded from analysis, removing 9.6% of all experimental trials. A repeated measures ANOVA with auxiliary (progressive, perfect) as a within-subjects factor and group (early exposure, late exposure) as a between-subjects factor indicated that incorrect responses to the comprehension questions were evenly distributed across auxiliary and group (Auxiliary, $F(1,66) = 2.67$, $p = 0.11$; Group, $F(1,66) = 1.12$, $p = 0.29$; Auxiliary x Group, $F(1,66) = 0.18$, $p = 0.67$).

We included Switch Position (at auxiliary, at participle), Cognate Status (cognate, non-cognate), Group status (early exposure, late exposure) and their interaction terms as fixed effects in the linear mixed-effects models. All factors were coded with contrast coding (-.5 for switches at the auxiliary, cognates, and the early exposure group). For the random effects structure, we first began by including random slopes for Switch Position and Cognate Status, and random intercepts on Subjects and random slopes for Switch Position and random intercepts on Items following a maximal random effects structure justified by the design[4] (Barr, Levy, Scheepers, & Tily, 2013). If models did not converge, then the random effects structure subsequently included

[4] We began by including the interaction between Switch Position and Cognate Status on random slopes, but these models never converged; thus, our base models included random slopes for Switch Position and Cognate Status separately.

the removal of the interaction between Switch Position and Cognate Status for Subjects slopes. Finally, if this model did not converge, then a subsequent model that only included random intercepts for Items and the interaction between Switch Position and Cognate Status on random slopes for Subjects was used. We indicate in the table summaries when models did not include the full random effects structure and report regression coefficients (*b*) and the *t*-values for each coefficient. We report regression coefficients as significant at the .05 level for *t*-statistic values greater than or equal to 1.96 (e.g., Schotter, Bicknell, Howard, Levy, & Rayner, 2014).

Code-switches involving the progressive structure In the progressive conditions, we compare first-pass reading time and total time across two bilingual code-switching groups on the three regions of analysis. The results of the linear mixed effects models for each of the two reading time measures are included in Tables 3-6.

Table 3. Results of the linear mixed-effects model on the critical Participle region in progressive structures

Measure	Variable	*b*	SE	*t*
Gaze Duration	Intercept	359.93	28.47	**12.64**
	Switch Position	56.26	30.1	1.87
	Cognate Status	-22.97	28.87	-0.8
	Group	17.98	41.33	0.44
	Switch Position * Cognate Status	-32.65	35.23	-0.93
	Switch Position * Group	-1.85	48.16	-0.04
	Cognate Status * Group	9.57	39.81	0.24
	Switch Position * Cognate Status *	12.99	56.45	0.23

	Group			
Total Time	Intercept	708.86	63.33	**11.19**
	Switch Position	114.36	55.94	**2.05**
	Cognate Status	-56.67	68.71	-0.83
	Group	-0.83	84.79	-0.01
	Switch Position * Cognate Status	-78.52	76.78	-1.02
	Switch Position * Group	-29.72	87.6	-0.34
	Cognate Status * Group	18.47	85.86	0.22
	Switch Position * Cognate Status * Group	32.22	120.12	0.27

* Results for the linear mixed effects models on first-pass reading time and total time for conditions involving the progressive structure. All predictor variables were contrast coded (-0.5 = switch at auxiliary; cognate; early exposure group). Significant *t*-values are bolded.

Table 4. Results of the linear mixed-effects model on the first word post critical region in progressive structures

Measure	Variable	*b*	SE	*t*
[a]Gaze Duration	Intercept	121.88	20.75	**5.88**
	Switch Position	17.72	21.31	0.83
	Cognate Status	16.48	26.22	0.63

	Group	-5.32	24.54	-0.22
	Switch Position * Cognate Status	-26.87	27.5	-0.98
	Switch Position * Group	7.54	34.13	0.22
	Cognate Status * Group	-26.38	27.89	-0.95
	Switch Position * Cognate Status * Group	-8.08	44.07	-0.18
Total Time	Intercept	247.73	33.76	**7.34**
	Switch Position	27.29	27.88	0.98
	Cognate Status	-14.7	39.8	-0.37
	Group	-20.37	42.68	-0.48
	Switch Position * Cognate Status	-30.7	40.83	-0.75
	Switch Position * Group	24.29	44.75	0.54
	Cognate Status * Group	-9.08	43.74	-0.21
	Switch Position * Cognate Status * Group	10.1	65.44	0.15

* Results for the linear mixed effects models on first-pass reading time and total time for conditions involving the progressive structure. All predictor variables were contrast coded (-0.5 = switch at auxiliary; cognate; early exposure group). Significant *t*-values are bolded. An [a] notation indicates a model with only random intercepts on Items.

Table 5. Results of the linear mixed-effects model on the second word post critical region in progressive structures

Measure	Variable	*b*	SE	*t*
[b]Gaze Duration	Intercept	298.02	28.43	**10.48**
	Switch Position	13.7	24.54	0.56
	Cognate Status	-38.42	32.51	-1.18
	Group	972	29.16	0.33
	Switch Position * Cognate Status	-0.27	34.31	-0.01
	Switch Position * Group	2.93	36.88	0.08
	Cognate Status * Group	73.78	37.5	**1.97**
	Switch Position * Cognate Status * Group	9.85	51.82	0.19
Total Time	Intercept	549.09	61.36	**8.95**
	Switch Position	10.28	42.55	0.24
	Cognate Status	-86.47	69.07	-1.25
	Group	-31.97	57.1	-0.56
	Switch Position * Cognate Status	1.41	58.25	0.02
	Switch Position * Group	21.74	66.38	0.33
	Cognate Status * Group	116.27	67.39	1.73
	Switch Position * Cognate Status * Group	11.32	90.93	0.12

* Results for the linear mixed effects models on first-pass reading time and total time for conditions involving the progressive structure. All predictor variables were contrast coded (-0.5 = switch at auxiliary; cognate; early exposure group). Significant *t*-values are bolded. A [b] notation indicates a model that had the interaction between random slopes and intercepts removed for model convergence.

