American Psychological Association

Journal of Experimental Psychology:
Learning, Memory, and Cognition

ISSN: 0278-7393

2020, Vol. 46, No. 4, 741–759
http://dx.doi.org/10.1037/xlm0000755

Does Integrating a Code-Switch During Comprehension Engage Cognitive Control?

Rachel M. Adler
University of Maryland, College Park

Jorge R. Valdés Kroff
University of Florida

Jared M. Novick
University of Maryland, College Park

We investigated whether bilinguals' integration of a code-switch during real-time comprehension, which involves resolving among conflicting linguistic representations, modulates the deployment of cognitive-control mechanisms. In the current experiment, Spanish-English bilinguals (N = 48) completed a cross-task conflict-adaptation paradigm that tested whether reading code-switched sentences triggers cognitive-control engagement that immediately influences performance on an ensuing Flanker trial. We observed that, while incrementally processing sentences, detecting a code-switch (as opposed to reading sentences that did not contain a code-switch) assisted subsequent conflict resolution. Such temporal interdependence between confronting cross-linguistic conflict and ensuing adjustments in behavior indicates that integrating a code-switch during online comprehension may recruit domain-general cognitive-control procedures. We propose that such control mechanisms mobilize to resolve among competing representations that arise across languages during real-time parsing of code-switched input. Overall, the findings provide novel insight into what language-processing demands of bilingualism regulate cognitive-control performance moment by moment.

Keywords: bilingualism, comprehension, conflict adaptation, cognitive control, code-switching

While processing text or speech, readers and listeners rapidly commit to provisional analyses of the input as it unfolds by coordinating multiple sources of linguistic and nonlinguistic cues to guide interpretation in real time (e.g., Altmann & Kamide, 1999; MacDonald, Pearlmutter, & Seidenberg, 1994; Tanenhaus, Spivey-Knowlton, Eberhard, & Sedivy, 1995). Though efficient, one by-product of incremental language processing is that we frequently confront temporary ambiguity that must be quickly resolved. For instance, words can have many meanings, and phrases can be consistent with multiple structures. A typical consequence of parsing "on the fly" then is that early processing decisions sometimes turn out to be wrong once later-arriving evidence conflicts with a developing analysis. According to one model, cognitive-control procedures resolve conflict at multiple levels of representation once a reader or listener discovers a misanalysis, thereby preventing comprehension from running astray. Specifically, conflict-resolution mechanisms engage to rein in an incorrect characterization of the input to promote an alternative one (Novick, Trueswell, & Thompson-Schill, 2005).

Much of the evidence supporting this account derives from sentence-processing studies in monolinguals (but see Teubner-Rhodes et al., 2016). Here, we consider how the real-time parsing demands of *bilingual* language processing may distinctively create conflict and recruit cognitive control. Specifically, we focus on the online comprehension of code-switches, that is, the alternation between languages within bilingual speech or text (Poplack, 1980). On the surface, it may seem odd that bilinguals purposefully code-switch with other bilinguals, because the prospect of a switch between languages potentially introduces greater ambiguity. Yet code-switching is a ubiquitous bilingual practice in conversation and increasingly in writing (e.g., emails, online chats, texts; Guzzardo Tamargo, Valdés Kroff, & Dussias, 2016; Montes-Alcalá, 2000). Although the reasons why bilinguals code-switch involve a complex array of cognitive, structural, and pragmatic factors (e.g., Bullock & Toribio, 2009; Gardner-Chloros, 2009), the very act of switching between languages within a discourse generates cross-linguistic conflict at multiple linguistic levels of representation

This article was published Online First August 26, 2019.

Rachel M. Adler, Program in Neuroscience and Cognitive Science and Department of Hearing and Speech Sciences, University of Maryland, College Park; Jorge R. Valdés Kroff, Department of Spanish and Portuguese Studies, University of Florida; Jared M. Novick, Program in Neuroscience and Cognitive Science and Department of Hearing and Speech Sciences, University of Maryland, College Park.

We thank Julian Acierno, Chris Dean, Karen Gonzalez, Damaris Mayans-Ramon, Hannah Sichel, Ana Vilfort, and Kelly Woodfine for assistance with stimulus design, data collection, and/or data coding. This work was partially supported by a Research and Scholarship from the University of Maryland to Jared M. Novick.

Correspondence concerning this article should be addressed to Jorge R. Valdés Kroff, Department of Spanish and Portuguese Studies, University of Florida, 170 Dauer Hall, P.O. Box 117405, Gainesville, FL 326011, or to Jared M. Novick, Department of Hearing and Speech Sciences, University of Maryland, 0100 Lefrak Hall, College Park, MD 20742. E-mail: jvaldeskroff@ufl.edu or jnovick1@umd.edu

(phonological, lexical, morpho-syntactic, etc.). From the comprehender's standpoint, this conflict must be resolved promptly to prevent a communicative exchange from reaching a bottleneck or breaking down entirely.

According to the proposal found in Novick et al. (2005), conflict-control procedures engage to resolve incompatible representations that arise in the natural course of incremental parsing. We pursue a theoretical connection between the demands of bilingual language comprehension and cognitive-control engagement within this established framework. To this end, we test the hypothesis that encountering a code-switch during sentence interpretation generates cross-linguistic conflict, which in turn recruits domain-general cognitive control. Namely, successfully integrating code-switches during comprehension may lead to processing costs (e.g., Altarriba, Kroll, Sholl, & Rayner, 1996; Litcofsky & Van Hell, 2017; Meuter & Allport, 1999; Moreno, Federmeier, & Kutas, 2002) and therefore may benefit from cognitive-control engagement to bias processing toward task-relevant cues. We will report initial evidence from an experiment that manipulates language-processing demands (e.g., code-switching vs. not) to test the effects of this manipulation on bilinguals' cognitive-control performance. To preview our results, we show that reading code-switched sentences on one trial (as opposed to single-language sentences) immediately assists performance on a nonverbal Flanker task on the next trial. This finding indicates that the conflict-processing demands of interpreting code-switches mobilize cognitive-control mechanisms to deploy as cross-linguistic conflict is detected. This link carries implications for understanding the cognitive mechanisms that engage during bilingual language processing.

Although we examine the interaction between cognitive control and bilingual sentence processing, we do not test the purported bilingual advantage. Whether bilinguals show cognitive-control benefits over monolinguals is controversial, and the findings are mixed (e.g., Abutalebi et al., 2012; Bialystok, Craik, & Luk, 2008; cf. Colzato et al., 2008; de Bruin, Treccani, & Della Sala, 2015; Duñabeitia et al., 2014; Hartanto & Yang, 2016; Hilchey & Klein, 2011; Martin-Rhee & Bialystok, 2008; Morton & Harper, 2007; Paap & Greenberg, 2013; Paap, Sawi, Dalibar, Darrow, & Myüz, 2014; Pelham & Abrams, 2014; Prior & Gollan, 2011; Prior & MacWhinney, 2010; Stasenko, Matt, & Gollan, 2017; Valian, 2015; von Bastian, Souza, & Gade, 2016; Yang, Hartanto, & Yang, 2016). Instead, we leverage discrepant results to raise questions about linking assumptions: What properties of bilingualism might engage cognitive control in the first place? Are there unique language-processing demands that bilinguals face in real time that might cause cognitive control to deploy? The answers to these questions could have profound impact on the advantage controversy by revealing how subtle manipulations of bilingual behavior (i.e., interpreting a code-switch vs. not) leave immediate traces on cognitive-control performance.

