Gosselin, Leah. 2021. Bilinguals have a single computational system but two compartmentalized phonological grammars: Evidence from code-switching. *Glossa: a journal of general linguistics* 6(1): 147, pp. 1–38. DOI: https://doi.org/10.16995/glossa.5800

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Bilinguals have a single computational system but two compartmentalized phonological grammars: Evidence from code-switching

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Classic linguistic models, such as Chomsky's minimalist schematization of the human language faculty, were typically based on a 'monolingual ideal'. More recently, models have been extended to bilingual cognition. For instance, MacSwan (2000) posited that bilingual individuals possess a single syntactic computational system and, crucially, two phonological systems. The current paper examines this possible architecture of the bilingual language faculty by utilizing code-switching data. Specifically, the natural speech of Maria, a habitual Spanish-English code-switcher from the Bangor Miami Corpus, was examined. For the interface of phonology, an analysis was completed on the frequency of syllabic structures used by Maria. Phonotactics were examined as the (unilingual) phonological systems of Spanish and English impose differential restrictions on the legality of complex onsets and codas. The results indicated that Maria's language of use impacted the phonotactics of her speech, but that the context of use (unilingual or code-switched) did not. This suggests that Maria was alternating between encapsulated phonological systems when she was code-switching. For the interface of morphosyntax, syntactic dependencies within Maria's code-switched speech and past literature were examined. The evidence illustrates that syntactic dependencies are indeed established within code-switched sentences, indicating that such constructions are derived from a single syntactic subset. Thus, the quantitative and qualitative results from this paper wholly support MacSwan's original conjectures regarding the bilingual language faculty: bilingual cognition appears to be composed of a single computational system which builds multi-language syntactic structures, and more than one phonological system.

1 Introduction

Since the onset of language research, one particular model has dominated the field: that of the monolingual speaker. Historically, monolinguals were viewed as the 'baseline' language user, while bilinguals were defined in relation to their simpler counterparts, notably as being "two monolinguals in one person" (see Grosjean 1989 for a discussion). While it is reasonable for science to first focus on less complex cases (i.e., monolinguals), global numbers indicate that monolinguals may not be a baseline after all. In fact, it is estimated that over half of the world's population speaks more than one language (Grosjean & Miller 1994), making bilingualism and multilingualism the norm rather than the exception.

With the development of the field, more and more interdisciplinary experts now agree that the bilingual mind may be distinct from that of the monolingual, simply by virtue of holding two languages within one single cognitive system (e.g., MacSwan 2000). For instance, a wealth of data indicates that many bilinguals possess cooperative lexicons (e.g., Beauvillain & Grainger 1987; Hartsuiker, Pickering & Veltkamp 2004; Sabourin, Brien & Burkholder 2014), seemingly integrated within at least one linguistic interface. Despite this upsurge in empirical interest, the underlying composition of the bilingual language system is still obscure. Fortunately, one practice may illuminate its particulars: CODE-SWITCHING.

Code-switching involves the "alternation of two languages within a single discourse, sentence or constituent" (Poplack 1980: 583), as in (1). The practice is rule-governed and systematic, rather than an indication of linguistic deficiency (see Heredia & Altarriba 2001). This means that code-switchers possess community-specific (e.g., Adamou & Shen 2019) intuitive judgements about mixed sentences (e.g., (1b) is plainly unacceptable).

(1) *Spanish*/English (Giancaspro 2015: 382; Lopéz *et al.* 2017: 7)

a. *Los ciudadanos están* supporting the program.
   the citizens are supporting the program
   'The citizens are supporting the program.'

b. *You have *contado esa historia*.
   you have told that story
   'You have told that story.'

Such consistent acceptability judgements offer a glimpse into the underlying bilingual system. They reveal the ways in which languages can and cannot be mixed, and therefore, shed light on the possible cognitive associations between the code-switched languages at each linguistic interface (e.g., phonology, morphology, syntax). In short, the examination of code-switched utterances allows linguists to model the bilingual language faculty while considering the bilingual as a baseline, rather than the monolingual.

As such, the current paper utilizes code-switching as a mechanism to assess previously purported models of bilingual cognition. In particular, the underlying structure of the bilingual language faculty is probed by two main questions: How many phonological systems are employed for code-switched utterances? How many syntactic subsets characterize code-switched sentences? Evidence both empirical (i.e., corpus-based data analyses) and theoretical in nature confirms that code-switching is derived from a unique syntactic grammar but dual phonologies, as past models have suggested (MacSwan 2000; MacSwan & Colina 2014).

The current paper is structured as follows: the next section expands on background concepts relative to code-switching and the bilingual language faculty under a minimalist perspective. Section 3 is devoted to the interface of phonology. Here, I analyze syllabic structure frequencies by using a Spanish-English code-switching corpus (the Bangor Miami Corpus; Deuchar, Davies, Herring, Parafita Couto & Carter 2014) in order to tap into the underlying phonological code-switching systems. In the fourth section, the interface of syntax is addressed; I expand on the theoretical support for the singularity of the syntactic code-switching grammar and once again utilize the code-switching corpus as empirical support. The final section concludes.

2 Background

2.1 Code-switching and the bilingual language faculty

As has been stated, code-switching consists of the juxtaposition of multiple languages within a single speech event. In many communities, code-switching is regarded as typical in-group linguistic behaviour (e.g., Poplack 1980; Poplack 1988; González-Vilbazo & López 2011; Adamou & Shen 2019; Gosselin & Sabourin 2021; etc.). Switching can occur both inter-sententially (between sentences) or intra-sententially (within sentences); the use of the intra-sentential code-switching has been linked to high proficiency or balanced language-skills among speakers (e.g., Poplack 1980; Koban 2013). The examples in (3) (from Valdés Kroff, Dussias, Gerfen, Perrotti & Bajo 2017) depict both switching types, respectively.

(2) *Spanish*/English

a. *Ayer* *fui* *al* *supermercado*. I bought some apples.
yesterday went to the supermarket I bought some apples
'Yesterday I went to the supermarket. I bought some apples.'

b. *El* *niño* *está* reading the book.
the boy is reading the book
'The boy is reading the book.'

As researchers recognized the systematicity of code-switches, a multitude of (primarily syntactic) language mixing constraints were introduced. For instance, the Equivalence Constraint (3), brought forth by Poplack (1980), claimed that code-switching boundaries are prohibited where such a switch may give rise to an illicit word-order in one of the two languages. Following the Equivalence Constraint, a series of language mixing constraints were proposed: the Closed class constraint (Joshi 1982), the Government constraint (Di Sciullo, Muysken & Singh 1986), the Matrix language frame (Myers-Scotton 1997), the Functional head constraint (Belazi *et al.* 1994), among others. While these theories often possess reasonable predictive power, most have been critiqued by proponents of the *constraint-free* approach (e.g., MacSwan 2000; 2014; MacSwan & Colina 2014). This is because the Equivalence Constraint and many of its successors directly refer to the act of code-switching and therefore impose upon it an otherwise vacuous 'third grammar'. By contrast, constraint-free formalism maintains that code-switching does not (and should not) possess constraints that are independent from monolingual speech. As it turns out, Chomsky's minimalism is well equipped to carry out a constraint-free analysis of code-switching (MacSwan 2000; 2014).

(3) **Equivalence Constraint:** Code-switches will tend to occur at points in discourse where juxtaposition of Ll and L2 elements does not violate a syntactic rule of either language, i.e. at points around which the surface structures of the two languages map onto each other. (Poplack 1980: 586)

In minimalism, patterns observed from linguistic data are preferentially elucidated by the most simple and elegant assumptions. Consider Chomsky's generally accepted hypothesis that the (monolingual) human language faculty is made up of A) a lexicon and B) a computational system (C_{HL}) (see Chomsky 1995). In brief, C_{HL} is responsible for Selecting lexical arrays from the lexicon, combining them into a syntactic structure with the operation Merge, and then Spelling-Out the derivation to logical form (LF: the interpretative level of language) and phonological form (PF: the sensorimotor aspect of language).

Adopting the constraint-free approach for code-switching data, MacSwan (2000) extended Chomsky's minimalistic view of the human language (see **Figure 1**, *left panel*) to the *bilingual* language faculty. The bilingual version of the model (see **Figure 1**, *right panel*) includes two differences. First, there are two lexicons available to the bilingual speaker. Second, bilinguals possess discrete phonological systems, which are compartmentalized before PF. Just like the monolingual language faculty, however, bilinguals are thought to construct sentences within a single syntactic component.

This system very simply accounts for code-switching while avoiding switching-specific grammars: in the bilingual language faculty, C_{HL} can select lexical items from multiple lexicons and combine them into a single syntactic construction. On the other hand, a bilingual individual can easily speak in a single language by selecting items from a single lexicon instead of two. Thus, by adopting a minimalist framework, MacSwan convincingly illustrated that an adequate code-switching grammar should not explicitly or conceptually refer to the act of using multiple languages (an insight previously broached by Mahootian 1993; Belazi *et al.* 1994). Instead, his model is anchored in the following assumptions (MacSwan 2000: 43):

(4) i. […] All grammatical relations and operations which are relevant to monolingual language are relevant to bilingual language, and only these.
ii. Nothing constrains code switching apart from the requirements of the mixed grammars.