Region 1 (The participle) No significant main effects or interactions were found for first-pass reading time (Switch Position, $b = 56.26$, $t = 1.87$; Cognate Status, $b = -22.97$, $t = -0.8$; Group, $b = 17.98$, $t = 0.44$ Switch Position x Cognate Status, $b = -32.65$, $t = -0.93$; Switch Position x Group, $b = -1.85$, $t = -0.04$; Cognate Status x Group, $b = 9.57$, $t = 0.24$; Switch Position x Cognate Status x Group, $b = 12.99$, $t = 0.23$). The analysis on total time only revealed a main effect for switch position (Switch Position, $b = 114.36$, $t = 2.05$) and no other main effects or interactions (Cognate Status, $b = -56.67$, $t = -0.83$; Group, $b = -0.83$, $t = -0.01$; Switch Position x Cognate Status, $b = -78.52$, $t = -1.02$; Switch Position x Group, $b = -29.71$, $t = -0.34$; Cognate Status x Group, $b = 18.47$, $t = -.22$; Switch Position x Cognate Status x Group, $b = 32.22$, $t = 0.27$). Regardless of the cognate status of the participle, the two Spanish-English bilingual groups were able to rapidly integrate code-switches, although switch position became significant in the late reading measure (i.e., total reading time) such that bilinguals read the participle slower when the switch occurred at the participle.

Region 2 (First word post participle) As with the critical participle region, there were no significant main effects or interactions for either first-pass reading (Switch Position, $b = 17.72$, $t = 0.83$; Cognate Status, $b = 16.48$, $t = 0.63$; Group, $b = -5.32$, $t = -0.22$; Switch Position x Cognate Status, $b = -26.87$, $t = -0.98$; Switch Position x Group, $b = 7.54$, $t = 0.22$; Switch

Position x Cognate Status x Group, b = -8.08, t = -0.18) or total time (Switch Position, b = 27.29, t = 0.98; Cognate Status, b = -14.69, t = -0.37; Group, b = -20.37, t = -0.75; Switch Position x Cognate Status, b = -30.7, t = -0.75; Switch Position x Group, b = 24.29, t = 0.54; Switch Position x Cognate Status x Group, b = 10.1, t = 0.15). In the region immediately following the swtich, bilinguals continue to show rapid integration of code-switches regardless of cognate status of the participle and switch position. As in the critical region, no group differences based on exposure to code-switching were detected.

Region 3 (Second word post participle) In the second word after the critical region, the mixed-effects analysis on first-pass reading times only revealed a significant interaction by cognate and group (Cognate Status x Group, b = 73.78, b = 1.97) and no other main effects or interactions (Switch Position, b = 13.7, t = 0.56; Cognate Status, b = -38.42, t = -1.18; Group, b = 9.72, t = 0.33; Switch Position x Cognate Status, b = -0.27, t = -0.01; Switch Position x Group, b = 2.93, t = 0.08; Switch Position x Cognate Status x Group, b = 9.85, t = 0.19). We used the multcomp package version 1.4-1 (Hothorn, Bretz, & Westfall, 2008) in R to further explore the interaction. Pairwise tests for multiple comparisons with Tukey's contrasts only indicated that the late exposure code-switching group read trials containing non-cognate verbs slower than the early exposure group in this spillover region (z = 3.67, p = 0.001). For the analysis on total time, no main effects or interactions were revealed (Switch Position, b = 10.28, t = 0.24; Cognate Status, b = -86.47, t = -1.25; Group, b = -31.97, t = -0.56; Switch Position x Cognate Status, b = 1.41, t = 0.02; Switch Position x Group, b = 21.74, t = 0.33; Cognate Status x Group, b = 116.27, t = 1.73; Switch Position x Cognate Status x Group, b = 11.32, t = 0.12). Apart from the finding that the bilingual groups differed in first-pass time in how they read non-cognate trials, the analyses

overall do not reveal any influence of cognate status or switch position on code-switches that involve the progressive structure for the bilingual groups.

To summarize, for code-switches that involve the progressive auxiliary either at the auxiliary (...*los diseñadores* are ORGANIZING…, …*los turistas* are ENJOYING...) or at the participle (...*los diseñadores están* ORGANIZING…, …*los turistas están* ENJOYING...) and irrespective of cognate status, both early-exposure and late-exposure bilinguals process these code-switches similarly and in line with the distributional properties of code-switches with the progressive auxiliary in production in our early reading measure. For our late reading measure, bilinguals exhibited slower total reading times for code-switches that occurred at the participle in the critical participle region. However, this effect is short-lived as it does not extend into either spillover region. We now turn to code-switches that include the perfect auxiliary.

Code-switches involving the perfect structure We adopted the same analysis strategy for the perfect conditions, examining reading times from first-pass reading time (or gaze duration for single-word regions) and total time for three regions of interest in code-switched conditions in which the participle is either a cognate or a non-cognate. Unlike the progressive structure, corpus results indicate that code-switches involving the perfect structure are dispreferred after the perfect auxiliary HABER. The results of the linear mixed effects models are presented in Tables 6-8.

Table 6. Results of the linear mixed-effects model on the critical region (Participle region) in perfect structures

Measure	Variable	*b*	SE	*t*
Gaze Duration	Intercept	328.15	25.3	**12.97**
	Switch Position	170.53	35.03	**4.87**

	Cognate Status	-37.79	29.41	-1.29
	Group	50.03	37.96	1.32
	Switch Position * Cognate Status	-86.3	40.71	**-2.12**
	Switch Position * Group	-42.71	53.78	-0.79
	Cognate Status * Group	-15.32	44.4	-0.35
	Switch Position * Cognate Status * Group	11.35	61.86	0.18
Total Time	Intercept	718.09	62.89	**11.42**
	Switch Position	341.31	64.67	**5.28**
	Cognate Status	-154.35	75.76	**-2.04**
	Group	11.62	83.24	0.14
	Switch Position * Cognate Status	-50.91	79.19	-0.64
	Switch Position * Group	-88.75	102.64	-0.87
	Cognate Status * Group	56.96	92.75	0.61
	Switch Position * Cognate Status * Group	102.41	126.47	0.8

* Results for the linear mixed effects models on first-pass reading time and total time for conditions involving the perfect structure. All predictor variables were contrast coded (-0.5 = switch at auxiliary; cognate; early exposure group). Significant *t*-values are bolded. A (*) indicates model with interaction removed from random slopes for Subjects.