Our approach therefore assumes a more dynamic process at play rather than cumulative differences: bilinguals' experiences vary widely, and their respective environments (e.g., where languages are functionally kept separate vs. those who fluidly code-switch; e.g., Green & Abutalebi, 2013; Green & Wei, 2014) may place different pressures on cognitive control over time that may not apply uniformly across all bilinguals as a fixed "trait." Thus, our study aims to uncover one such demand—code-switching—in hopes of providing new insight into the conditions under which bilingual language processing has a causal and direct impact on more general cognitive-control procedures. This would ultimately suggest that a more promising way to study the effects of bilingualism on cognitive control would be to consider its "state" of engagement, which may vary by language context, instead of considering cognitive control as a population trait that is not subject to subtle environmental influences. To address these issues, we compare Spanish-English bilinguals with *themselves*, testing whether cognitive-control performance fluctuates as a function of whether they are in a code-switching situation that creates cross-linguistic conflict and, thus, pressure to engage cognitive control to resolve it.

Before detailing our study, we briefly review relevant findings on what we currently know about the role of cognitive control during sentence processing in monolinguals, and then turn to how these findings apply to understanding its role in sentence processing conditions that are exclusively bilingual in nature, namely, while interpreting code-switches.

Cognitive Control and Sentence Processing: Evidence From Monolinguals

Cognitive control refers to the regulation of mental activity to bias processing toward task-relevant information during goal-directed behavior. This is particularly important when confronted with information-conflict in the environment (Botvinick, Braver, Barch, Carter, & Cohen, 2001; Miller & Cohen, 2001), which can arise when current task demands require countermanding a dominant way of representing a stimulus. In such cases, one must rebias attention to other input characteristics that are related to current task demands (think: Flanker and Stroop). In the domain of sentence processing, cognitive control may adjust parsing strategies in the moment according to pertinent cues, to keep comprehension on track.

This theoretical relationship is corroborated by data revealing a causal connection between cognitive control and parsing in studies that exploit the "conflict adaptation" phenomenon. *Conflict adaptation* refers to events where conflict detection initiates behavioral regulation that attenuates the cost of resolving subsequent conflict (e.g., Botvinick et al., 2001; Duthoo, Abrahamse, Braem, Boehler, & Notebaert, 2014; Gratton, Coles, & Donchin, 1992; Kerns et al., 2004; cf. Weissman, Colter, Grant, & Bissett, 2017). For instance, adults are faster and more accurate to respond to an incongruent Stroop trial (e.g., *yellow* in blue ink) if it follows another incongruent trial as compared to a congruent one (e.g., *green* in green ink). This pattern reflects sustained online adjustments in cognitive control, yielding measurable behavioral savings when confronted with new instances of conflict (but see Schmidt, 2018). To address whether readers' discovery of a misinterpretation engages cognitive control during incremental parsing, Kan et al. (2013) designed a cross-task conflict adaptation paradigm that pseudorandomly interleaved Stroop conflict and no-conflict items with syntactically unambiguous and ambiguous sentences that induced misanalysis. They showed that temporary misinterpretation during comprehension, due to conflict between two incompatible representations of sentence meaning, diminished the cost of processing Stroop-conflict on an immediately ensuing trial, consistent with conflict adaptation (see also Gollan, Sandoval, & Salmon, 2011; Hsu &

Novick, 2016; Thothathiri, Asaro, Hsu, & Novick, 2018). This finding suggests that cognitive-control processes deploy following misanalysis, theoretically to enable correction of comprehension errors that would otherwise hamper communication. The present research will take a similar approach to test whether interpreting a code-switch, which involves the detection of cross-linguistic conflict, recruits cognitive control in the same way.

Although theoretical models differ in how they describe the mechanisms underlying conflict-adaptation phenomena (e.g., cf. Botvinick et al., 2001; Schmidt, 2018; Ullsperger, Bylsma, & Botvinick, 2005; Weissman et al., 2017), most agree that such behavioral adjustments reflect some form of reactive control to bias processing toward task-relevant over task-irrelevant information in the service of successful goal-directed behavior (Duthoo & Notebaert, 2012). Regardless of the particular mechanism(s) through which this is achieved, a cognitive filter of this sort assists with the correction of performance errors and/or the prevention of errors in the first place, which enhances behavioral functioning (Nozari & Novick, 2017). Here, we report an experiment that tests whether detecting a code-switch during real-time comprehension regulates bilinguals' ensuing behavior to optimize performance on an arrow-Flanker task (by biasing processing toward the relevant central arrow and away from the irrelevant flankers), even though the two tasks' stimuli and representations are from different domains. Such an effect would suggest that this type of bilingual language processing rapidly recruits a general-purpose control mechanism.

Cognitive Control in Bilingual Language Comprehension: Code-Switching as a Test Case

Bilingualism has been associated with distinctive cognitive-control demands that arise from having to manage two languages that link to a common conceptual order but do not share form (Bialystok, Craik, Green, & Gollan, 2009; Green & Abutalebi, 2013). For instance, phonological, syntactic, and semantic representations from a bilingual's two languages are not walled-off from each other, even when only one is currently in use (for reviews, see Bialystok et al., 2009; Kroll, Dussias, Bice, & Perrotti, 2015). As spoken input or text unfolds, bilinguals experience brief interference from sound-, form-, and meaning-based representations from their other language until additional linguistic evidence and/or contextual cues help resolve it (Chambers & Cooke, 2009; Costa, Miozzo, & Caramazza, 1999; Grainger & Frenck-Mestre, 1998; Schwartz & Kroll, 2006; Spivey & Marian, 1999; Van Assche, Duyck, Hartsuiker, & Diependaele, 2009). Dealing with such cross-linguistic coactivation results in notable costs to language processing, such as delays in lexical access (Gollan, Montoya, Cera, & Sandoval, 2008; Gollan, Slattery et al., 2011; Ivanova & Costa, 2008; Olson, 2016).

However, in dual-language settings, the situation may become more perilous: a listener must navigate additional demands for resolving competition when her bilingual interlocutor code-switches within a conversation—and particularly within the same sentential clause (i.e., intrasentential code-switches; Poplack, 1980)—which draws her two lexicons and grammars into direct conflict (Gollan, Schotter, Gomez, Murillo, & Rayner, 2014; Guzzardo Tamargo et al., 2016; Hernandez, Martinez, & Kohnert, 2000; Meuter & Allport, 1999; Valdés Kroff, Dussias, Gerfen, Perrotti, & Bajo, 2017). Because languages rarely overlap entirely in sound, structure, or meaning—even those that are typologically or genealogically similar—this conflict creates potential hazards to communication by increasing the prospect of uncertainty, confusion or, worse, misinterpretation. Take, for instance,

1. Pero no tenían el flag out there?[1] ("But didn't they have the flag out there?")

Here, the speaker switches from a Spanish determiner to an English noun. Although this is a highly typical switch site in Spanish-English code-switched speech (Jake, Myers-Scotton, & Gross, 2002; Poplack, 1980; Valdés Kroff, 2016), Example 1 illustrates how cross-linguistic conflict between representations from the two languages arises. Specifically, unlike English, Spanish nouns have grammatical gender and most determiners must agree in gender with the noun. After the Spanish masculine definite article "el" then, a Spanish listener should expect a noun to surface in Spanish, and for that noun to be masculine (the gender congruency effect; Friederici & Jacobsen, 1999; Hagoort & Brown, 1999; Lew-Williams & Fernald, 2007). But in this case, there are two violations of this bias that create conflict. First, the sentence continues with a code-switch into an English word, *flag*, instead of a preferred Spanish one. Second, the Spanish translation equivalent of flag is *bandera*, which is actually feminine. Thus, during real-time comprehension, the input generates incompatible representations across languages: the listener commits to a Spanish masculine noun upon hearing "Pero no tenían el . . .", but late-arriving evidence ("flag") conflicts with this characterization of the input (Beatty-Martínez & Dussias, 2017; Valdés Kroff et al., 2017).