In short, assuming that two languages, L_x and L_y, are involved in a mixed sentence, and that these languages each possess their own grammar, G_x and G_y, any code-switched sentence is determined by $G_x \cup G_y$. We do not need to know the arbitrary identity of any L, and we do not need to generate a switching-specific grammar.

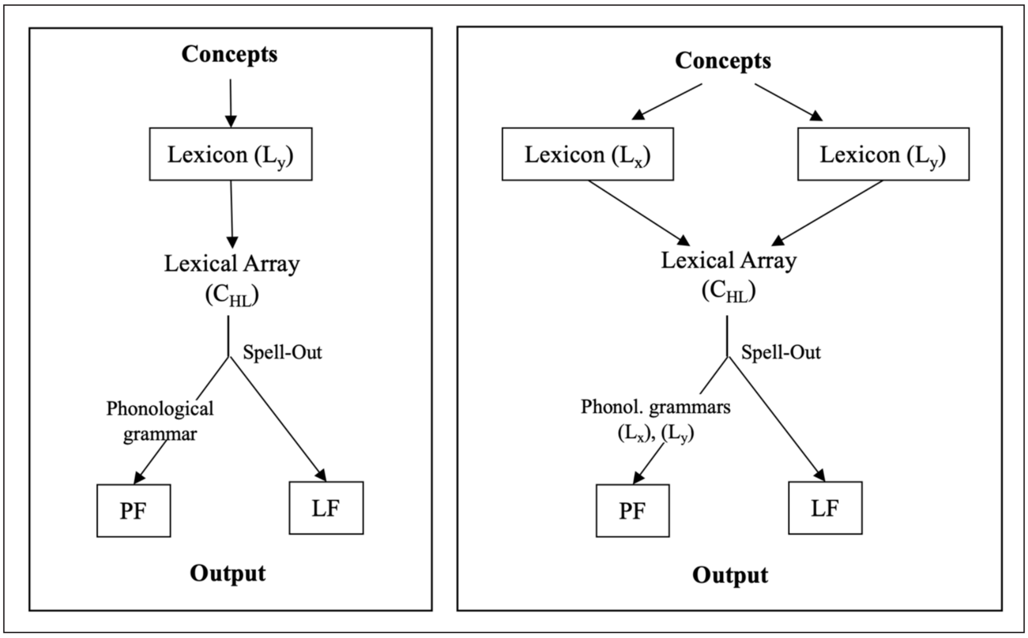

Figure 1: Left: The (monolingual) language faculty, according to Chomsky (1995). Right: MacSwan's model of the bilingual language faculty (both adapted from MacSwan 2000; 2016).

Once the syntactic structure (the overt component) is derived, it must surface as a phonological/phonetic form. The monolingual model simply sends the sensorimotor elements of the derivation to the unique phonological system in the configuration. The bilingual language faculty, on the other hand, possesses more than one lexical set, and thus, more than one phonological system. In a monolingual utterance, bilinguals can easily respect the phonology of any of their languages: items from each lexicon are merely rendered to their corresponding phonological system. Contrastively, during code-switching, all lexical items must be parsed by their appropriate phonological systems after Spell-Out.[1] Hence, to give rise to a felicitous code-

[1] Strikingly, this schematization also appears to stand for bimodal bilinguals. Instead of simply spelling-out a derivation to a given phonological system, bimodal bilinguals may spell-out the structure to the phonology of distinct articulators: speech or sign (see Lillo-Martin, Müeller de Quadros & Chen Pichler 2016).

switched speech segment, we assume that the phonological systems (PS) within the bilingual architecture are sequestered (*PSx*, *PSy*) before PF. Note that this architecture starkly contrasts other (primarily non-lexicalist) models (see also González-Vilbazo & López 2012; Alexiadou, Lohndal, Åfarli & Grimstad 2015; Alexiadou & Lohndal 2018; Stefanich, Cabrelli, Hilderman & Archibald 2019; etc.) which posit that bilinguals possess *fully* integrated grammars, including at the level of phonology (López 2020).

To recapitulate, MacSwan's model of the bilingual language faculty implies that code-switching is possible at the syntactic level, but that code-switching at PF is unavailable. This means that each segment involved in the switch respects the phonology of the lexical set it originates from, and furthermore, that there is no singular alternate phonological grammar that can account for the mixed utterance in its entirety. Presently, it may be asked exactly *why* the syntactic and phonological interfaces, by nature, differ within the architecture of the bilingual system. That is, what motivated MacSwan to posit that syntactic grammars can be combined, while the phonological counterparts could not? Essentially, this conjecture is based on the computational features of each interface—regardless of whether the system is monolingual or bilingual.

Within the syntactic interface, operations can take place at any given time. For instance, inserting a post-nominal adjective into a derivation *before* introducing a noun will still give rise to a correct surface form, as the lexical item is labeled with [adj. +post-nom.]. Based on this imperviousness to underlying order relations, there is no concern in stipulating that items from code-switched sentences are syntactically derived from an assembled set (i.e., a single lexical array constructed by C_{HL}).

On the other hand, phonological rules or constraints have been noted as being order-dependent at least since Bromberger and Halle (1989), who penned the Principle in (5). Since phonological grammars are sensitive to ordering, it would not be parsimonious to assume that code-switching is characterized by the united phonologies of the languages involved in the switch. Consider, for instance, a set of phonological rules $\{R_1, R_2, R_3\}$. In PS_x of L_x, $R_1 > R_2, R_3$; in PS_y of L_y, $R_1, R_3 > R_2$. What would take place if Spell-Out introduced a code-switched sentence composed of L_x and L_y into a combined *PS*? At the very least, the result of such a computation is challenging to obtain (though see Chapter 6 of López 2020 for a potential analysis).

(5) Phonological rules are ordered with respect to one another. A phonological rule R does not apply necessarily to the underlying representation; rather, R applies to the derived representation that results from the application of each applicable rule preceding R in the order of the rules (Bromberger & Halle 1989: 58–59).

Thus, the separation of the phonological systems within the architecture of the bilingual mind directly falls from the "imperfection" of phonology, notably its poor computational properties

(Chomsky 2002: 118). It is a consequence of the order-specific nature of the phonological interface; if phonological systems were united in the model, their respective orders could be compromised. As strikingly noted by MacSwan & Colina (2014: 188), this entails that "language switching *is* phonological switching", and nothing more. Such an observation falls into line with conceptualizations of language which claim that variation is confined to the externalization of language (Chomsky, Gallego & Ott 2019), while the internal language remains largely invariant.

The PF Interface Condition (PFIC; previously the PF Disjunction Theorem; MacSwan 2000: 45), spelled out in (6), accounts for the separation of the bilingual's phonologies as per the computational properties of this interface (MacSwan & Colina 2014: 191). MacSwan and Colina assert (6.iv) that phonological switching is prohibited within words but not between words. This behaviour is based on the following assumption: on the way to PF, sensorimotor material is minimally parsed at the *word level* (see MacSwan & Colina 2014 for a discussion). Recent data does in fact indicate that word-internal phonological switching is virtually unattested, even if an acceptable morphological switch has occurred (Bessett 2017; see also MacSwan & Colina 2014; Stefanich & Cabrelli Amaro 2018).

(6) PF Interface Condition

i. Phonological input is mapped to the output in one step with no intermediate representations.
ii. Each set of internally ranked constraints is a constraint dominance hierarchy, and a language-particular phonology is a set of constraint dominance hierarchies.
iii. Bilinguals have a separately encapsulated phonological system for each language in their repertoire in order to avoid *ranking paradoxes*, which result from the availability of distinct constraint dominance hierarchies with conflicting priorities.
iv. Every syntactic head (word) must be phonologically parsed at Spell-Out. Therefore, the boundary between heads represents the minimal opportunity for code-switching.

Before continuing, it is important to distinguish code-switching from nonce-borrowing (and attested loanwords). According to original theory, code-switching, whether inter- or intra-sentential, involves unique processes (e.g., Grosjean 1995). Unlike switched segments, borrowed words are said to be morphologically, and often phonologically integrated into the target language (Poplack & Meechan 1998; though see Poplack, *et al.* 2020 for recent data). Since borrowings (and not code-switches) may be parsed by the phonological system of the recipient language (e.g., '*rid-er*' is pronounced as French-like /ʁa͡ɪde/, even though it originates from the English *riding* /ɹa͡ɪdɪŋ/), these types of items do not give us much insight into the architecture of the bilingual's phonological systems. From a computational perspective, sentences featuring borrowed words or loan words are not at all different from single-language speech; these items will not be considered in the empirical analyses of this paper.

In the subsequent section, past phonetic studies examining code-switching will be reviewed; these indirectly support MacSwan's model of the bilingual language faculty.

2.2 Experimental phonetic/phonological literature

A moderately large literature has investigated whether bilinguals abruptly switch between the *phonetics* of their languages when they produce mixed utterances, or alternatively, whether the phonetic systems somehow converge towards a new schema that is dissimilar from that of both languages in unilingual contexts. The results from these studies remain conflicting.