Table 7. Results of the linear mixed-effects model on the first word post critical region in perfect structures

Measure	Variable	*b*	SE	*t*
Gaze Duration	Intercept	127.46	18.78	**6.82**
	Switch Position	52.22	21.88	**2.39**
	Cognate Status	-6.95	23.15	-0.3
	Group	-32.47	24.94	-1.3
	Switch Position * Cognate Status	-29.81	28.51	-1.05
	Switch Position * Group	7	34.47	0.2
	Cognate Status * Group	27.53	29.19	0.94
	Switch Position * Cognate Status * Group	19.26	45.11	0.43
Total Time	Intercept	260.47	47.06	**5.54**
	Switch Position	83.85	35.15	**2.39**
	Cognate Status	-21.26	49.05	-0.43
	Group	13.83	53.63	0.26
	Switch Position * Cognate Status	0.3	49.61	0.01
	Switch Position * Group	16.8	53.92	0.31
	Cognate Status * Group	-1.26	54.13	-0.02
	Switch Position * Cognate Status * Group	-25.63	76.6	-0.34

* Results for the linear mixed effects models on first-pass reading time and total time for conditions involving the perfect structure. All predictor variables were contrast coded (-0.5 = switch at auxiliary; cognate; early exposure group). Significant *t*-values are bolded.

Table 8. Results of the linear mixed-effects model on the second word post critical region in perfect structures

Measure	Variable	*b*	SE	*t*
Gaze Duration	Intercept	275.22	27.35	**10.06**
	Switch Position	28.79	22.26	1.29
	Cognate Status	2.49	31.03	0.08
	Group	54.17	29.16	1.86
	Switch Position * Cognate Status	-15.45	31.44	-0.49
	Switch Position * Group	-29.42	34.29	-0.86
	Cognate Status * Group	-20.38	34.4	-0.59
	Switch Position * Cognate Status * Group	31.48	48.71	0.65
Total Time	Intercept	517.53	54.9	**9.43**
	Switch Position	51.75	43.36	1.19
	Cognate Status	23.8	67.72	0.35
	Group	93.91	63.84	1.47
	Switch Position * Cognate Status	-41.67	60.03	-0.69
	Switch Position * Group	-58.54	68.33	-0.86

Cognate Status * Group	-128.29	68.6	-1.87
Switch Position * Cognate Status * Group	128.46	95.1	1.35

* Results for the linear mixed effects models on first-pass reading time and total time for conditions involving the perfect structure. All predictor variables were contrast coded (-0.5 = switch at auxiliary; cognate; early exposure group). Significant *t*-values are bolded.

Region 1 (The participle) For first-pass reading time, the mixed-effects model reveals a main effect for Switch Position (b = 170.53, t = 4.87) such that, when code-switches occurred at the participle, reading times on the participle were longer than when code-switches occurred at the auxiliary. In addition, the interaction between Switch Position and Cognate Status was also significant (b = -86.3, t = -2.12). Pairwise tests corrected for multiple comparisons with Tukey's contrasts indicated several significant effects. Non-cognate participles (e.g., *enjoyed*) were read slower when code-switches occurred on the participle than on the auxiliary (376.69 ms v. 303.57 ms, respectively; z = 2.58, p = 0.048). Cognate participles (e.g., *organized*) revealed a similar effect; however, the magnitude of difference was larger (at participle, 419.31ms v. at auxiliary, 369.31 ms; z = 5.52, $p < 0.001$). All other main effects and interactions were not significant (Cognate Status, b = -37.79, t = -1.29; Group, b = 50.03, t = 1.32; Switch Position x Group, b = -42.71, t = -0.79; Cognate Status x Group, b = -15.32, t = -0.35; Switch Position x Cognate Status x Group, b = 11.35, t = 0.18). For total time, we detected a main effect for Switch Position (b = 341.31, t = 5.28), continuing to show that trials in which code-switches occurred at the participle are read more slowly than those in which the code-switch occured at the auxiliary. Additionally, we now see a main effect for Cognate Status (b = -154.35, t = -2.04), revealing that cognate

status impacts total time such that participles that are also cognates are read more slowly than non-cognates. The main effect for group and all interactions are non-significant (Group, b = 11.62, t = 0.14; Switch Position x Cognate status, b = -50.91, t = -0.64; Switch Position x Group, b = -88.75, t = -0.87; Cognate Status x Group, b = 59.96, t = 0.61; Switch Position x Cognate Status x Group, b = 102.41, t = 0.81). Thus, in line with the production asymmetry found in code-switched corpora, the early exposure group showed increased difficulty in integrating code-switches when they occurred at the participle. This effect was modulated by cognate status at earlier and later stages of processing. Because of the lack of group effects for either reading measure on the critical region for progressive and perfect trials, we present mean reading times collapsed for group in Table 9.

Table 9. Mean reading times and standard error on the participle

Measure	Switch Position	Cognate	Non-cognate
Progressive structure, e.g., …*los diseñadores* are/*están* ORGANIZING / …*los turistas* are/*están* ENJOYING…			
Gaze Duration	At Auxiliary	369.31 (16.24)	344.1 (15.16)
	At Participle	419.31 (15.7)	371.91 (16.69)
Total Time	At Auxiliary	713.63 (36.94)	645.76 (30.97)
	At Participle	800.52 (34.13)	684.37 (32.35)
Perfect structure, e.g., …*los diseñadores* have/*han* ORGANIZED / …*los turistas* have/*han* ENJOYED…			
Gaze Duration	At Auxiliary	351.51 (14.35)	303.57 (13.16)
	At Participle	504.07 (23.72)	374.69 (17.84)

Total Time	At Auxiliary	725.1 (32.97)	577.24 (26.68)
	At Participle	1022.54 (43.45)	875.73 (40.84)

* Mean reading times in milliseconds for first-pass reading time and total time on the participle split by cognate status and switch position. Standard error is presented in parentheses. Progressive conditions appear in the upper panel and Perfect conditions are presented in the lower panel.