Such cross-linguistic conflict results in momentary slowdown or greater unexpectancy (Altarriba et al., 1996; Moreno et al., 2002), but bilinguals quickly recover, rarely arriving at the wrong interpretation of a code-switched sentence (Beatty-Martínez & Dussias, 2017; Fricke, Kroll, & Dussias, 2016; Guzzardo Tamargo et al., 2016; Kootstra, Van Hell, & Dijkstra, 2012; Valdés Kroff et al., 2017). But how do bilinguals maintain such control over their languages, integrating so seamlessly? Does processing a code-switch in real time engage more general cognitive-control procedures, much like when monolinguals deal with syntactic and/or semantic conflict (Hsu & Novick, 2016; Kan et al., 2013; Thothathiri et al., 2018)? The idea is that cognitive control may assist with the resolution of competing cues across languages (e.g., ". . . *tenían el flag* . . .") to allow integration of a code-switch with representations built in the other language earlier in the sentence.

There is evidence that code-switches or switching more generally recruits bilinguals' cognitive control. Neuroimaging studies demonstrate greater activity in prefrontal areas when engaging in language-switching (Abutalebi et al., 2007; Abutalebi & Green, 2008; Hernandez, Dapretto, Mazziotta, & Bookheimer, 2001; cf. Blanco-Elorrieta & Pylkkaňen, 2017; Luk, Green, Abutalebi, & Grady, 2012), and bilinguals' performance on conflict-adaptation paradigms suggest that they may bias information-processing more proactively than monolinguals by recruiting brain regions involved

[1] This example is taken from the Bangor Miami Corpus, a publicly available Spanish-English bilingual spoken language corpus (see Deuchar, Davies, Herring, Parata Cuoto, & Carter, 2014, for details).

in switching languages (Teubner-Rhodes, Bolger, & Novick, 2019; see also Grundy, Chung-Fat-Yim, Friesen, Mak, & Bialystok, 2017). Similarly, German-English bilinguals who are "dense" code-switchers (i.e., those who frequently and fluidly alternate between languages within major sentential clause boundaries; Green & Abutalebi, 2013) demonstrate a reduced Flanker effect as compared to German-English bilinguals who are not dense code-switchers (Hofweber, Marinis, & Treffers-Daller, 2016).

Although these studies suggest that code-switching may involve cognitive control, they are based on correlational data from between-subjects designs that test whether linguistic profile (i.e., bilingual, monolingual, dense code-switcher) is associated with cognitive-control performance. That is, they assume population traits. Yet correlations do not permit causal inferences, as lurking variables (e.g., socioeconomic status, culture, etc.) may be confounded with the language-background factor that also contributes to group differences. Furthermore, most bilingual studies primarily (and unnaturally) involve exogenously cuing language switches between isolated words and concepts without an accompanying sentence (Gollan & Goldrick, 2018; Valdés Kroff, Guzzardo Tamargo, & Dussias, 2018). For example, the cued language-switching paradigm (e.g., Costa & Santesteban, 2004; Hernandez et al., 2001; Meuter & Allport, 1999; Olson, 2016) signals via a visual prompt (e.g., the color of the background) the language in which bilinguals should name digits or objects. Other sentence-level studies that use bilingual stimuli do embed code-switches in sentential contexts, but they are often limited to single words (Altarriba et al., 1996; Gullifer & Titone, 2019; Moreno et al., 2002). Finally, both experimental paradigms inevitably derive stimuli from just one grammatical class (nouns), which greatly underestimates the broad repertoire of grammatical boundaries where code-switches occur (Poplack, 1980). Thus, it remains unclear how interpreting a code-switch during more naturalistic situations (e.g., reading text) creates representational conflict as a regular byproduct of incremental interpretation and whether this engages cognitive control.

Preliminaries to the Present Study

Here, we manipulate linguistic context (e.g., real-time interpretation of code-switched sentences vs. single-language sentences) to test its effect on cognitive-control functioning, as measured by a canonical Flanker task. Despite controversy about the effects of bilingualism on cognitive control (Bialystok et al., 2009; Blumenfeld & Marian, 2013; Kroll & Bialystok, 2013; Paap & Greenberg, 2013; Prior, Degani, Awawdy, Yassin, & Korem, 2017; Valian, 2015), surprisingly little research attempts to understand the properties of bilingualism that might adjust cognitive-control performance in the first place. To this end, we assume that cognitive-control activity fluctuates on the basis of various factors (Cavanagh, Cohen, & Allen, 2009), linguistic context among them. We therefore compare bilinguals to themselves to test whether processing an intrasentential code-switch is a linguistic demand that recruits cognitive control in ways that comprehending single-language sentences does not.

Because we are studying real-time comprehension, we are not bound to provoke switches with an arbitrary cue as is the common (and perhaps necessary) practice in production studies, nor do we limit code-switches to single words or grammatical categories. Instead, we introduce ecologically valid code-switches during reading to create cross-linguistic conflict as bilinguals read text. Specifically, bilinguals read monolingual and code-switched sentences interleaved with nonlinguistic Flanker trials. For the code-switched stimuli, switches occurred within the sentence (as in Example 1 earlier), and we varied the grammatical category and location of where code-switches arose (see Appendix A). Following the predictions of conflict adaptation, if processing code-switched stimuli engages cognitive control, this should influence subsequent incongruent but not congruent Flanker performance (faster and/or more accurate responses) where the need for biased processing is stronger, resulting in a previous by current trial type interaction. Such a pattern would be especially consistent with conflict adaptation in studies that show behavioral adjustments across linguistic and nonlinguistic tasks (Hsu & Novick, 2016; Kan et al., 2013; Thothathiri et al., 2018) and would indicate that comprehending a code-switch regulates mental activity that biases information processing in accordance with task-related cues.

Method

Participants

Fifty-seven adult bilingual Spanish-English speakers (40 female, *M* age = 21, *SD* = 2.6) were recruited from the University of Florida community. All were right-handed, healthy, and had normal or corrected-to-normal vision. They provided written informed consent, and the human subjects review board at the University of Florida approved all experimental procedures. Subjects were paid $20 total or given class credit for their participation.