Early findings examining the voice-onset time (VOT) of French-English code-switchers indicate that bilinguals shift from one phonetic system to the next, with absolutely no phonetic remnant of the opposite language after a switching boundary (Grosjean & Miller 1994). These results have seldom been replicated (though see Brown 2015; Olson 2013 (bilingual contexts) for comparable conclusions). For the most part, studies have observed some sort of effect between the languages involved in the code-switch.

On one hand, some research indicates that code-switched speech may actually be hyper-articulated. This result has primarily been found for suprasegmental features, such as pitch (Olson 2012; see also Olson & Ortega-Llebaria 2010) and stress, as indicated by vowel length (Olson, 2012; Muldner *et al.* 2019). In other words, the suprasegmental features of the languages involved in the switch may diverge from each other, possibly in order to ensure maximal distance between their acoustic features. Hyper-articulation of code-switched items may also occur since switches are said to be "less predictable" (Olson 2012: 451) than single-language speech (see Bell, Brenier, Gregory, Girand & Jurafsky 2009 for supporting results). In any case, hyper-articulation is not problematic to MacSwan's model of the bilingual language faculty; it still presupposes that bilinguals have encapsulated phonological systems and that code-switches are not phonologically integrated.

On the other hand, several studies indicate that phonetic convergence does indeed take place between languages involved in a code-switch; this is by far the most common finding (Bullock, Toribio, Davis & Botero 2004; Bullock, Toribio, González & Dalola 2006; Antoniou, Best, Tyler & Kroos 2011; Balukas & Koops 2015; Piccinini & Arvanti 2015; López 2012; Ojeda, de Prada Pérez & Wayland 2018). For instance, when participants produced switches between Spanish and English, the VOT values of stops in these languages may shift towards each other. Interestingly, this shift is often asymmetric: it is primarily observed within the language that contains a broader VOT spectrum. Thus, English VOT may shift towards shorter Spanish-like values, since these segments can afford to shift while respecting their own phonological thresholds (Bullock *et al.* 2006; Balukas & Koops 2015; Piccinini & Arviniti 2015).

Despite these complex and often antithetical findings, one result remains unchanged: the presence of phonetic convergence does not result in a merge of the systems. In fact, the phonetic shift never extends as far as the respective phonological categorization boundaries of each language. For example, Balukas and Koops (2015) observed a durational shift for English voiceless stops in code-switched compared to monolingual speech, notably towards shorter Spanish-like VOT values. Nevertheless, the VOTs of the code-switched English stops still remained within the typical English range (see also Bullock *et al.* 2004; 2006; Antoniou *et al.* 2011; Piccinini & Arvaniti 2015, etc.). This means that the often-observed phonetic convergence is, as its name implies, simply phonetic in nature. It does not negate the duality of the phonological systems according MacSwan's model of the bilingual language faculty.

In brief, the acoustic literature illustrates that phonetic convergence (among other possibilities) is available for code-switches, but that this shift is virtually never phonological. These results rather support the notion that code-switching does not impact the phonologies of the languages involved in the mixed utterances. Up to this point, however, mostly indirect evidence concerning this matter has been examined. In the subsequent section, the duality of the *phonological* systems, as postulated by MacSwan's model of the bilingual language faculty, is assessed. Unlike previous research, this is done by examining a facet that is quite distinct from the phonetic system: that of syllabic structure.

3 Phonology: Divorced but co-parenting

3.1 Background

The goal of the current section is to investigate the underlying phonological system of code-switched utterances, in order to verify MacSwan's model of the bilingual language faculty. One way of tapping into these rather abstract notions is by comparing code-switched languages which differ within a specific aspect of their respective phonological systems. For instance, MacSwan and Colina (2014) utilized the Spanish-specific phonological rule resulting in the realization of intervocalic stops as approximants. Unilingual English displays no pattern similar to the Spanish approximant rule. These authors observed that in Spanish-English code-switches favouring the application of the Spanish rule (e.g., /m**igo**wst/ '*mi* ghost' → */m**iɰo**wst/), stops were only realized as approximants in about 10% of the recordings (compared to 93% in unilingual Spanish). However, phonological processes were successfully triggered for segments belonging to the same language in which the process was active (e.g., Spanish voicing rule: /mi**s**gowsts/ '*mis* ghosts' → /mi**z**gowst/). MacSwan and Colina thus cleverly demonstrated that code-switching boundaries involve an abrupt shift in the bilingual's phonological systems.

In the current paper, I utilize the phonotactic structure (i.e., the permissibility of certain phoneme combinations and not others; Anttila 2008) of Spanish-English code-switched speech in order to garner insight into the phonological system(s) that is—or are—employed during mixed-language utterances. The majority of the research substantiates the idea that language-specific phonotactic patterns are psychologically real (e.g., Friederici & Wessels 1993; Jusczyk, Friederici, Wessels, Svenkerud & Jusczyk 1993; Jusczyk, Luce & Charles-Luce 1994), and that they arise from speakers' underlying grammar (Coleman & Pierrehumbert 1997; Frisch, Large & Pisoni 2000; Shademan 2006; Albright 2008; though see Bailey & Hahn 2001; Hammond 2004). This means that examining such patterns effectively allow us to hone into the phonological component of the language faculty, as modelled by Chomsky and MacSwan.

The possible empirical outcomes are presented in (7). Outcome A) supports phonological encapsulation as it is posited in current model of the bilingual language faculty (MacSwan 2000); outcome B) does not support MacSwan's model. Rather, outcome B) may indicate a degree of integration for bilinguals' phonological systems.

(7) **Potential empirical outcomes:** Let a code-switch be composed of *x* and *y*

A. If *x* respects the phonotactics of L_x, and *y* respects the phonotactics of L_y, the phonologies of L_x and L_y are impermeable.

B. Alternatively, if *x* does not respect the phonotactics of L_x, or *y* does not respect the phonotactics of L_y the phonologies of L_x and L_y are permeable.

The general phonotactic differences between Spanish and English are exploited in order to test the outcomes in (7). Spanish and English have distinct constraints regarding the legality of certain syllabic structures. English has a relatively lax syllable structure; it can accommodate up to three consonants in the onset position, and even more in the coda (e.g. strengths /**str**ɛ**ŋ(k)θs**/ → CCCVC(C)CC, glimpsed /**gl**ɪ**mpst**/ → CCVCCCC). Contrastively, consonant clusters within a given syllable are greatly disfavoured in Spanish (e.g., Barlow 2003). As can be seen in **Table 1**, this is reflected in the relative frequency of syllable types in unilingual English (Delattre & Olsen 1969) and Spanish (Villanueva-Reyes 2013).

As it turns out, the grammatical distinction between English and Spanish is easily modeled with the Optimality Theory framework (OT). In OT (see Smolensky & Prince 1993), the ranking of universal constraints forms a language-specific grammar; the numerous permutations for hierarchical constraint rankings give rise to cross-linguistic differences in phonological systems. When comparing languages with different constraints rankings (and thus different superficial phonological attributes), one can use OT to determine which system is currently active in code-switched discourse.

In the present study, the relevant constraint which primarily accounts for the phonological differences between Spanish and English is *COMPLEX (i.e., "Assign a violation for every syllable with a consonant cluster"). That is, *COMPLEX possesses a distinct ranking in Spanish and English, being of a relative higher rank in the former than the latter (8). This simple distinction accounts for the resulting phonotactics of both languages, as can be seen in **Tables 2** and **3** (loosely adapted from Misker & Anderson 2003).

Syllable type	English	Spanish	Syllable type	English	Spanish
CV	27.6	55.82	CVCC	6.7	0.02
CVC	31.9	21.6	CCVCC	1.3	0.01
V	8.1	9.58	CVCCC	0.3	–
VC	11.9	8.34	CCVCCC	0.2	–
CCV	4	3.14	VCCC	0.1	–
VCC	2.9	0.13	CCCVC	0.1	–
CCVC	4.8	0.06	CCCV	0.05	–

Table 1: Proportion of syllable types reported in previous literature for unilingual English[2] (Delattre & Olsen 1969) and Spanish[3] (Villanueva-Reyes 2013) language.

/absorb-d/	DEP-IO	PEAK	MAX-IO	*COMPLEX
☞ a) ab.zorbd				*
b) ab.zord			*!	*
c) ab.zor.bed	*!			
d) ab.zor.bd		*!		

Table 2: English syllabification of 'absorbed'.

In English (**Table 2**), *COMPLEX is ranked lower than DEP-IO (i.e., 'No insertion'), PEAK ('Syllables must contain vowels') and MAX-IO ('No deletion'). Consequently, an input like /abzorbd/ 'absorbed' is syllabified into two units: a VC syllable, and a complex CV**CCC** syllable. Simply put, this pattern is obtained since English grammar 'prefers' outputs that preserve all of their original segments (i.e., faithful candidates), rather than outputs without consonant clusters. Crucially, this preference is determined by the outranking of MAX-IO over *COMPLEX (8a).

[2] Delattre and Olsen obtained these syllabic frequencies by examining 2000 syllables in texts from contemporaneous authors (e.g., short stories, plays).