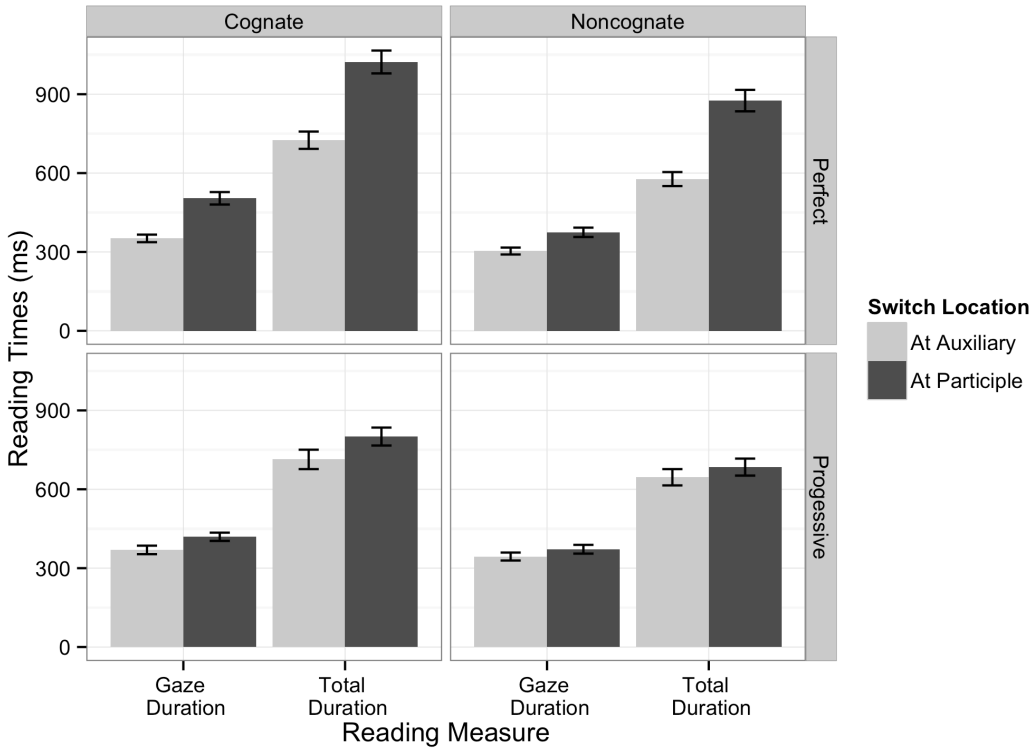
Region 2 (First word post participle) For the word immediately following the participle, we only find a main effect for Switch Position for both reading measures (first-pass reading time: b = 52.22, t = 2.39; total time: b = 83.85, t = 2.39), thus underscoring the difficulty in integrating code-switches involving the perfect structure that occur at the participle when compared to code-switches at the auxiliary. No other main effects or interactions are significant for either reading measure (first-pass reading time: Cognate Status, b = -6.94, t = -0.3; Group, b = -32.47, t = -1.3; Switch Position x Cognate Status, b = -29.81, t = -1.05; Switch Position x Group, b = 7, t = 0.2; Cognate Status x Group, b = 27.53, t = 0.94; Switch Position x Cognate Status x Group, b = 19.26, t = 0.43; total time: Cognate Status, b = -21.26, t = -0.43; Group, b = 13.83, t = 0.26; Switch Position x Cognate Status, b = 0.3, t = 0.01; Switch Position x Group, b = 16.8, t = 0.31; Cognate Status x Group, b = -1.26, t = -0.02; Switch Position x Cognate Status x Group, b = -25.63, t = -0.34). The failure to detect an effect of cognate status in the region immediately following the code-switch suggests that this effect is transient compared to the switch position effect. Moreover, the persistent switch effect leading to greater integration costs to code-switches

at the participle is in contrast with the temporary effect detected only on the critical for total time with the progressive structure.

Region 3 (Second word post participle) By the second word after the participle, no main effects or interactions are detected for either reading measure (first-pass reading time: Switch Position, $b = 28.79$, $t = 1.29$; Cognate Status, $b = 2.49$, $t = 0.08$; Group, $b = 54.17$, $t = 1.85$; Switch Position x Cognate Status, $b = -15.45$, $t = -0.49$; Switch Position x Group, $b = -29.42$, $t = -0.86$; Cognate Status x Group, $b = -20.38$, $t = -0.59$; Switch Position x Cognate Status x Group, $b = 31.48$, $t = 0.65$; total time: Switch Position, $b = 51.75$, $t = 1.19$; Cognate Status, $b = 23.8$, $t = 0.35$; Group, $b = 93.91$, $t = 1.47$; Switch Position x Cognate Status, $b = -41.67$, $t = -0.69$; Switch Position x Group, $b = -58.54$, $t = -0.86$; Cognate Status x Group, $b = -128.29$, $t = -1.87$; Switch Position x Cognate Status x Group, $b = 128.46$, $t = 1.35$).

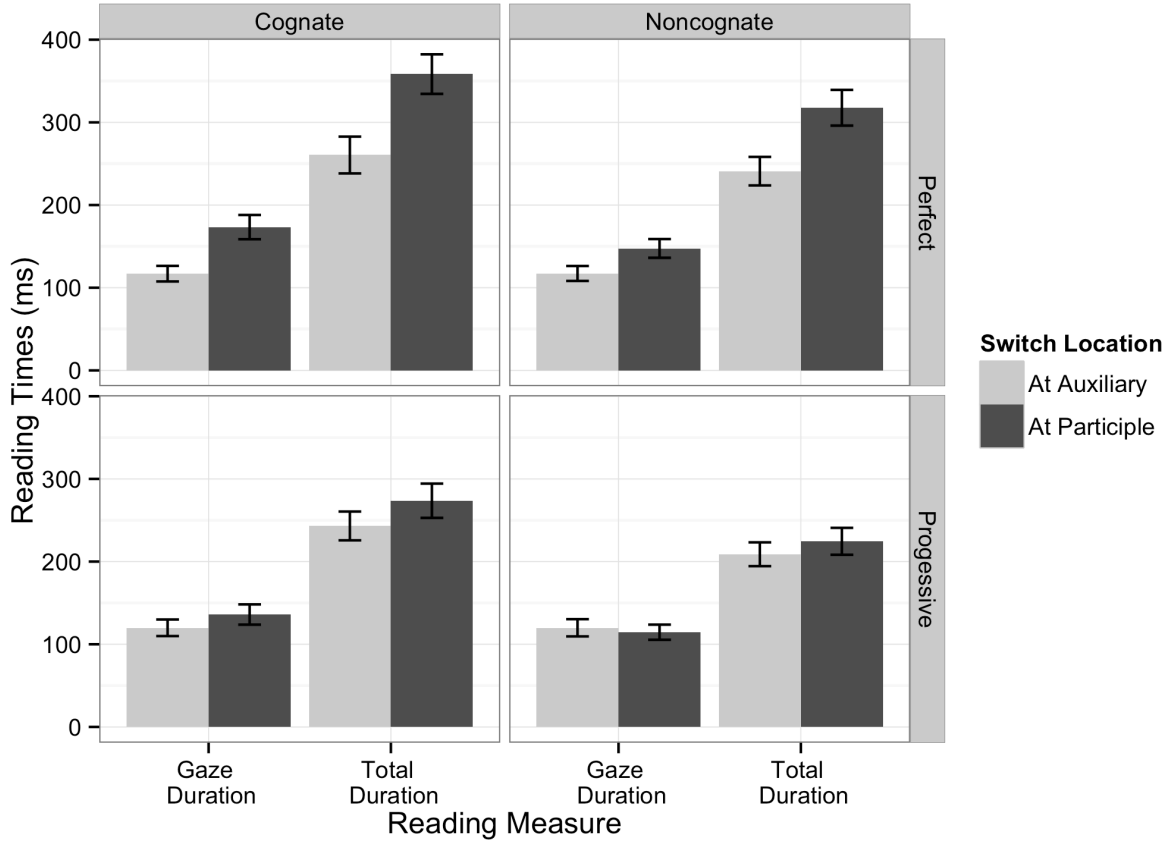
To summarize, bilinguals demonstrated an asymmetry in how they process code-switched sentences with the perfect structure vis-à-vis code-switched sentences with the progressive structure, and how cognate status impacted the rapid integration of code-switched sentences. Specifically, in both early and late reading measures, Spanish-English bilinguals were slower while reading a code-switch at the participle (*...los diseñadores han* ORGANIZED*..., ...los turistas han* ENJOYED*...)* than when the code-switch occurred at the auxiliary (*...los diseñadores* have ORGANIZED…, …*los turistas* have ENJOYED...) in the perfect structures. This processing difficulty extended to the word immediately following the participle, and it dissipated by the second word after the participle. In addition, bilinguals showed modulation to their reading times based on cognate status, with cognate participles showing increased differences with respect to the switch position manipulation with the earlier reading time measure and a simple main effect for cognate status with the later reading measure in the critical participle region. In the