In a separate session after the experiment, participants completed a battery of subjective and objective proficiency measures following the procedure outlined in Guzzardo Tamargo et al. (2016) and Valdés Kroff et al. (2017). These tests included an online Language History Questionnaire; a 50-question, multiple-choice English grammar assessment adapted from the Michigan English Language Institute College English Test (English Language Institute, 2001); a 50-question, multiple-choice Spanish grammar assessment adapted from the highest level of the *Diploma de español como lengua extranjera* [Diploma of Spanish as a Foreign Language] (Ministry of Education, Culture, and Sport of Spain, 2006); and an English and Spanish picture-naming task (30 items each) adapted from the Boston Naming Test (Kaplan, Goodglass, Weintraub, & Segal, 1983). This session took approximately 1 hr to complete. Descriptive statistics of the bilinguals' proficiency and demographic profiles are shown in Table 1. In addition, participants rated their own use of code-switching on a 5-point Likert scale, ranging from 1 (*never*) to 5 (*always*), giving a mean rating of 3.39 (*SD* = 1.15). Participants in aggregate were more English dominant, both by their own assessment and via standardized assessment, reflecting at least a subset of the participants' status as Spanish heritage speakers (i.e., first-language acquirers of Spanish who subsequently become dominant in their second language, English; e.g., Carter & Lynch, 2015; Prada Pérez & Hernández, 2017). Indeed, only 16 participants had been in the United States less than 5 years, whereas 28 were born in the United States or arrived before 5 years of age, with the remaining six participants having arrived in young childhood or adolescence

Table 1
Proficiency Profile of Spanish-English Bilingual Participants

Measure	English	Spanish	Difference
LHQ—Speaking (out of 10)	8.83 (1.8)	8.8 (1.43)	*n.s.*
LHQ—Listening (out of 10)	9.11 (1.6)	9.37 (.94)	*n.s.*
LHQ—Writing (out of 10)	8.8 (1.79)	7.93 (1.9)	*
LHQ—Reading (out of 10)	9.02 (1.52)	8.5 (1.5)	*n.s.*
Grammar (out of 50)	39.8 (9.02)	33.72 (7.55)	**
BNT Picture Naming (out of 30)	21.07 (5.93)	16.85 (6.25)	**

Note. LHQ = Language History Questionnaire; BNT = Boston Naming Test; *n.s.* = not significant. Mean assessment scores (with standard deviation) and paired t-tests on the difference between English and Spanish. * $p < .05$. ** $p < .01$.

(two participants did not leave a response on the Language History Questionnaire).

Materials and Procedure

We interspersed sentence-processing trial types and Flanker trial types pseudorandomly to create a 2 × 2 design: incongruent (conflict) or congruent (no-conflict) Flanker items on trial *n* followed either code-switch or no-switch (monolingual) sentences on trial *n* − 1 (see Figure 1). Participants completed 48 critical sentence-to-Flanker pairs: 12 no-switch-incongruent Flanker pairs, 12 no-switch-congruent Flanker pairs, 12 switch-incongruent Flanker pairs, and 12 switch-congruent Flanker pairs. These sequences were embedded within a larger experimental context that also contained 69 filler sentences and 60 additional Flanker trials, so that there were several sentence-to-sentence, Flanker-to-Flanker, and sentence-to-Flanker sequences, thus preventing participants from predicting upcoming trial or even task type. We never had more than two conflict types consecutively (e.g., incongruent Flanker, code-switch, incongruent Flanker) because of a prior report that a third incongruent trial "resets" cognitive control and can mask conflict adaptation effects (Kim, Johnson, & Gold, 2014; for similar cross-task designs, see Hsu & Novick, 2016; Kan et al., 2013; Thothathiri et al., 2018). We measured adaptation effects on the Flanker task because its behavioral profile has been studied extensively and it is widely used in studies of cognitive control and conflict adaptation. Thus, we tested if cross-linguistic conflict arising from code-switched sentences influences performance, via conflict adaptation, on a standard cognitive-control task (i.e., Flanker).

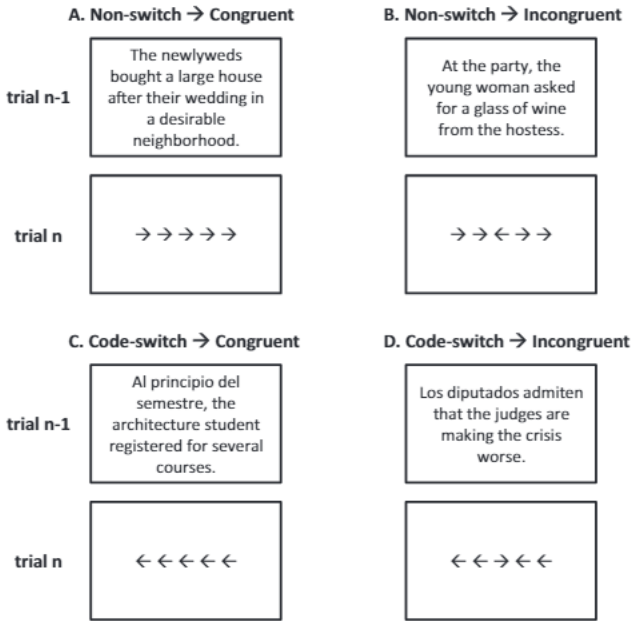

Figure 1. Experiment design showing four critical trial sequences. (A) Nonswitch sentence preceding a congruent Flanker trial; (B) nonswitch sentence preceding an incongruent Flanker trial: (C) code-switched sentence preceding a congruent Flanker trial; and (D) code-switched sentence preceding an incongruent Flanker trial. Sentences were displayed using the self-paced moving-window paradigm but are illustrated as whole sentences here for clarity.

Each trial began with a central fixation cross for 500 ms (see Figure 2). On a Flanker trial, the critical stimulus was then displayed for 1,000 ms or until the participant responded, whichever came first. On a sentence-reading trial, the masked sentence was displayed with dashes until the participant pressed the down arrow key to reveal the first word (and every word thereafter; see below). Finally, a blank screen was displayed during the 1,000-ms intertrial interval before the fixation appeared again, indicating the start of the next trial.

Flanker task. In the Flanker task, subjects pressed the left or right arrow key to indicate whether an arrow located in the center of the computer screen faced left or right. On congruent (no conflict) trials, the center arrow pointed in the same direction as the flanking arrows (e.g., →→→→→). On incongruent (conflict) trials, the center arrow pointed in the opposite direction of the flanking arrows (e.g.,→→←→→). Arrows were separated by .06° of visual angle and, together, the five angles subtended a horizontal visual angle of .55°.

Self-paced reading (SPR) task. Participants read sentences one word at a time in a noncumulative moving-window procedure

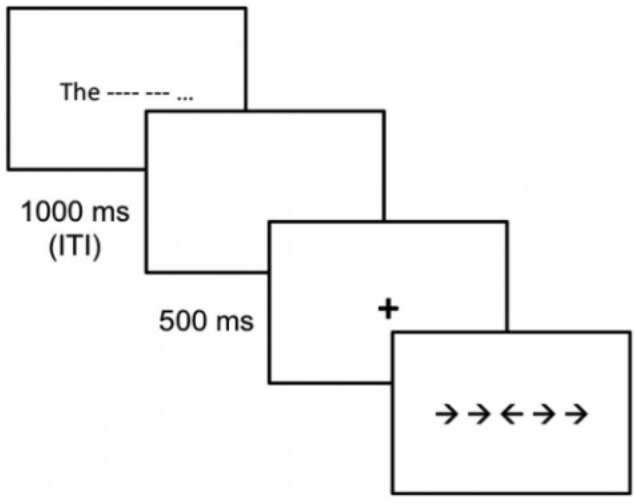

Figure 2. Example display sequence and timing for one sentence-Flanker pair. Following each trial, there was an intertrial interval (ITI) of 1,000 ms, followed by a 500-ms fixation cross and then the next trial.