[3] Villanueva-Reyes (2013) originally separated syllables according to whether they contained a simplex vowel or a diphthong. Since vowel quality is of no interest to the current paper, diphtongues and simple vowels were collapsed. It is not specified whether these relative syllabic frequencies were obtained from speech or text samples.

/absorb-to/	DEP-IO	PEAK	*COMPLEX	MAX-IO
☞ a) ab.sor.to				*
b) ab.sorb.to			*!	
c) ab.sor.be.to	*!			
d) ab.sor.b.to		*!		

Table 3: Spanish syllabification of absorb-to ('absorbed').

Contrastively, in Spanish (**Table 3**), an input such as /absorb-to/ 'absorbed' is syllabified into three units, none of which include a consonant cluster: VC, CVC and CV syllables. Syllabification occurs in this manner since consonant clusters are less desirable in Spanish than deleted segments, as determined by the ranking of * COMPLEX over MAX-IO (8b).

(8) **Crucial constraint rankings of interest:**

a. English: MAX-IO > *COMPLEX

b. Spanish: *COMPLEX > MAX-IO

With only a handful of constraints, we can observe quite simply from where arise the differential phonotactic patterns in English and in Spanish. While this analysis may be slightly idealized, it demonstrates the key idea upon which the current section hinges: cross-linguistic differences in the ranking of *COMPLEX give rise to distinct relative syllabic frequencies in Spanish and English. As such, this paper capitalizes on these distinct rankings of the *COMPLEX constraint while examining natural speech from a Spanish-English corpus. If bilinguals do indeed possess encapsulated phonological systems (in line with MacSwan's model and the constraint-free approach), the hierarchy of constraints in code-switched speech should respect the hierarchy of constraints of each respective language involved in the code-switch.

3.2 Methods

3.2.1 The corpus

The publicly available Bangor-Miami corpus was consulted (see Deuchar *et al.* 2014; available at http://bangortalk.org.uk through the Free Software Foundation's General Public License). This corpus contains transcribed audio files of several hours of recorded speech from Spanish-English bilinguals in the region of Miami, Florida. The current paper focused on the recordings (n = 15) from a 45-year-old female speaker with the pseudonym 'Maria', who was known to the researchers as an avid code-switcher and a balanced bilingual. As such, she was given a microphone and invited to record code-switched conversations in her daily life (Deuchar *et al.* 2014). The corpus contains a total running time of approximately 14 hours of Maria's speech.

Maria's recordings were chosen over those of other speakers in the corpora, since her conversations took place in-the-field. In fact, Maria was conversing with friends, family and colleagues (Deuchar *et al.* 2014), and her recordings are thus very likely to reflect her natural speech. Recent reviews indeed call for both a) the use of habitual code-switching participants; and b) more ecologically valid data sets or collection methods (González-Vilbazo *et al.* 2013; Beatty-Martínez, Valdés Kroff & Dussias 2018; Blanco-Elorrieta & Pylkkänen 2018; van Hell, Fernandez, Kootstra, Litcofsky & Ting 2018). By using Maria's spontaneous recordings, these methodological considerations are addressed.

3.2.2 Coding procedures and variables of interest

Based off the audio files and their transcriptions, sentences produced by Maria were coded according to two crucial variables: CONTEXT and LANGUAGE. The variable of CONTEXT refers to the type of utterance: code-switch or unilingual. Code-switched segments correspond to streams of speech containing both Spanish and English, as shown in the examples in (9). Unilingual segments correspond to streams of speech occurring in either English (10a) or Spanish (10b). In order to avoid possible inter-sentential switching points, segments were only extracted and coded as unilingual if they were preceded by at least one other single-language sentence in the same language. Occurrences of single other-language items such as (11a–b) were excluded, since they may be borrowed words; attested loanwords were also omitted (see Section 2.1).

The variable of LANGUAGE simply corresponds to whether each segment was produced in Spanish or in English, regardless of CONTEXT. In code-switched sentences, the portions of speech are also coded as belonging to Spanish or English (e.g., from (9b): *tienen ese salon grande, pero en,* etc. are coded as Spanish and *county, so it's very easy to hang out,* etc. as English). The language tag (Spanish or English) is determined by the lexicon of origin of each word (i.e., L_x or L_y in **Figure 1**). For instance, in (9a), *menos* is a lexical item in Spanish, but not in English. In the case of cross-linguistic homonyms (*e.g., tan* in means 'so' in Spanish, and 'shade of brown' in English), the syntactic context provided a disambiguation for the language tag (e.g., for (9b) to be well-formed, *tan* must possess the Spanish meaning and is thus tagged as belonging to Spanish). Notice that the phonotactics of the words are not consulted during the coding of the language tags.

Though Spanish and English share a high number of cognates, near-cognates (e.g., *resistir*/resist, *compañía*/company, etc.) are more frequent than identical cognates (e.g., *natural*/natural, *cables*/cables) (see Schepens, Dijkstra & Grootjen 2012); this was also the case in Maria's speech. Thus, the language tag of the cognates could be established according to lexical and morphological features of the word. For example, *resistir* in (9c) contains Spanish verbal inflection, and is thus tagged as Spanish; similarly, *compañía* possesses the Spanish feminine declension class -*a*, and is thus tagged as Spanish. With respect to orthographically identical cognates, single phonemes were used to disambiguate the language tag. For instance, *natural* may be tagged as Spanish if the rhotic is produced as /ɾ/ rather than /ɹ/. Consequently, even in the case of cognates, no reference to the phonotactics of the word is required in order to attribute a language tag to Maria's segments of speech. Note that proper nouns and other pronounced speech sounds were not analyzed ('Henry', 'Naomi', 'uh', 'oh', 'woo', etc.), as the language tag is often ambiguous.

(9) **Code-switched sentences** (*Spanish*/English)

a. We may have to put the house shields you know home house shields on those *para por lo menos quitar un poquitico porque* he wants to at least show the *mira cuando no tenia un* shield […]. (Maria, 7, 61)
'We may have to put the house shields you know home house shields on those in order to at least remove a little bit because he wants to at least show the… look when he didn't have a shield…'

b. In XXX county *tienen ese salon grande* so it's very easy to hang out *pero* en XXX county *no es tan* comfy *como eso*. (Maria, 24, 588)
'In XXX county they have that big lounge so it's very easy to hang out but in XXX county it's not so comfy as that.'

c. *No lo pude resistir* cause they were too cute. (Maria, 40, 153)
'No I can't resist because they were too cute.'

(10) **Unilingual sentences** (*Spanish*/English)

a. I saw that we have some proposal due on the tenth. Are you going to want me to review it? (Maria, 2, 1–5).

b. *Pedro me dijo. Vamos a dar tragos a todo el mundo*. (Maria, 16, 48–49).
'Pedro told me. We're offering drinks to everybody.'

(11) **Excluded other single-language items** (*Spanish*/English)

a. *Mi hermano llego el sabado antes de* **Christmas**. (Maria, 4, 164)
'My brother came the Saturday just before Christmas.'

b. They are not going to remove it but they wanna be able to say ***bueno*** you know it's no different than whatever your house your street light or something. (Maria, 7, 59)

Once each segment was coded for CONTEXT and LANGUAGE, its corresponding syllables were manually extracted and, based on impressionistic judgements, categorized as one of the following types: CV, CVC, V, VC, CCV, VCC, CCV, CCVC, CVCC, CCVCC, CVCCC, CCVCCC, VCCC, CCCVC and CCCV. This process was accomplished with reference to both the transcription and the corresponding auditory files for Maria's conversations. In the case of any uncertainty (i.e., degraded sound quality, differences between the transcription and the audio recording), Spanish informants were consulted (see acknowledgements) to identify the syllables. Since vowel quality was of little interest to the current project, syllables with simplex vowels and diphthongs were collapsed into a single syllabic type.

Note that only intra-sentential (and not inter-sentential) code-switches were extracted (see 9), since this is the environment in which phonological convergence is most likely to materialize. In other words, if convergence were to take place in code-switched speech, it is most probable during instances of lengthy switches, when Maria is freely using both of her languages to express her thoughts. If convergence does not appear even in these types of contexts, it serves as robust evidence that Maria is actively alternating between compartmentalized phonological systems.

3.2.3 Potential empirical outcomes

The syllabic structure extracted from Maria's code-switched speech was compared to that of her unilingual speech. More specifically, the proportions for each syllable type within the Spanish portions of Maria's code-switched speech were compared to their relative proportions in the Spanish portions of Maria's unilingual conversations. Similarly, the proportions for each syllable type within the English portions of Maria's code- switched speech were compared to their relative frequency in the English portions of Maria's single-language conversations. Since the constraints relative to syllable structure (e.g., *COMPLEX) vary between Spanish and English, Maria's use of different syllables structures during code-switched speech will give insight into the underlying phonological system(s) that is—or are—employed when she mixes her languages. As such, the possible empirical outcomes from (7) are specified to Maria's speech in (12).