immediately following spillover region, the switch position effect continued to exhibit greater processing costs for code-switches that occur at the participle, but cognate status no longer results in differential integration. In contrast, for trials with the progressive structure, bilinguals only showed a temporary switch position effect at later stages of processing on the critical region. Cognate status did not affect the switch position manipulation. These asymmetric differences reflect the distributional asymmetries reported in Spanish-English bilingual corpora. Mean reading times split by switch location and cognate status are plotted for the critical region and immediately following word in Figures 1 and 2.



* Mean reading times in milliseconds are presented for gaze duration (first-pass reading time) and total time on the critical region split by code-switch position, cognate status, and auxiliary. The left panel depicts code-switches with cognate participles. The upper panel depicts trials including the perfect structure. Error bars represent standard error of the mean.

Figure 1. Mean reading times on the participle split by switch location and cognate status



* Mean reading times in milliseconds are presented for gaze duration (first-pass reading time) and total time on the immediately following spillover region split by code-switch position, cognate status, and auxiliary. The left panel depicts code-switches with cognate participles. The upper panel depicts trials including the perfect structure. Error bars represent standard error of the mean.

Figure 2. Mean reading times on the first spillover region split by switch location and cognate status

Discussion

Research with bilinguals has consistently found that word recognition proceeds differently for cognates compared to non-cognates. Extensive evidence shows a facilitatory effect for cognates relative to control words (e.g., Dijkstra et al., 2005; Lemhfer & Dijkstra, 2004; Mulder, Dijkstra,

Schreuder, & Baayen, 2014) and bilinguals, but not monolinguals, have shown differential processing patterns within a single-language for cognates compared to lexically matched control words, indicating that the lexical representations of both languages are activated even when bilinguals find themselves in unilingual contexts (Dijkstra, 2005; Van Hell & Dijkstra, 2002). The absence of such effects in monolingual speakers indicates that the differential processing is due to bilingualism and not to lexical variation.

However, it has been recently argued that different contexts of bilingual language use impose distinct demands on the cognitive system to negotiate language selection (e.g., Green & Abutalebi, 2013). The significance of the work presented here, then, is in understanding how language co-activation proceeds in contexts that arguably entail maintenance of the joint activation of both languages by virtue of the fact that bilinguals are engaged in the processing of code-switched utterances. To examine language co-activation, we employed cognates verbs. To investigate how co-activation proceeds in contexts that necessitate the parallel activation of both languages, we embedded the verbs in code-switched constructions in which the structures that participated in the switch were derived from real alternational patterns of language use in bilingual communities. One finding from the work reported here is that the comprehension costs displayed by the bilingual speakers in the eye-tracking study generally mirrored the production patterns reported in past code-switching literature; that is, switches at the participle were costly when bilinguals read switches that occurred infrequently in naturalistic speech (i.e., those involving the perfect structure) but not when reading switches that are commonly produced in bilingual communities (i.e., those involving the progressive structure). A second finding is that the two groups of bilinguals behaved similarly when reading ESTAR switches and HABER switches. Given the large literature reporting age effects in language acquisition and language

processing (e.g., Johnson & Newport, 1989; Webber-Fox & Neville, 1999; Clahsen & Felser, 2006), it would not have been surprising to find that the early and late bilinguals performed differently. Indeed, the fact the late bilinguals had an entrenched L1 system when they joined the code-switching community could have "tuned" the perceptual system in such a way that their learned attention patterns could have prevented them from noticing the production distributions of the two types of code-switches in their environment (for a discussion of this point in the language acquisition literature, see Beckner, Blythe, Holland, Bybe, Ke, Christiansen, Larsen-Freeman, Croft, & Schoenemann, 2009). However, our findings show instead that patterns of use in production strongly affected how the two types of code-switches were processed by the comprehension system, a finding that is congenial with usage-based accounts of learning and processing (e.g., Bybee, 2006; MacDonald, 2013). According to these accounts, language emerges through the interaction of cognition and use. Individuals who belong to a particular speech community are attuned to the linguistic variation produced by its speakers and adapt to the regularities of their speech. Comprehension difficulty is thought to be intimately linked to distributional regularities in production. One prediction from these models, which was confirmed by our findings, is that the differential probability of producing a code-switch at a participle when it is preceded by the auxiliary ESTAR and by the auxiliary HABER will be reflected when bilinguals comprehend these two types of code-switched structures. As was shown earlier, the bilingual speakers in this study processed switches at the auxiliary and at the participle involving the progressive structure similarly; however, when the perfect structure was involved, switches at the auxiliary incurred less processing disruptions relative to switches at the participle.

The third and most relevant finding for the purposes of the present study is that the presence of a cognate verb in the verbal bundle had no impact when bilinguals processed

frequently occurring verb-phrase code-switches (i.e., switches involving the auxiliary ESTAR). That a cognate facilitation effect was not present when bilinguals were processing the progressive switches may not be altogether surprising given that studies examining cognate verb processing in sentence contexts have reported cognate facilitation effects that are rather weak (e.g., Van Assche et al. 2013). Conversely, when they read code-switches involving the auxiliary HABER, a somewhat counter-intuitive and unexpected finding emerged: the presence of a cognate verb increased the processing cost already imposed by processing an infrequent code-switch. In what remains, we discuss the importance of examining language activation in alternational code-switching contexts, and also provide a possible explanation for the longer processing times for cognates in the HABER construction.