(Just, Carpenter, & Woolley, 1982). Sentences began with a full mask (a string of —s replacing the letters of all words) until subjects pressed the down arrow key to begin reading word-by-word. As each new word appeared, the prior word was again masked. This procedure was chosen to more closely mimic the incremental unfolding of spoken language: input toward the end of sentences could not benefit from any preview since it was masked until actually encountered (concealing any preview of a code-switch was especially critical). On 50 filler trials (see below), the sentence was followed by a yes or no comprehension question designed to ensure that the participant was paying attention. The comprehension question was presented in the same language as the sentence it followed. For code-switched sentences, because the sentences started in Spanish and ended in English, the comprehension questions were presented in English to maintain consistency with the immediately preceding text. Comprehension probes appeared 200 ms after the sentence's offset and remained on the screen until participants responded. They pressed the left arrow key to indicate "no" and the right arrow key to indicate "yes."

We generated 192 sentence "frames," which were translated to suit each of three language presentation modes: English only, Spanish only, and code-switched. For the code-switched materials, all sentences began in Spanish and ended in English because of the preponderance of highly proficient Spanish-English bilinguals in the United States who code-switch in this language direction (Herring, Deuchar, Parafita Couto, & Moro Quintanilla, 2010; Moreno et al., 2002; Valdés Kroff, 2016; Valdés Kroff et al., 2018; cf. Blokzijl, Deuchar, & Parafita Couto, 2017). This switch direction is more natural because it reflects the code-switching practices among the U.S. Spanish-English bilinguals that we test, that is, it is the type of switching that they are accustomed to. Crucially, the location of the code-switch varied unpredictably across items: code-switches occurred between two and 13 words from the end of the sentence (mean location = 7 words from end of sentence) and were balanced across six grammatical categories that are attested code-switch sites in Spanish-English code-switching (verb, noun, complementizer/conjunction, preposition, determiner, auxiliary/infinitive; Belazi, Rubin, & Toribio, 1994; Di Sciullo, Muysken, & Singh, 1986; Poplack, 1980; see Appendix A). Thus, type and location of code-switch was not a manipulated variable by design, in order to preserve an element of ecological validity (i.e., in naturalistic speech or text, bilinguals switch in myriad ways and grammatical positions, as presented here). Consequently, there was no direct comparison between a code-switched region and a corresponding one in the monolingual sentences because the constructions were unique (e.g., if a sentence code-switched into an English preposition toward the end of a sentence, there was no equivalent monolingual sentence that would have been matched in form, length, or position).

Stimuli were administered in E-prime (Version 2.0.10.353, Psychology Software Tools, Pittsburgh, PA). Participants completed a total of 225 trials: 108 Flanker trials (27 congruent left, 27 congruent right, 27 incongruent left, and 27 incongruent right) and 117 sentence trials. Of these, 65 trials were monolingual sentences and 52 were code-switched sentences.

Participants were randomly assigned to one of four lists. In List 1, all monolingual sentences appeared in English and in List 2, all monolingual sentences appeared in Spanish. We generated Lists 3 and 4 by rotating the critical 48 sentence items across conditions (e.g., sentences from List 1 that preceded congruent Flanker trials now preceded incongruent Flanker trials in List 3; and sentences from List 2 that preceded congruent Flanker trials now preceded incongruent Flanker trials in List 4). We manipulated the language in which the monolingual sentences were presented across lists for the following reason: Because our conflict adaptation design aimed to pinpoint immediate effects of code-switching on cognitive-control performance, this allowed us to test whether conflict adaptation results from code-switching specifically, or whether cognitive control performance is also (unexpectedly) modulated by the language/dominance of the monolingual sentences on the preceding trial type. In addition, including a list that used only Spanish monolingual sentences allowed us to obscure the code-switching manipulation. In the list with only English monolingual items, any sentence that began in Spanish would signal the presence of an upcoming code-switch (into English), which could induce strategies even though the participants would not be able to predict when or where in the sentence the code-switch would occur. To minimize the impact of such demand characteristics on our data, we compare effects across lists, expecting to find conflict adaptation that does not interact with list (and that results from code-switches on trial $n - 1$). Participants completed 22 practice trials prior to the experiment: 16 Flanker trials and six SPR trials.

Data Analysis

We collected response times (RTs) and accuracy on the Flanker task and, by default, RTs to read each word (measured by self-paced button presses between words) on the SPR trials. However, we present only descriptive statistics on the SPR data as no linguistic manipulation was introduced. Differences in lexical properties of English and Spanish (e.g., Spanish words are longer on average than English words) also make the monolingual and code-switched sentences difficult to compare, as does the different rate at which bilinguals read in each language. To ensure that our participants were completing the task as intended, we recorded readers' accuracy on the comprehension questions for the filler trials as a measure of sustained attention throughout the experiment.

Flanker RT and accuracy analyses were conducted in R (Version 3.2.2; R Core Team, 2017) using the lme4 package (Bates, Mächler, Bolker, & Walker, 2015). For Flanker RTs, a linear mixed effects model was constructed, with prior sentence type, current Flanker trial type, and their interaction as fixed effects, and subject as a random intercept. Only correct trials were included in the RT analyses, and RTs were log-transformed prior to analysis to correct for non-normal distribution. Accuracy data were analyzed using mixed effects logistic regression. Again, prior sentence type, current Flanker trial type, and their interaction were included as fixed effects, and subject was included as a random intercept. The lmerTest package was used to compute p values using Satterthwaite's approximation for denominator degrees of freedom (Kuznetsova, Brockhoff, & Christensen, 2017).

Results

Manipulation Checks and Confirmatory Analyses

Flanker task. We first included the language of the monolingual sentences (English vs. Spanish lists) as a fixed effect in the models to determine whether list had any unexpected impact

on the results. Namely, because subjects assigned to lists with English monolingual (congruent) sentences could theoretically prepare for a switch whenever a sentence began in Spanish (it was guaranteed to switch to English, although where was unpredictable because we purposefully varied the syntactic site of the code-switch and whether the code-switch occurred early or late), we wanted to be sure that any adaptation effects are not larger in such lists that could be ascribed to strategies and learning, instead of cognitive control. Crucially, list did not result in any main effects or interactions with previous and current trial types for accuracy or RT ($ps > .88$), and inspection of the means confirms this (for details, see Appendix B). All experimental results reported below for Flanker performance therefore collapse across Spanish and English sentences into a single no-switch variable on preceding trial type. The lack of interaction with list suggests that any effects we observe in the experimental analyses resembling conflict adaptation cannot easily be ascribed to predictability.