(12) **Potential empirical outcomes** (let Spanish be L_x, English be L_y and consonant clusters be CC):

A. Evidence for the encapsulation of the phonological systems:
   i. %CC in L_x within code-switching = %CC in L_x within unilingual AND
   ii. %CC in L_y within code-switching = %CC in L_y within unilingual

B. Evidence against the encapsulation of the phonological systems:
   i. %CC in L_x within code-switching > %CC in L_x within unilingual OR
   ii. %CC in L_y within code-switching < %CC in L_y within unilingual

To be clear, outcome A) entails that Maria is capable of abruptly switching between the different OT grammars of her languages, and thus that her phonological systems are encapsulated. On the other hand, outcome B) suggests that Maria does not experience a sudden shift in phonological systems, and that her language faculty may not be composed of compartmentalized phonologies.

Maria's data may yield outcome B) if she resyllabifies the lexical items in her code-switches or repairs a consonant cluster with the help of faithfulness constraints (see the hypothetical examples 13a–c). Indeed, such cluster reductions are attested in Spanish-influenced dialects of

English in the United States, such as Chicano English (Santa Ana & Bayley 2008) and Puerto Rican English (Bayley & Bonnici 2009).[4] Alternatively, outcome B) may arise if Maria simply implicitly avoids lexical items that would be problematic for an integrated phonological system (see the hypothetical examples 14a–c). Rather than phonological resyllabification, this second alternative entails that Maria reformulates her message—or at the very least, that she executes lexical substitutions or insertions—in order to avoid computational complexity in the integrated phonological system. In any case, both resolutions involve a difference in the relative syllabic structure between Maria's unilingual and code-switched speech (12B).

(13) Resyllabification

a. I **drove** *el coche.* 'I drove the car.'
   = Convergence of 'drove' towards Spanish: /**a͡ɪ.dɹov** / → /**a͡ɪd.ɹov**/

b. The ***libro*** *se ha caído* off the table. 'The book has fallen off the table.'
   = Convergence of 'libro' towards English: /ðə.**lib.ro**/ → /ðə.**li.bro/**

c. I **sent** *la carta a mi* mom. 'I sent the letter to my mom.'
   = Convergence of 'sent' towards Spanish: /a͡ɪ.**sɛnt** / → /a͡ɪ.**sɛn**/

(14) Lexical reformulations

a. I **drove** *el coche.* 'I drove the car.'
   = Cluster avoidance: I drove *el coche.* → *Conduje* (/**kon.du.je**/) the car.

b. The ***libro*** *se ha caído* off the table. 'The book has fallen off the table.'
   = Cluster pursuit: The **libro** → The **libro gris** (/ðə.**lib.ro.gris**/)

c. I **sent** *la carta a mi* mom. 'I sent the letter to my mom.'
   = Cluster avoidance: I sent → I posted (/**pos.tɪd**/)

As per MacSwan's minimalist model of the bilingual language faculty, the analysis is expected to yield outcome A; the relative frequency of syllabic structure used by Maria is not hypothesized to differ significantly from her unilingual speech in each respective language.

3.2.4 Analyses

In order to verify this hypothesis empirically, two separate analyses were realized: generalized linear models and repeated measure ANOVAs. As the frequencies of the syllable types are

[4] Miami Latino English (colloquially referred to as the "Miami-Dade accent") appears to present its own dialectal attributes. In particular, linguistic studies have observed differences in the prosody (e.g., Alvord 2006; Carter, López Valdez & Sims 2020), the realization of the lateral /l/ (e.g., Rogers & Alvord 2019) and the realization of low vowels (e.g., Carter, López Valdez & Sims 2020) in Miami English. To my knowledge, research up to this point has not yet examined the phenomenon of cluster reduction in this dialect.

interdependent for a given analysis, and are skewed for values below 0.5, all proportion values were transformed into logits. This was the dependent variable in both analyses.

Firstly, three generalized linear models were constructed for the data (see Supplementary material for *R* script). The first ("Baseline") contained the following independent (categorical) predictors: ONSET (zero Cs, one C, two Cs, three Cs) and CODA (zero Cs, one C, two Cs, three Cs). In the second ("LanguageModerator") and third ("ContextModerator") models, the additional categorical predictor of, respectively, LANGUAGE (English or Spanish) and CONTEXT (unilingual or code-switched), were introduced. The interaction between this additional predictor and each other initial predictor was also included in the last two models (e.g., Context*Onset, Context*Coda, Context*Onset*Coda). The goal of this analysis was to examine the goodness of fit of each model, in order to assess whether the introduction of LANGUAGE or CONTEXT enable the model to make better predictions about the frequency of each syllable type. The goodness of fit of each model was interpreted via the Akaike Information Criterion (AIC; Akaike 1987). The AIC gives information about the quality of a given model: the lesser the AIC, the better the fit of the model. AIC is useful, as it penalizes the addition of any new predictor to the model. This prevents more complex models from being a better fit simply by virtue of being more complex. A difference in AIC larger than +/–2 between models is interpreted as a significant difference between the models. If Maria is using compartmentalized phonological systems when she is code-switching, the inclusion of LANGUAGE should provide the truest model for the data.

The second analysis was used to confirm the results from the AIC analysis. Separate 2 x 2 repeated-measures ANOVAs were conducted for each syllable type (i.e., CV, CVC, V, VC… etc.) using the data from the disaggregated audio-files (see Supplementary material for summarized data). This wasn't accomplished for CCCVCC and CCVCCC syllable types due to lack of data. The ANOVAs included the experimental factors of CONTEXT and LANGUAGE. Note that audio files (n = 15) represent different conversations recorded by Maria (i.e., different times, places and co-interlocutors). This type of analysis allows us to treat the audio file as a factor potentially introducing variability into the results. Furthermore, it tests for differences according to LANGUAGE and/or CONTEXT within individual syllable types, giving us more fine-grained insight into the data. If Maria's phonological systems are indeed separate, LANGUAGE should produce significant differences between syllable types, but not CONTEXT.

3.3 Results

3.3.1 The data

From the 14 hours of Maria's recorded conversations, 37 609 syllables were coded, with 88% of syllables belonging to unilingual speech (within unilingual speech: English = 69%; Spanish = 31%) and 12% belonging to intra-sentential code-switching (within code-switches: English = 45%; Spanish = 55%). The number and proportions belonging to each syllable type according to the experimental factors (Context and Language) are detailed in **Table 4** and depicted visually in **Figure 2**. Note that Maria's syllable proportions largely match those that have been reported previously for unilingual English and Spanish speech (see **Table 1**).

3.3.2 Generalized linear models

The results from all three models are presented in **Table 5**. As can be seen, the inclusion of the Language predictor (*LanguageModerator*) produced the best fitted model; its AIC is the smallest in magnitude, and the difference in AIC between *LanguageModerator* and both other models is larger than 2. As such, even when additional predictors were penalized, Language (Spanish vs. English) improved the predictability of the data. *ContextModerator* was not better fitted than the baseline model (difference in AIC = 0.5), indicating that Context (monolingual vs code-switched) does *not* improve the goodness of fit of the model to the data.

3.3.3 Repeated-measure ANOVAs

The results from the ANOVAs are presented in **Table 6**. As can be seen, the factor of Language produced significant (or near-significant) differences between syllable proportions for the following syllable types: CVC, V, VC, CCV, CCCV, VCC, CVCC, CCVCC, CVCCC. The factor of Context was only significant for one syllable type (devoid of any consonant clusters): VC. Based on these results, it is clear that Language (i.e., belonging to an English vs. a Spanish portion of speech) is a better predictor of syllable identification than Context (i.e., belonging to a unilingual vs. a code-switched portion of speech).

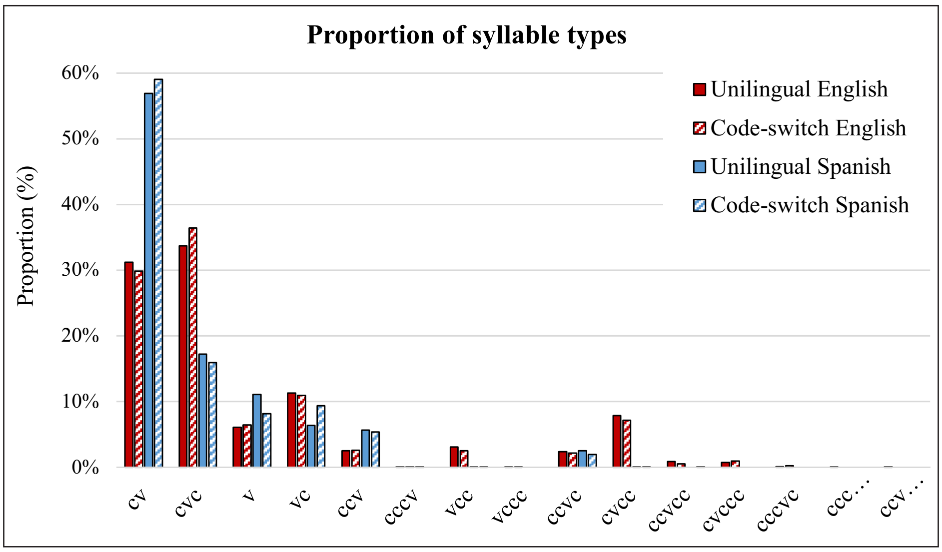

Figure 2: Proportion of syllables according to Context and Language.