Accounting for the labored processing of cognate verbs If cognate processing typically shows facilitatory effects, one might have expected a cognate advantage for cognate verbs as well. In fact, in spite of the obvious differences between nouns and verbs (Gentner, 1981), recent studies have shown that the cognate facilitation effect can be obtained for verbs presented in isolation (e.g., Bultena, Dijkstra, & Van Hell, 2013), and also when verbs appear in low-constraint sentence contexts (Van Assche, Duyck, & Brysbaert, 2013). This provides evidence that the cognate facilitation effect is not tied to the particular formal and semantic properties of words. The findings reported here, however, are inconsistent with the previous literature: processing cognate verbs (in the context of the infrequent code-switches involving the present perfect form) resulted in a disadvantage for cognates relative to non-cognates. It is unlikely that this disadvantage arose due to lexical differences between the cognate and non-cognate verbs selected. The same verbs were used when the switch involved the present progressive, a syntactic context in which no differences between cognate and non-cognate verbs were observed. In

addition, as mentioned in the *Materials* section, there were no differences in lexical frequency between the cognate and the non-cognate verbs in either of the morphological forms.

If the lexical characteristics of our materials do not provide a feasible explanation, what can account for our results? We speculate that the code-switching context in which the cognates appeared functioned to constrain language selectivity in a manner similar to how cognate processing is affected by the semantic constraint of a sentence. Some past work has shown that semantic constraints may play a role in creating language-selective processing, and that the cognate facilitation effect typically reported in out-of-context word recognition is either reduced or eliminated in sentence context. When the sentence context is semantically constrained, making the lexical target predictable, the effects of the non-target language are eliminated (e.g., Schwartz & Kroll, 2006; Van Hell & De Groot, 2008). In other words, the cognate facilitation effect disappears when the sentence context is semantically constraining (e.g., Schwartz & Kroll, 2006; Van Hell & De Groot, 2008; but see Van Assche, Dreighe, Duyck, Welvaert, & Hartsuiker, 2011). In low-constraint sentence contexts, however, the cognate effects are as robust as in the out-of-context word recognition studies. Our proposal is that the syntactic site in which the code-switch occurs also functions to constrain language selectivity. When the code-switch involves a site in which code switching is syntactically restricted and thus unexpected (i.e., at the participle in perfect constructions), bilinguals exploit this information to selectively process the target language. Our data suggest that this is a viable hypothesis because switches involving non-cognate verbs in perfect constructions also produced higher fixation durations relative to switches at the auxiliary. In this sense, syntactic information acts just like the highly semantically constrained sentences in eliminating a cognate advantage. We speculate that the higher processing cost for cognate vs. non-cognate words may have stemmed from the fact that

the vast majority of the cognate verbs had identical onset in both English and Spanish (e.g., organizing [Spanish 'organizando']; practicing [Spanish 'practicando']; presenting [Spanish 'presentando']; negotiating [Spanish 'negociando']). The onset information could have acted to initially support participants' expectations that the participle was a Spanish word; under this scenario, encountering the English progressive morphology may have caused a "surprisal effect" that required readers to revise their commitment to the language membership of the verb (from Spanish to English), resulting in the higher total reading times for cognates v. non-cognates. To summarize our proposal, we suggest that the syntactic context was strong enough to weaken the cognate facilitation effect, and that interlingual orthographic overlap effectively led bilinguals down a "garden-path," resulting in labored processing for cognate verbs.

Concluding remarks

The present study is the first to investigate bilingual visual word recognition during the processing of alternational code-switches involving two syntactic constructions. When processing code-switches involving progressive constructions (ESTAR + ENGLISH PROGRESSIVE), early and late bilinguals did not show a cognate effect. When bilinguals processed switches involving the perfect construction (HABER + ENGLISH PARTICIPLE), a processing disadvantage emerged for cognates when the switch occurred at a dispreferred syntactic site (i.e., at the participle). We suggest that the processing disadvantage for cognates arises from the joined contribution of the syntactic context, which effectively acted to constrain language selectivity.

Our current knowledge of cognate effects during the processing of code-switched language derives almost entirely from studies that have examined insertional switches involving nouns. Where single-word code-switches involving cognate nouns may be unconstrained enough

to allow the deployment of sufficient processing resources to reveal the facilitatory effects reported in the literature, alternational code-switches require so much more control and complex integration of two grammatical systems (Poplack, 1980) that the effects observed in single-word switching may no longer emerge. This is, in fact, what our findings show. The processing of cognate verbs was not affected when they appeared in frequently occurring code-switched constructions, but were processed more slowly when embedded in infrequent alternational code-switches. Additional research examining the extent to which the syntactic site of a code-switch and the expectancy of a code-switch modulate cognate effects constitutes an important direction for future research, as it will allow uncovering aspects of bilingual lexical access in rich and more naturalistic contexts that will contribute to the refinement of bilingual processing models.

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Appendix: Experimental item sets

Sentences with cognate participles

El compositor dice que los pianistas are practicing the symphony for the concert.
El compositor dice que los pianistas están practicing the symphony for the concert.
El compositor dice que los pianistas have practiced the symphony for the concert.
El compositor dice que los pianistas han practiced the symphony for the concert.
'The composer says that the pianists…'

El consejero dijo que sus estudiantes are presenting their results at the conference.
El consejero dijo que sus estudiantes están presenting their results at the conference.
El consejero dijo que sus estudiantes have presented their results at the conference.
El consejero dijo que sus estudiantes han presented their results at the conference.
'The adviser said that his/her students…'

El contador cree que los banqueros are negotiating the loan for the clients.
El contador cree que los banqueros están negotiating the loan for the clients.
El contador cree que los banqueros have negotiated the loan for the clients.
El contador cree que los banqueros han negotiated the loan for the clients.
'The accountant believes that the bankers…'

El contador piensa que los banqueros are preparing the report for the supervisors.
El contador piensa que los banqueros están preparing the report for the supervisors.
El contador piensa que los banqueros have prepared the report for the supervisors.
El contador piensa que los banqueros han prepared the report for the supervisors.
'The accountant thinks that the bankers…'

El director afirmó que los técnicos are repairing the photocopiers in the school library.
El director afirmó que los técnicos están repairing the photocopiers in the school library.
El director afirmó que los técnicos have repaired the photocopiers in the school library.
El director afirmó que los técnicos han repaired the photocopiers in the school library.
'The principal affirmed that the technicians…'