In addition, although we do not compare reading times between code-switched and monolingual sentences, we do report some descriptive statistics on overall reading times from the SPR task. First, we aimed to confirm that participants in the English list did not read code-switched sentences faster because they always started in Spanish and could thus predict a switch. This pattern would corroborate our inference above. We also aimed to determine whether language dominance influenced reading rate.

SPR task. We report mean RTs by word separated by the language of the monolingual sentences (English vs. Spanish). Between lists, overall mean RTs were similar:[2] when monolingual sentences were English, the mean RT per word was 389 ms (SD = 131); when monolingual sentences were Spanish, the mean RT per word was 493 ms (SD = 221). When broken down by sentence type, for the English lists, English monolingual sentences had a mean RT per word of 369 ms (SD = 137) whereas the mean for code-switched sentences was 409 ms (SD = 122). For the Spanish lists, Spanish monolingual sentences were read with a mean RT per word of 493 ms (SD = 199), and code-switched sentences with a mean RT of 493 ms (SD = 242).

We also examined mean RTs by word split by list, sentence type, and dominance as a way to inspect whether reading rate was affected by language dominance (as expected) and whether participants in the English list demonstrated facilitation (i.e., anticipation) for reading code-switches because they were uniquely signaled by beginning in Spanish. In both lists, participants read faster when language dominance matched language list (in English lists, English-dominant group mean RT = 371 ms [SD = 121] vs. Spanish-dominant group mean RT = 424 ms [SD = 144]; in Spanish lists, English-dominant group mean RT = 517 ms [SD = 141] vs. Spanish-dominant group mean RT = 473 ms [SD = 269]). The difference between code-switched and monolingual sentences was in all cases less than 10 ms except for the English-dominant group, which was slower when reading code-switched sentences (mean RT = 404 ms, SD = 128) as compared to reading English sentences (mean RT = 338 ms, SD = 103). As can be seen, participants did not evince an overall advantage in reading code-switched sentences, even when distinctively prompted by the presence of Spanish early in the sentence. For full descriptive results, see Appendix B.

Experimental Analyses

Nine participants with accuracy rates below 80% on the SPR comprehension questions were removed from analyses; we thus analyzed data from 48 subjects. Flanker trials with RTs beyond 2.5 SDs from the overall mean were removed (1.95% of all trials).

As our main interest is determining the effect of language context on cognitive control, our dependent measures were RT and accuracy on the Flanker task.

Flanker RT. We analyzed Flanker RT data for correct trials only (98.1% of the full dataset). Participants were faster overall on congruent trials (M = 561 ms, SE = 16) compared to incongruent trials (M = 655 ms, SE = 17), resulting in a main effect of Flanker trial congruency ($\beta = -0.083$, $SE = 0.004$, $t = -19.14$, $p < .0001$). But, did the manipulation of prior sentence-trial type modulate this pattern? As can be seen in Figure 3A, subjects were faster on incongruent Flanker items that followed code-switched (M = 648 ms, SE = 17) as compared to no-switch (monolingual) sentences (M = 662 ms, SE = 18), but this sentence manipulation did not influence performance on congruent Flanker items. This observation was confirmed by a significant Previous Trial (Sentence Type) × Current Trial (Flanker Type) interaction ($\beta = -0.009$, $SE = 0.004$, $t = -1.99$, $p < .05$), consistent with conflict adaptation. The findings suggest that detecting a code-switch triggers sustained cognitive-control engagement, which facilitates conflict-resolution performance on a subsequent nonverbal Flanker task.

We followed-up with an analysis that included experimental half as a fixed effect to determine whether conflict adaptation increased over time as monitoring demands theoretically escalated throughout the experimental session, because more code-switching occurred (Figure 3B). Indeed, we found a significant three-way interaction among previous sentence type, current flanker type, and session half ($\beta = 0.011$, $SE = 0.004$, $t = 2.47$, $p < .05$). This interaction was the result of a reliable conflict adaptation effect in the second half of the experiment ($\beta = -0.02$, $SE = 0.006$, $t = -3.25$, $p < .01$) but not in the first ($\beta = 0.003$, $SE = 0.007$, $t = 0.480$, $p > .05$). Thus, even though bilinguals could anticipate more switching as time wore on, this pattern contradicts the assumption that such predictions will necessarily alleviate cognitive-control demands. Because we administered a wide range of switch types and locations to preserve naturalness, we believe instead that the pressure to rebias processing in favor of representations in the "new" language may have accrued (clearly, it does not dissipate at least), even as a reader realizes that she will face an increasing number of code-switches. In fact, this interaction with time may reveal that the reader is more apt to implement control despite (or because of) the rising need to integrate a switch. We return to this idea in the Discussion.

Flanker accuracy. Overall, participants were more accurate on congruent trials (M = 99.61%, SE = 0.90) than incongruent trials (M = 95.92%, SE = 2.86). This difference was statistically significant ($\beta = 1.58$, $SE = 0.34$, $t = 4.67$, $p < .0001$). However, there was no significant effect of prior trial type ($p > .05$), nor an interaction between current and previous trial type ($p > .05$), perhaps because of near-ceiling effects, even on incongruent trials.

[2] Because of programming error across a couple of lists, two sentence items were removed from analyses, which affected 26 subjects.

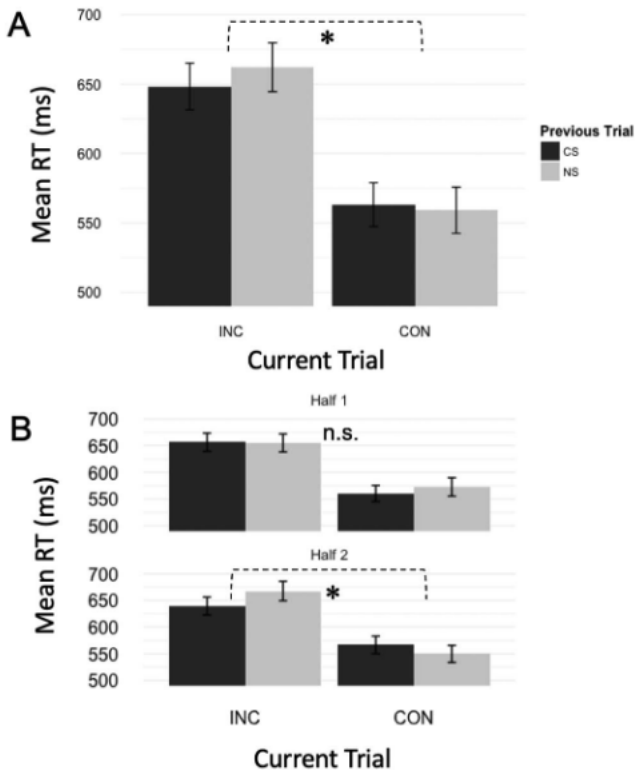

Figure 3. Mean response time (RT) for Flanker type as a function of the prior sentence trial (code-switched vs. not). (A) All trials; (B) Split by experimental half. Error bars represent standard errors. INC = incongruent; CON = congruent; CS = code-switch; NS = nonswitch; *n.s.* = not significant. Log-transformed RTs were used for analysis, but raw RTs are shown here for clarity. $^{*}p < .05$.