	Unilingual EN		CSwitched EN		Unilingual SP		CSwitched SP	
	n	**%**	***n***	**%**	***n***	**%**	***n***	**%**
CV	6954	31.20 %	638	29.85 %	6086	56.93 %	1461	59.02 %
CVC	7877	33.72 %	697	36.45 %	1681	17.25 %	402	15.95 %
V	1480	6.07 %	119	6.44 %	839	11.11 %	205	8.15 %
VC	2459	11.33 %	201	10.98 %	796	6.41 %	212	9.37 %
CCV	567	2.51 %	59	2.57 %	549	5.65 %	132	5.42 %
CCCV	5	0.03 %	1	0.02 %	1	0.00 %	0	0.00 %
VCC	684	3.08 %	65	2.57 %	1	0.06 %	1	0.02 %
VCCC	7	0.05 %	1	0.06 %	0	0.00 %	0	0.00 %
CCVC	593	2.39 %	46	2.14 %	310	2.57 %	53	1.94 %
CVCC	1856	7.92 %	165	7.20 %	7	0.03 %	2	0.06 %
CCVCC	186	0.86 %	16	0.54 %	0	0.00 %	2	0.06 %
CVCCC	133	0.72 %	20	0.96 %	0	0.00 %	0	0.00 %
CCCVC	28	0.10 %	4	0.23 %	0	0.00 %	0	0.00 %
CCCVCC	2	0.02 %	0	0.00 %	0	0.00 %	0	0.00 %
CCVCCC	6	0.02 %	0	0.00 %	0	0.00 %	0	0.00 %
TOTAL	**22837**	**100%**	**2032**	**100%**	**10270**	**100%**	**2470**	**100%**

Table 4: Overall summary of coded data, collapsed across audio files.

	AIC	Delta AIC
Baseline	155.8	5.9
LanguageModerator	149.9	0.00
ContextModerator	155.3	5.4

Table 5: AIC results from the generalized linear models (null deviance = 95.535, df = 59).

Syll. Type	**Effect**	***Mean Square***	***F***	***p***	η^2_p
CV	Context	2.023	3.180	.096	.185
	Language	3.603	3.480	.083	.199
CVC	Context	1.602	3.212	.095	.187
	Language	10.093	21.183	< **.001****	.602
V	Context	.048	0.152	.702	.011
	Language	.962	4.361	**.056**	.238
VC	Context	2.227	8.303	**.012***	.372
	Language	2.734	5.251	**.038***	.273
CCV	Context	.008	0.019	.892	.001
	Language	4.677	8.631	**.011***	.381
CCCV	Context	<.001	0.213	.651	.015
	Language	.007	4.171	**.060**	.230
VCC	Context	.143	2.069	.172	.129
	Language	20.491	92.813	< **.001****	.869
VCCC	Context	<.001	0.010	.923	<.001
	Language	.023	2.145	.165	.133
CCVC	Context	.111	0.501	.491	.035
	Language	.046	0.259	.619	.018
CVCC	Context	.005	0.023	.883	.002
	Language	57.636	278.786	< **.001****	.952
CCVCC	Context	.081	1.712	.212	.109
	Language	2.755	35.209	< **.001****	.715

(Contd.)

Syll. Type	Effect	*Mean Square*	*F*	*p*	η^2_p
CVCCC	Context	.006	0.084	.776	.006
	Language	3.775	35.323	**< .001****	.716
CCCVC	Context	< .001	0.019	.894	.001
	Language	.129	3.003	.105	.177

Table 6: Results from RM-ANOVA. Significant *p*-values are flagged with asterisk(s) and bolded; *p*-values trending towards significance are also bolded. In all cases, df = (1,14).

3.4 Discussion

In line with the hypotheses, statistical models indicated that the language of production of each syllable *was* a significant predictor in determining syllabic frequency in intra-sentential code-switches. Context was neither a significant predictor for syllabic use in Spanish nor in English. As such, even when Maria was code-switching, the Spanish portions of her mixed utterances were Spanish-like, and the English portions of her mixed utterances were English-like (see assumption *A* in (12)). By contrast, context was neither a significant predictor for syllabic use in Spanish nor in English—Maria was not using an excess of complex onsets and codas in the Spanish portions of her code-switched speech, and she was not limiting these same syllabic structures in the English portions. These main findings demonstrate that Maria was actively and abruptly switching between the encapsulated phonological systems of her language.

Recall that MacSwan suggests that code-switching at the phonological form of language is unavailable, since PF is composed of hierarchical constraints: if the phonological forms were united, in a code-switching context, the order of the constraints would not be upheld. In consequence, when a derivation arrives at Spell-Out, two separate phonologies (PS_x and PS_y) are compartmentalized before PF. This means that lexical items originating from either lexicon can only be conditioned by L_x *or* L_y. The results from the current study thoroughly support MacSwan's model: Maria's language-specific orderings of *Complex were preserved during code-switching (i.e., the syllabic structure in her code-switched speech matched the syllabic structure of respective monolingual speech). Consequently, the current data also fail to support models which maintain that bilinguals possess fully integrated grammars (see López 2020); Maria displayed no convergence between her phonological systems. The interface of phonology is clearly dichotomized in the bilingual language faculty.

How can independent phonological systems be analyzed within OT? Preliminary considerations tend to support the notion of co-phonologies. The formalism of co-phonology has mostly been applied to morphologically conditioned phonological systems. In a co-phonology (e.g., Inkelas 1998; Inkelas & Zoll 2007), different morphological components (within a single language) are treated with different grammars (e.g., one for suffixes, one for roots). Co-phonologies have previously been implemented for words from different lexical classes (Inkela & Zoll 2007). From this line of thinking, it is not a huge leap to suppose that co-phonologies can be applied to different *lexical sets*, as in code-switching.

A co-phonology seems to correspond to what was observed in Maria's code-switched speech: Maria abruptly alternated from one phonological system to the next when she mixed Spanish and English. In a code-switching co-phonology, each language involved in the utterance would possess its own compartmentalized phonological system. That is, phonological systems would map to a single language involved in the switch. Spoken works would thus be parsed by the appropriate system, depending on the language from which they originate.

3.5 Section summary

Up to this point, the minimalist model of the bilingual language faculty (MacSwan 2000) has been supported. Utilizing the phonotactic differences between Spanish and English (i.e., regarding the *COMPLEX constraint), the speech of a Spanish-English code-switcher was analyzed in order to determine whether she abruptly alternated between her phonological systems during code-switching. The analysis revealed differences in syllabic proportion between languages (Spanish vs. English), but *not* between contexts (unilingual vs. code-switched). These results reinforce the idea, in line with MacSwan's model of bilingual language faculty, that A) distinct phonological systems are accessed during code-switching and B) that these systems correspond to those of each monolingual language involved.

We can now answer the first half of the primary research question: the bilingual language faculty is composed of two compartmentalized phonological systems. Just like MacSwan originally conjectured, "language switching *is* phonological switching" (MacSwan & Colina 2014: 188). In the next section, I will answer the second part of the research question. That is, I will review theoretical evidence that suggests that code-switching is composed of a single syntactic grammar. This evidence will once again be supported by in-the-field instances of Maria's code-switched speech.

4 Syntax: Single and ready to mingle

4.1 Background

While the independence of the phonological systems is supported, this does not reflect the entire conceptualization of the bilingual language faculty. Recall that MacSwan's model also ascertains that bilinguals (just like Chomsky's monolingual) possess a computational system (C_{HL})

which combines items into a single syntactic derivation. That is, once items are chosen from the lexicon(s), the array is Spelled-Out in one fell swoop (or, potentially, in a series of phases; see López *et al*. 2017); structures are built when items are derivationally combined via the operation of Merge (MacSwan 2000).

Up to this point, I have taken the singularity of C_{HL} for granted. Nonetheless, another option is possible when it comes to the bilingual language faculty: individuals who speak more than one language may possess globally compartmentalized systems for each language, as in **Figure 3** (right panel). Luis López (2017 and onward) coins this framework as *separationism* or the *common-sense* framework, since it is reflective of the way humans intuitively think about language (e.g., "*I speak three languages, but my mom only speaks two*."). As MacSwan's model also involves some degree of architectural separation (i.e., at the level of phonology), I will refer to the common-sense framework as *global* separationism. Global separationism entails that bilinguals' morphosyntactic grammars[5] are just as independent as their phonological systems.