El empleado supone que sus colegas are notifying their boss of the accident.
El empleado supone que sus colegas están notifying their boss of the accident.
El empleado supone que sus colegas have notified their boss of the accident.
El empleado supone que sus colegas han notified their boss of the accident.
'The employee suposes that his colleagues…'

El entrenador dijo que los atletas are ignoring the remarks from the opposing team.
El entrenador dijo que los atletas están ignoring the remarks from the opposing team.
El entrenador dijo que los atletas have ignored the remarks from the opposing team.
El entrenador dijo que los atletas han ignored the remarks from the opposing team.
'The coach said that the athletes…'

El entrenador piensa que los atletas are celebrating their win at the bar.
El entrenador piensa que los atletas están celebrating their win at the bar.
El entrenador piensa que los atletas have celebrated their win at the bar.
El entrenador piensa que los atletas han celebrated their win at the bar.
'The coach thinks that the athletes…'

El maestro notó que los estudiantes are copying the answers on their desks.
El maestro notó que los estudiantes están copying the answers on their desks.
El maestro notó que los estudiantes have copied the answers on their desks.
El maestro notó que los estudiantes han copied the answers on their desks.
'The teacher noticed that the students…'

El periodista anunció que los músicos are producing the album in the studio.
El periodista anunció que los músicos están producing the album in the studio.
El periodista anunció que los músicos have produced the album in the studio.
El periodista anunció que los músicos han produced the album in the studio.
'The journalist announced that the musicians…'

El presidente anunció que los senadores are negotiating the terms of the agreement.
El presidente anunció que los senadores están negotiating the terms of the agreement.
El presidente anunció que los senadores have negotiated the terms of the agreement.
El presidente anunció que los senadores han negotiated the terms of the agreement.
'The president announced that the senators…'

El vendedor confirmó que los coleccionistas are importing the sculptures from India.
El vendedor confirmó que los coleccionistas están importing the sculptures from India.
El vendedor confirmó que los coleccionistas have imported the sculptures from India.
El vendedor confirmó que los coleccionistas han imported the sculptures from India.
'The seller confirmed that the collectors…'

La enfermera afirmó que los doctores are consulting a specialist about the results.
La enfermera afirmó que los doctores están consulting a specialist about the results.
La enfermera afirmó que los doctores have consulted a specialist about the results.
La enfermera afirmó que los doctores han consulted a specialist about the results.
'The nurse affirmed that the doctors…'

La estilista confirmó que los diseñadores are organizing their collections for the fashion show.
La estilista confirmó que los diseñadores están organizing their collections for the fashion show.
La estilista confirmó que los diseñadores have organized their collections for the fashion show.
La estilista confirmó que los diseñadores han organized their collections for the fashion show.
'The stylist confirmed that the designers…'

La familia notó que los jardineros are planting the trees in the backyard.
La familia notó que los jardineros están planting the trees in the backyard.
La familia notó que los jardineros have planted the trees in the backyard.
La familia notó que los jardineros han planted the trees in the backyard.
'The family noticed that the gardeners…'

La secretaria dijo que los asistentes are accusing their boss of fraud.
La secretaria dijo que los asistentes están accusing their boss of fraud.
La secretaria dijo que los asistentes have accused their boss of fraud.
La secretaria dijo que los asistentes han accused their boss of fraud.
'The secretary said that the assistants…'

El arquitecto supone que los pintores are considering the colors for the house.
El arquitecto supone que los pintores están considering the colors for the house.
El arquitecto supone que los pintores have considered the colors for the house.
El arquitecto supone que los pintores han considered the colors for the house.
'The architect supposes that the painters…'

El director dijo que los instructors are preparing the exam for the students.
El director dijo que los instructors están preparing the exam for the students.
El director dijo que los instructors have prepared the exam for the students.
El director dijo que los instructors han prepared the exam for the students.
'The principal said that the instructors…'

El director dijo que los productores are preparing the set for the movie.
El director dijo que los productores están preparing the set for the movie.
El director dijo que los productores have prepared the set for the movie.
El director dijo que los productores han prepared the set for the movie.
'The director said that the producers…'

El entrenador mencionó que los atletas are practicing five hours a day.
El entrenador mencionó que los atletas están practicing five hours a day.
El entrenador mencionó que los atletas have practiced five hours a day.
El entrenador mencionó que los atletas han practiced five hours a day.
'The coach said that the athletes…'

El jefe anunció que las secretarias are notifying the media about the strike.
El jefe anunció que las secretarias están notifying the media about the strike.
El jefe anunció que las secretarias have notified the media about the strike.
El jefe anunció que las secretarias han notified the media about the strike.
'The boss announced that the secretaries…'

El psiquiatra afirmó que los prisioneros are justifying their behavior in the session.
El psiquiatra afirmó que los prisioneros están justifying their behavior in the session.
El psiquiatra afirmó que los prisioneros have justified their behavior in the session.
El psiquiatra afirmó que los prisioneros han justified their behavior in the session.

'The psychiatrist affirmed that the prisoners…'

La profesora anunció que los editors are approving her article for the journal.
La profesora anunció que los editors están approving her article for the journal.
La profesora anunció que los editors have approved her article for the journal.
La profesora anunció que los editors han approved her article for the journal.
'The professor announced that the editors…'

El sargento garantizó que los soldados are preparing the weapons for the mission.
El sargento garantizó que los soldados están preparing the weapons for the mission.
El sargento garantizó que los soldados have prepared the weapons for the mission.
El sargento garantizó que los soldados han prepared the weapons for the mission.
'The sergeant guaranteed that the soldiers…'

Sentences with non-cognate participles

El abogado descubrió que los criminales are bribing the policeman to destroy the evidence.
El abogado descubrió que los criminales están bribing the policeman to destroy the evidence.
El abogado descubrió que los criminales have bribed the policeman to destroy the evidence.
El abogado descubrió que los criminales han bribed the policeman to destroy the evidence.
'The lawyer discovered that the criminals…'

El abogado garantizó que los criminales are improving their behavior in jail.
El abogado garantizó que los criminales están improving their behavior in jail.
El abogado garantizó que los criminales have improved their behavior in jail.
El abogado garantizó que los criminales han improved their behavior in jail.
'The lawyer guaranteed that the criminals…'

El carcelero dijo que los prisioneros are washing their clothes for the week.
El carcelero dijo que los prisioneros están washing their clothes for the week.
El carcelero dijo que los prisioneros have washed their clothes for the week.
El carcelero dijo que los prisioneros han washed their clothes for the week.
'The warden said that the prisoners…'

El chef piensa que los turistas are enjoying the food at his gourmet restaurant.
El chef piensa que los turistas están enjoying the food at his gourmet restaurant.
El chef piensa que los turistas have enjoyed the food at his gourmet restaurant.
El chef piensa que los turistas han enjoyed the food at his gourmet restaurant.
'The chef thinks that the tourists…'

El decano notó que las recepcionistas are filing the applications in alphabetical order.
El decano notó que las recepcionistas están filing the applications in alphabetical order.