Discussion

We investigated whether there is heightened use of cognitive control when processing code-switched sentences in real time. The findings show that if a bilingual had just encountered a code-switch during incremental sentence processing, her performance on the following incongruent Flanker trial was more efficient compared to when she had just encountered a monolingual sentence (no switch). Such temporal interdependence is consistent with conflict adaptation and suggests that encountering a code-switch during real-time interpretation recruits domain-general cognitive-control procedures, presumably to bias processing toward representations from the switched-into language (thereby resolving competition from representations in the other language). This finding parallels those from previous studies showing a cause-and-effect relationship between the resolution of linguistic conflict and the dynamic engagement of cognitive control to revise misinterpretations (Hsu & Novick, 2016; Kan et al., 2013; Thothathiri et al., 2018). Here, we show that cognitive-control mechanisms are mobilized in the same causal fashion when a bilingual comprehender must integrate a code-switch.

Our results contribute new insight into what processing demands of bilingualism might dynamically modulate cognitive-control performance. Recently, bilingualism research has taken a nuanced view of how a bilingual's experience with her two languages generates the use of different control processes and, thus, mixed advantages in cognitive control (e.g., Adaptive Control Hypothesis, Green & Abutalebi, 2013). For example, bilinguals who report frequent switching between languages enjoy advantages over less frequent switchers and monolinguals (Hofweber et al., 2016; Prior & Gollan, 2011; Verreyt, Woumans, Vandelanotte, Szmalec, & Duyck, 2016). Moreover, individual differences in cognitive-control can affect parallel language activation by reducing later stage cross-language phonological competition (Blumenfeld & Marian, 2013) or interlingual homograph interference (Pivneva, Mercier, & Titone, 2014). Yet it was previously unknown whether interpreting a language switch during incremental processing is itself a cognitive-control task, because across-group comparisons (and indeed, across-individual comparisons) are not designed to address this issue. The finding reported here reveals a relationship between bilingual sentence processing and cognitive-control engagement within individuals and addresses the problem of how to link linguistic and nonlinguistic mechanisms. Our results suggest that how bilinguals engage with their languages may be central to any potential differences with monolinguals and even with other bilingual speakers.

Crucially though, increased cognitive-control functioning is clearly not a static property or trait of bilingualism just by virtue of being bilingual per se. Rather, cognitive control performance can be "pushed around" depending on the status of linguistic context and whether the input, at any given moment, generates representational conflict and, thus, demands more or less cognitive control to bias processing. This notion connects to other work indicating that the proportion of incongruent trials in a Flanker task (Costa, Hernández, Costa-Faidella, & Sebastián-Gallés, 2009) or the proportion of cued language switch trials (Olson, 2016) affects performance: greater overall conflict induces greater monitoring and control. Whether this "state effect" yields performance advantages in general is, however, an open empirical issue for others to settle (for a review, see Bialystok, 2017).

Our contribution is a more detailed and theoretically guided notion of how bilingual processing demands may adjust cognitive-control performance. Akin to how monolinguals' resolution of syntactic ambiguity during processing recruits cognitive control (e.g., Hsu & Novick, 2016; January, Trueswell, & Thompson-Schill, 2009; Novick et al., 2005), we show that when bilinguals encounter code-switches during real-time interpretation, this increases engagement of cognitive control mechanisms. Nevertheless, we do not equate interpreting code-switches in real-time with the reanalysis necessary to resolve (temporary) syntactic ambiguity, but there are clear processing commonalities. For example, both situations pressure the parsing system to handle representational conflict and thus bias competition to relevant cues and away from irrelevant ones that will enable accurate characterization of linguistic input, a rather cognitive-control demanding affair.

Cognitive Control and Code-Switching: Connection to Prior Work

Green and Abutalebi (2013) articulated three different bilingual language contexts—single language, dual language, and dense code-switching—that tap into different aspects of executive functioning. They hypothesize that dual-language contexts, where both languages are copresent in society and thus frequent switching is necessary (e.g., in Barcelona, Spain), impose the greatest conflict monitoring and

response inhibition. By contrast, dense code-switchers are better opportunistic planners, who "mak[e] use of whatever comes most readily to hand in order to achieve a goal" (Green & Abutalebi, 2013, p. 519). In view of our results, this adaptive control framework can be updated to describe how comprehending code-switched speech and text increases demands on cognitive control and what implications this carries for performance. In particular, this and other similar proposals (Green & Wei, 2014; Treffers-Daller, 2009) emphasize the cognitive *costs* of producing code-switched speech, which may vary by the type of code-switch (e.g., inter- vs. intrasentential; insertional, alternational, congruent lexicalization, Muysken, 2000), whether the bilingual is in a more monolingual versus bilingual "mode" (e.g., Blanco-Elorrieta & Pylkkänen, 2017; Olson, 2016), and the familiarity that a bilingual has with code-switching (Beatty-Martínez & Dussias, 2017; Valdés Kroff, Guzzardo Tamargo, & Dussias, 2018). Potentially, *producing* code-switches may actually lead to reduced control demands, essentially facilitating access to the more available language (e.g., Gollan & Ferreira, 2009; Kleinman & Gollan, 2016). That is, switching is part of a speaker's own planning process, and speakers' production choices depend largely on what is linguistically (Bock, 1986b), conceptually (Bock, 1986a), and attentionally accessible to them (e.g., Gleitman, January, Nappa, & Trueswell, 2007). Consequently, they may subsequently plan for upcoming code-switches if it is an expedient way of achieving a linguistic goal.

In contrast, a comprehender does not know when a code-switch may occur, although she may be guided by linguistic and extralinguistic cues such as slight modifications in speech rate, morpho-syntactic regularities, or pragmatic contexts (Fricke et al., 2016; Guzzardo Tamargo et al., 2016; Valdés Kroff et al., 2017, 2018). Our suggestion is that during comprehension, a reader or listener must be prepared sometimes to override expectations that sentences will continue in the same language (particularly if they have not just used code-switching as a communicative device themselves; Fricke & Kootstra, 2016), and to resolve competing cross-linguistic representations that inevitably arise at multiple levels (lexically, phonologically, and grammatically) when a switch does occur. Cognitive-control procedures might engage to bias processing toward relevant informational cues (those arriving in the new language) and resolve the cross-linguistic conflict that allows representations from both languages to be seamlessly integrated, resulting in accurate (and more efficient) comprehension despite the switch.

Our work provides initial evidence in favor of this hypothesis, yet we should not gloss over potential differences in how the syntactic site of the code-switch and when the code-switch is encountered affect sentence processing. Here, we remained agnostic to where a code-switch occurs within a sentence. We selected syntactic junctures that have broad attestation in Spanish-English code-switching (e.g., Belazi et al., 1994; Poplack, 1980), and we varied when in the sentence (e.g., early, middle, late) a code-switch could occur. Yet certainly some code-switches may be more "expected" than others and consequently may require less cognitive control in comprehension. For example, linguists make a distinction between inter- and intrasentential code-switches which take the sentence (i.e., Complementizer Phrase) as a major clause boundary demarcating two classes of code-switches (Bullock & Toribio, 2009). This classification corresponds with bilingual proficiency, affecting the type of code-switch that bilinguals are more likely to produce (e.g., Miccio, Scheffner-Hammer, & Rodríguez, 2009), and the ease with which these structures are processed (e.g., Byers-Heinlein, Morin-Lessard, & Lew-Williams, 2017). Bilinguals who are highly proficient engage more successfully in fluid and intricate code-switching that can occur within a major clause boundary (i.e., intrasentential code-switching) whereas less proficient bilinguals are more likely to produce intersentential and single word code-switches. We envision future studies teasing apart these distinctions to test their relative effect on cognitive control.