Crucially, global separationism and MacSwan's model make different assumptions with regard to multi-language structures. If global separationism is correct, the bilingual language faculty

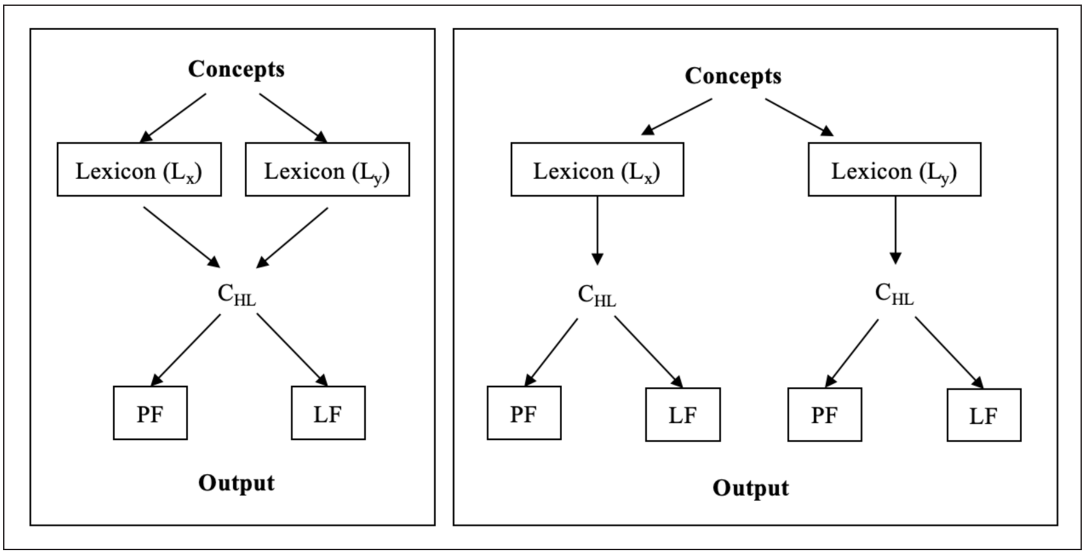

Figure 3: *Left*: Simplified version of MacSwan's (2000) model of the bilingual language faculty. *Right*: The bilingual language faculty from a globally separatist perspective (adapted from López 2020: 17).

[5] When alluding to the *morpho*syntactic system or grammar, I refer to this component in a purely minimalist sense. That is, I examine morphemes that are essentially realizations of *syntactic* features (e.g., case, person, gender, number, etc.). This should not be confused with morphological traits privy to integration, which has often been linked to a change in the phonological system (e.g., MacSwan 2000).

would only be able to Merge items from a single lexicon, since the C_{HL} is language-dependent, or language-encapsulated. Contrastively, MacSwan's minimalist model of the bilingual language faculty allows for the combination of items originating from multiple languages.

You may think that global separationism is immediately falsified, since bilinguals evidently do combine items from more than one lexicon—that is the very core of intra-sentential code-switching, after all. However, a sceptic might argue that the mere existence of code-switching does not negate global separationism, since bilinguals may simply be building partial syntactic structures within their compartmentalized computational systems, before pronouncing these structures in juxtaposition. In other words, some may argue that code-switching has the outward appearance of a combined syntactic system, but that it is actually composed of independent structures being outputted side-by-side. This would entail that code-switching is a surface phenomenon that exists in performance but not in competence.

How can we verify whether this is the case? It seems that the solution lies in the examination of syntactic dependencies (i.e., c-command, grammatical case, complement relations), which presupposes the singularity of C_{HL}. The theoretical outcomes are the following.

(15) **Theoretical outcomes**

A. If syntactic dependencies are found between items of L_y and L_x, code-switching can be represented by G_{xy}.

B. If items from L_y and L_x do not interact syntactically, code-switching cannot be represented by G_{xy}.

The diverse syntactic code-switching literature, as well as Maria's speech from the Bangor-Miami corpus, provide us with ample opportunities to verify these assumptions. Much of the argumentations provided in this section are inspired by Luis López' generativist body of work, most notably his recent book (2020). Recall that, unlike MacSwan, López believes that the bilingual language faculty is combined at every interface, including PF. While the syllabic data from Section 3 markedly refutes the integration of a bilingual's *phonological* systems, this does not mean that López' entire model is unsupported. In fact, MacSwan and López appear to agree in their assumption that bilinguals derive code-switches from a unique syntactic subset. Maria's naturalistic data provides more evidence for this conjecture.

Given that much of the evidence provided in the subsequent sections was also presented by López (2020), novel data (i.e., Maria's data from the Bangor-Miami corpus; syntactic judgements obtained by the author) are identified as such.

4.2 Negative polarity items

According to Hoeksema (2000: 115), negative polarity items (NPIs) are linguistic units that "give rise to minimal pairs of affirmative and negative sentences". Crucially, in order to produce grammatical sentences, NPIs must be c-commanded (see Chomsky 2014) by negative elements, like *not* (Giannakidou 2011). Thus, the difference between the sentences in (16) is that *any* is licensed (or triggered) in (16a) but not in (16b).

(16) a. I do <u>not</u> have **any** more candy.
b. *I have **any** more candy.

Past data (and novel judgements)[6] indicate that sentences containing opposite-language NPIs and negation triggers are acceptable, as indicated in (17–19). In each case, the NPI is bolded and the license is underlined. Under a globally separatist point of view, such sentences should be ill-formed, since syntactic relations like c-command can only take place within the language-compartmentalized C_{HL}. On the other hand, MacSwan's model predicts that such constructions should be entirely acceptable, since lexical arrays are built into a single syntactic structure and can thus Command one another.

(17) Spanish / *Basque* (Vergara & Lopéz 2017 : 270)

a. *<u>Ez</u> zen* **nadie** *etorri etxera.*
NEG AUX anyone come home
'No one came home.'

b. <u>No</u> vino ***inor*** a casa.
NEG come anyone home
'Nobody came home.'

(18) English / *Canadian French* (novel data; author's judgements)

a. *Y'a <u>pas</u> de* snow **anymore**. / **Y'a du* snow **anymore**.
there is no snow anymore there is snow anymore
'There's no snow anymore.'

b. *Jean lave <u>jamais</u>* **ever** *sa* van. / **Jean lave* **ever** *sa* van.
Jean washes never ever his van Jean washes ever his van
'Jean doesn't ever wash his van.'

(19) English / *Lebanese Arabic* (novel data; personal communications)

a. He's <u>not</u> better than ***7adan***.
he is not better than anyone
'He's not better than anyone.'

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[6] Code-switched NPIs were not observed in Maria's speech. This does not mean that such constructions are ill-formed in Spanish-English, only that they were not produced by Maria within the corpus (the 'induction problem': MacSwan & McAlister 2010).

In each of these cases, a syntactic dependency is established between an NPI and a trigger that originate from distinct lexical sets. That is, a negative particle from L_x licences an NPI from L_y. Thus, the singularity of the syntactic component is supported: the examples above clearly demonstrate that code-switching is not simply the juxtaposition of two partial syntactic structures constructed in language-dependent C_{HL}. In actuality, the lexical items from the code-switched language pairs are united into a combined array, from which the unique C_{HL} can build a single syntactic construction.

4.3 Grammatical case

Grammatical case is associated to the syntactic or grammatical function of an item within a given sentence. Many languages possess complex case systems, wherein grammatical case is indicated by an inflectional morpheme; the sentence becomes unacceptable in the absence of case marking or when the wrong case is assigned. For instance, in (20b) *bedny*- 'poor' is assigned the genitive case instead of the dative case (as in 20a), and the resulting sentence is ill-formed.

(20) Russian (Babby 1987)

a.	Bogatye	nijogda	ne	zavidujut	**bednym**.
	the-rich.NOM	never	NEG	envy	the-poor-**DAT**
	'The rich never envy the poor.'				
b.	*Bogatye	nikogda	ne	zavidujut	**bednyx**
	the-rich-NOM	never	NEG	envy	the-poor-**GEN**

If case assignment occurs between a verb from L_x and an item from L_y, we can say that there is a syntactic dependency between these items, and that they co-exist within the same C_{HL}. Past evidence suggests that these syntactic dependencies do indeed take place in code-switching (21–24). For instance, in the sluicing constructions in (21), the verb 'to threaten' assigns the dative case in German (21a), but the accusative case in Spanish (21b). However, in the code-switch, the German remnant 'who' must possess the accusative case (21c). This judgement was confirmed by an acceptability task (González-Vilbazo & Ramos 2011). López (2020) also gives evidence that these types of constructions occur (23–24).

(21) German / *Spanish* (González-Vilbazo & Ramos 2018)

a.	Juan	hat	jemandem	gedroht	aber	ich	weiß	nicht	{*wer/ *wen/**wem**.
	Juan	has	someone.DAT	threatened	but	I	know	not	who.NOM/ACC/**DAT**
b.	*Juan*	*amenazó*	*a alguien*		*pero*	*no*	*sé*		*{*quién / **a quién**}*.
	Juan	threatened	someone.ACC		but	not	know		who.NOM / **ACC**
c.	*Juan*	*amenazó*	*a alguien*		aber	ich	weiß	nicht	{**wen** / *wem}.
	Juan	threatened	someone.ACC		but	I	know	not	**who.ACC** / DAT
	'Juan threatened someone, but I don't know who.								

(22) Basque / *Spanish* (González-Vilbazo & Ramos 2018)
a. *Algún ancian-o* ***maestr-o*-k** fabrika-n bai barre egiten dut.
some old **teacher-.ERG** factory-LOC indeed laugh do AUX
'Some old teacher(m/f) laughs in the factory.'

(23) German / *Turkish* (Lopéz 2020)
a. Neu-e **Film-*i*** sehen *yapiyor*.
new **film-ACC** see do
'Seeing a new film.'