El decano notó que las recepcionistas have filed the applications in alphabetical order.
El decano notó que las recepcionistas han filed the applications in alphabetical order.
'The dean noticed that the receptionists…'

El general mencionó que los veteranos are enjoying the celebration in their honor.
El general mencionó que los veteranos están enjoying the celebration in their honor.
El general mencionó que los veteranos have enjoyed the celebration in their honor.
El general mencionó que los veteranos han enjoyed the celebration in their honor.
'The general mentioned that the veterans…'

El locutor dijo que los entrenadores are reaching their goals with the players.
El locutor dijo que los entrenadores están reaching their goals with the players.
El locutor dijo que los entrenadores have reached their goals with the players.
El locutor dijo que los entrenadores han reached their goals with the players.
'The announcer said that the trainers…'

El supervisor mencionó que los carpinteros are fixing the cabinets in the kitchen.
El supervisor mencionó que los carpinteros están fixing the cabinets in the kitchen.
El supervisor mencionó que los carpinteros have fixed the cabinets in the kitchen.
El supervisor mencionó que los carpinteros han fixed the cabinets in the kitchen.
'The supervisor mentioned that the carpenters…'

La enfermera descubrió que los cirujanos are deceiving the patient about his illness.
La enfermera descubrió que los cirujanos están deceiving the patient about his illness.
La enfermera descubrió que los cirujanos have deceived the patient about his illness.
La enfermera descubrió que los cirujanos han deceived the patient about his illness.
'The nurse discovered that the surgeons…'

El gerente notó que los turistas are enjoying their stay in the hotel.
El gerente notó que los turistas están enjoying their stay in the hotel.
El gerente notó que los turistas have enjoyed their stay in the hotel.
El gerente notó que los turistas han enjoyed their stay in the hotel.
'The manager noticed that the tourists…'

La maestra supone que los estudiantes are checking their email in the library.
La maestra supone que los estudiantes están checking their email in the library.
La maestra supone que los estudiantes have checked their email in the library.
La maestra supone que los estudiantes han checked their email in the library.
'The teacher supposes that the students…'

La reportera afirmó que los científicos are testing the vaccine on rats.
La reportera afirmó que los científicos están testing the vaccine on rats.
La reportera afirmó que los científicos have tested the vaccine on rats.
La reportera afirmó que los científicos han tested the vaccine on rats.
'The reporter affirmed that the scientists…'

El sargento garantizó que los detectives are removing the evidence from the crime scene.
El sargento garantizó que los detectives están removing the evidence from the crime scene.
El sargento garantizó que los detectives have removed the evidence from the crime scene.
El sargento garantizó que los detectives han removed the evidence from the crime scene.
'The sergeant guaranteed that the detectives…'

Los estudiantes notaron que las profesoras are placing their quizzes on the bookshelf.
Los estudiantes notaron que las profesoras están placing their quizzes on the bookshelf.
Los estudiantes notaron que las profesoras have placed their quizzes on the bookshelf.
Los estudiantes notaron que las profesoras han placed their quizzes on the bookshelf.
'The students noticed that the professors…'

Los inquilinos notaron que los electricistas are fixing the powerlines in the building.
Los inquilinos notaron que los electricistas están fixing the powerlines in the building.
Los inquilinos notaron que los electricistas have fixed the powerlines in the building.
Los inquilinos notaron que los electricistas han fixed the powerlines in the building.
'The tenants noticed that the electricians…'

La superintendente garantiza que los instructores are testing the students appropriately.
La superintendente garantiza que los instructores están testing the students appropriately.
La superintendente garantiza que los instructores have tested the students appropriately.
La superintendente garantiza que los instructores han tested the students appropriately.
'The superintendent guarantees that the instructors…'

El dueño dijo que los arquitectos are signing the documents for the construction.
El dueño dijo que los arquitectos están signing the documents for the construction.
El dueño dijo que los arquitectos have signed the documents for the construction.
El dueño dijo que los arquitectos han signed the documents for the construction.
'The owner said that the architects…'

El editor notó que los voluntarios are arranging the photographs for the Entertainment section.
El editor notó que los voluntarios están arranging the photographs for the Entertainment section.
El editor notó que los voluntarios have arranged the photographs for the Entertainment section.
El editor notó que los voluntarios han arranged the photographs for the Entertainment section.
'The editor noticed that the volunteers…'

El entrenador notó que los atletas are grabbing their uniforms from the pile.
El entrenador notó que los atletas están grabbing their uniforms from the pile.
El entrenador notó que los atletas have grabbed their uniforms from the pile.
El entrenador notó que los atletas han grabbed their uniforms from the pile.
'The coach noticed that the athletes…'

El guardia dijo que los prisioneros are cooking the food in the kitchen.
El guardia dijo que los prisioneros están cooking the food in the kitchen.
El guardia dijo que los prisioneros have cooked the food in the kitchen.
El guardia dijo que los prisioneros han cooked the food in the kitchen.
'The guard said that the prisoners…'

El investigador piensa que los gánsters are shipping the drugs to New York City.
El investigador piensa que los gánsters están shipping the drugs to New York City.
El investigador piensa que los gánsters have shipped the drugs to New York City.
El investigador piensa que los gánsters han shipped the drugs to New York City.
'The investigator thinks that the gangsters…'

El reporter confirmó que los senadores are requesting the funds for the project.
El reporter confirmó que los senadores están requesting the funds for the project.
El reporter confirmó que los senadores have requested the funds for the project.
El reporter confirmó que los senadores han requested the funds for the project.
'The reporter confirmed that the senators…'

El reporter dijo que las modelos are signing a contract with the agency.
El reporter dijo que las modelos están signing a contract with the agency.
El reporter dijo que las modelos have signed a contract with the agency.
El reporter dijo que las modelos han signed a contract with the agency.
'The reporter said that the models…'

La revista indicó que los actors are answering the letters from their fans.
La revista indicó que los actors están answering the letters from their fans.
La revista indicó que los actors have answered the letters from their fans.
La revista indicó que los actors han answered the letters from their fans.
'The magazine indicated that the actors…"