(24) Russian / *Kazakh* (Lopéz 2020; originally from Auer & Muhamedova 2005)
a. *Anau* star-y **ploshod-*tï*** *ne-ler-di zönder-di.*
this old-NOM/ACC **square-ACC** thing-ACC renovate
'There the old square and so were were already renovated.'

Altogether, these data illustrate that grammatical case assignment can take place between items from different languages. As case assignment entails syntactic dependency (assumption A), it is clear that the intra-sentential code-switches shown above were derived from a singular syntactic construction. The evidence above therefore supports the singularity of the syntactic component, in line with MacSwan's formulation of the bilingual language faculty.

4.4 Mixed selection

López (e.g. 2020) originally introduced the 'Mixed Selection' problem by examining code-switching between light verbs and infinitives. To generalize this concept, I assume that Mixed Selection has occurred when an item from L_x selects one from L_y as its complement, or vice versa.

4.4.1 Determiner phrases

The general consensus in syntax is that constituents such as *that flower, la flor* are headed by the determiner (see Bernstein 1991). In Spanish and English, the determiner-head requires a nominal complement. For instance, the sentence in (25) becomes unacceptable if the noun phrase within the scope of the DP is empty.

(25) a. Ben went to **the store** to buy apples. / *Ben went to **the** to buy apples.
b. *Ben fue a* ***la tienda*** *a comprar manzanas. / *Ben fue a* ***la*** *a comprar manzanas.*

Thus, if a determiner from L_x selects a nominal complement from L_y, we can assume that Mixed Selection has occurred. Under global separationism, the derivation containing the DP should crash within the language specific C_{HL}, since the complement position would be empty. However, if we assume that code-switching is built from a single syntactic construction, Mixed Selection involving determiners and nouns is entirely unproblematic.

Mixed determiner phrases were copious in Maria's spontaneous speech (26). There also exist innumerable examples in the code-switching literature (Ewing 1984; Köppe & Meisel 1995; MacSwan 2000; Liceras Fernández Fuertes, Perales, Pérez-Tattam & Spradlin 2008; Myers-Scotton & Jake 2009; Gonzalez-Vilbazo & López 2011; Burkholder 2018; López 2020; etc.). Thus, Mixed Selection between determiners and nouns supports MacSwan's minimalist model of the bilingual language faculty.

(26) Maria's English / *Spanish* (Bangor Miami Corpus) (novel data)
- a. I mean you can see the big ***las*** **pieces of property** (Maria, 1, 68)
  'I mean you can see the big, the big pieces of property…'
- b. *Es* ***el*** **north side** so it doesn't get any sun. (Maria, 1, 119–120)
  'It's the north side so it doesn't get any sun.'
- c. *Me dice no es que tienen* ***el*** **heating thing**. (Maria, 1, 289–290)
  'She told me no, it's that they had the heating thing.'
- d. *Chica te hace falta* ***un*** **new calendar**. (Maria, 2, 36)
  'Girl, you need a new calendar.'
- e. *Dejame ver ya guardaste* ***tu*** **pink shirt**. (Maria, 16, 189)
  'Let me see, did you already put away your pink shirt?'
- f. *Cuándo es* ***el*** **swearing in**? (Maria, 18, 830)
  'When is the swearing in (ceremony)?'

4.4.2 Verbal complements

Some transitive and ditransitive verbs require complements. For instance, the sentence in (27), which contains the transitive verb 'to buy'/'*comprar*', is rendered unacceptable if the object DP is absent. In this case, one would say that the verbal head 'selects' (or Merges with) its complement, 'a pair of socks'/'*un par de calcetines*'.

(27)
- a. Mona bought a pair of socks. / *Mona compró un par de calcetines.*
- b. *Mona bought. / **Mona compró.*

If an obligatorily transitive verb from L_x selects a complement from L_y, this means that Mixed Selection has occurred. There are countless examples of this type of Mixed Selection in Maria's naturally produced speech (28). It is also abundant in the code-switching literature (Pfaff 1979; Ewing 1984; Azuma 1993; Mahootian & Santorini 1996; Gonzalez-Vilbazo & López 2011). The presence of such constructions provides solid evidence of a united syntactic component, in line with MacSwan's model of the bilingual language faculty. If the C_{HL} were language-dependent, the partial structure involving the verb would crash before Spell-Out in the absence of its complement.

(28) Maria's English / *Spanish* (Bangor Miami Corpus) (novel data)

a. *Si* *es* **four-wheel drive**? (Maria, 1, 33)
'If it's four-wheel drive?'

b. *Mi carro* *tiene* **heated seats**. (Maria, 1, 283)
'My car has heated seats.'

c. In fact, I was watching ***las noticias*** *y había una mujer que salio con* identical triplets. (Maria, 20, 245–246)
'In fact I was watching the news and there was a woman on the news who has had identical triplets.'

d. *Pero ellos no* *querían* **multiple kids**. (Maria, 20, 249)
'But they didn't want multiple kids.'

e. *Comiendo* **two bowls of cereal** *todas las noches*… (Maria, 27, 177)
'Eating two bowls of cereal every night.'

f. *No creo que* *haya* **orange soda** *mama*. (Maria, 40, 236)
'I don't think there's orange soda honey.'

4.5 Section summary

In the current section, the second half of MacSwan's model of the bilingual language faculty was supported: code-switching is in fact governed by a singular morphosyntactic grammar. The evidence from the literature and Maria's spontaneous speech shows that syntactic dependencies do indeed take place between different-language items. This is not predicted by global separationism, which presupposes globally encapsulated systems for each language known by a bilingual or multilingual.

We can now answer the second half of the primary research question. Contra the "common-sense" hypothesis, the bilingual language faculty is composed of a unique computational system, wherein syntactic constructions are built.

5 Concluding remarks

The current paper has examined the architecture of the bilingual language faculty by reviewing code-switching data. As MacSwan originally conjectured, bilingual cognition is composed of a single computational system, which can build multi-language syntactic constructions, and two phonological systems. MacSwan's model was supported using both empirical (corpus-based) data and theoretical frameworks. This means that code-switching, essentially, is 'just phonological switching". Interestingly, neuroimaging studies have shown that language switching does indeed engage brain regions associated to phonological processing (Price, Green & von Studnitz 1999).

This paper is not only relevant for formal bilingualism research; it may also allow researchers to contextualize past experimental studies. For instance, past research has demonstrated that cognates (i.e., orthographically and/or phonologically similar words cross-linguistically, such as *table* in French and English) may act as catalysts for code-switching (e.g., Brown 2015). That is, the alternation between languages (code-switching) is most likely to occur after a cognate has been produced. This finding also appears to be predicted by the architecture of the bilingual language faculty. If the assembling process is cognitively costly, then this effort may be mitigated by the presence of a cognate, since such words possess similar entries in each of the lexicons. Bilinguals may thus utilize this temporary dip in the required cognitive effort to juxtapose items from their languages. Future research should examine this interesting pattern more closely.

Before ending this paper, one last peripheral point can be made about MacSwan's model of the bilingual language faculty. Recall that, in the pursuit of computational efficiency, MacSwan theorizes that bilinguals possess separate lexicons for each language that they speak (for alternative perspectives see work by Artemis Alexiadou, Kay González-Vilbazo, Luis López and Sara Stefanich). This is not the prevalent view, particularly in psycholinguistics, since a wealth of data indicates that bilinguals possess cooperative or (partially) overlapping lexicons (e.g., Beauvillain & Grainger 1987; Hartsuiker *et al.* 2004; Sabourin *et al.* 2014). While this issue is beyond the scope of the present paper, it does not appear that the architecture of the lexicons is particularly pivotal to MacSwan's model. Whether or not the lexicons are overlapped, the reality remains that bilinguals possess one C_{HL} and two phonological systems. It is not immediately apparent how the presence of an integrated lexicon would challenge these assumptions.

Altogether, in bolstering MacSwan's model of the bilingual language faculty, this paper supports the constraint-free approach for code-switching, as it achieved by the minimalist program. That is, code-switching is uniquely governed by the languages that compose it, and not a third grammar. Future studies should examine switching using this minimalist tradition.

Abbreviations

Accusative (ACC), Akaike Information Criterion (AIC), Auxiliary (AUX), Computational system of human language (C_{HL}), Consonant cluster (CC), Dative (DAT), Determiner phrase (DP), Ergative (ERG), Genitive (GEN), Locative (LOC), Negation (NEG), Negative polarity items (NPI), Nominative (NOM), Optimality Theory (OT), Phonological form interface condition (PFIC); Phonological system (PS), Voice onset time (VOT)

Supplementary files

The *R* script for the generalized linear models and the summary of the audio-file disaggregated data are available in the supplementary materials: https://doi.org/10.16995/glossa.5800.s1. Full coded data sets are also available upon request.

Acknowledgements

The author would like to thank Flavio Barinas, Mariana Cortés Kandler and Belén López Assef for providing valuable insights in regard to the Spanish-English data. Many thanks to Dr. Kevin McMullin, Dr. Dennis Ott, and Dr. Marc Brunelle for providing thoughtful comments that helped improve this paper.

Competing Interests

The author has no competing interests to declare.

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