Because previous results demonstrate that code-switching can be costly, resulting in increased reading times (e.g., Altarriba et al., 1996) or neuro-cognitive components associated with unexpectancy (Moreno et al., 2002), one might have reasonably expected that Flanker performance would be worse following a code-switch compared to sentences that did not contain a switch—that is, consistent with "more caution" after an unexpected switch. However, our finding of improved performance is perfectly consistent with theories of cognitive control. For instance, conflict monitoring theory suggests that the presence of information-conflict in the environment prepares the system to engage cognitive control to bias attention when necessary in the future (Botvinick, Nystrom, Fissell, Carter, & Cohen, 1999). One outcome of this architecture is that conflict detection adjusts behavior by tuning the system to attend to task-relevant over task-irrelevant information, which assists the resolution of other instances of conflict to be more effective (Botvinick et al., 1999; Gratton et al., 1992; Kerns et al., 2004). What is interesting in the current experiment is that there is no shared feature across stimuli or even goals in the two tasks (e.g., to report an arrow's direction; to understand a code-switched sentence), yet a common process appears to operate over the distinct representations when conflict arises in each task. Here, detecting a code-switch on one trial increases demand to bias processing toward task-relevant input (representations in the current language), which in turn primes information-processing on an ensuing (Flanker) task also to bias goal-appropriate information (attend to the central arrow; ignore the surrounding ones despite their attraction).

Demands for Control Despite Switching Predictability

One could argue that maintaining the direction of the code-switch as always from Spanish to English in this study may have cued participants in the English monolingual sentence list to prepare for a code-switch; that is, when seeing that the sentence begins with Spanish the participant will know that a code-switch will occur. However, where and exactly when the code-switches will emerge is unpredictable because we purposefully varied the syntactic site of the code-switch as well as whether the code-switch occurs earlier or later in the sentence. Thus, there is still ambiguity about the timing of a switch (because multiple sites are grammatical, and many of those sites are sampled in this experiment). As such, a switch should still generate a conflict (or rebiasing) signal, and arguably even more so if monitoring demands are higher (e.g., Costa et al., 2009; Gollan & Ferreira, 2009; Olson, 2016). That we find no interaction with list suggests that regardless of predictability, cognitive control is still upregulated following a code-switch, at least in the current experimental context (for more details on RT by list and dominance, see Appendix B). We also note that the three-way interaction with time, which shows the adaptation increases in the second half of the experiment, itself argues against increased predictability in the English lists. That is, in the second half of the experiment, participants know that code-switching is likely—yet they still exhibit adaptation presumably because monitoring demands are heightened over the course of the

study. Moreover, we reiterate that participants completed 48 critical sentence-to-Flanker pairs: 12 no-switch-incongruent Flanker pairs, 12 no-switch-congruent Flanker pairs, 12 switch-incongruent Flanker pairs, and 12 switch-congruent Flanker pairs. These sequences were embedded within a larger set of items that contained 69 filler sentences and 60 additional Flanker trials, so that there were several sentence-to-sentence, Flanker-to-Flanker, and sentence-to-Flanker sequences that prevented participants from predicting upcoming trial or even task type, which also likely masked manipulations of interest.

Finally, our results may inform a paradox in the processing of code-switched speech and text. Despite its ubiquity worldwide among bilingual communities, the processing of code-switches inevitably leads to measurable switch costs in the laboratory (e.g., Altarriba et al., 1996; Moreno et al., 2002). Whereas current psycholinguistic debates on code-switching argue about whether these costs can be eliminated or attenuated (Beatty-Martínez & Dussias, 2017; Litcofsky & Van Hell, 2017; Moreno et al., 2002; Valdés Kroff et al., 2018), a more fruitful avenue may be to reconsider switch costs as an optimal trade-off that can, on balance, lead to performance benefits. In other words, it may be that code-switches are hard to predict as linguistic input unfolds in a single language or that the bilingual is unsure of whether a sentence will continue in the same language or code-switch into another. This momentary uncertainty may lead to behaviorally observable slow-downs in integration (i.e., switch costs), but such costs, in turn, may also reflect a bilingual's ramping up of cognitive-control processes.

Closing Remarks

Incremental language processing often engenders conflict between incompatible representations of sentence meaning. During real-time comprehension, readers and listeners commit to a single interpretation among multiple possibilities at points of local ambiguity in the input; but sometimes, these commitments must be revised when later-arriving cues clash with initial analyses. Previous work demonstrates that the discovery of a misanalysis rapidly recruits conflict-resolution and cognitive-control mechanisms to prevent comprehension failure (Hsu & Novick, 2016; Kan et al., 2013; Thothathiri et al., 2018). This background provided a basis for testing the hypothesis that bilinguals must resolve cross-linguistic conflict that arises in the natural course of processing code-switches during moment-to-moment comprehension. Much like other forms of linguistic conflict, we showed that integrating a code-switch in real time also engages cognitive control, theoretically to assist with regulating interpretations and achieving communicative success. We argue that explicating the processing demands of bilingualism that might create contact with domain-general cognitive-control systems is a critical component to understanding the architecture of the bilingual mind. We take an important step toward that goal by applying an established theoretical account (the cognitive control and parsing account) to address questions about the role cognitive control plays in bilingual sentence processing.

References

Abutalebi, J., Brambati, S. M., Annoni, J.-M., Moro, A., Cappa, S. F., & Perani, D. (2007). The neural cost of the auditory perception of language switches: An event-related functional magnetic resonance imaging study in bilinguals. *The Journal of Neuroscience, 27,* 13762–13769. http://dx.doi.org/10.1523/JNEUROSCI.3294-07.2007

Abutalebi, J., Della Rosa, P. A., Green, D. W., Hernandez, M., Scifo, P., Keim, R., . . . Costa, A. (2012). Bilingualism tunes the anterior cingulate cortex for conflict monitoring. *Cerebral Cortex, 22,* 2076–2086. http://dx.doi.org/10.1093/cercor/bhr287

Abutalebi, J., & Green, D. W. (2008). Control mechanisms in bilingual language production: Neural evidence from language switching studies. *Language and Cognitive Processes, 23,* 557–582. http://dx.doi.org/10.1080/01690960801920602

Altarriba, J., Kroll, J. F., Sholl, A., & Rayner, K. (1996). The influence of lexical and conceptual constraints on reading mixed-language sentences: Evidence from eye fixations and naming times. *Memory & Cognition, 24,* 477–492. http://dx.doi.org/10.3758/BF03200936

Altmann, G. T. M., & Kamide, Y. (1999). Incremental interpretation at verbs: Restricting the domain of subsequent reference. *Cognition, 73,* 247–264. http://dx.doi.org/10.1016/S0010-0277(99)00059-1

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software, 67,* 1–48. http://dx.doi.org/10.18637/jss.v067.i01

Beatty-Martínez, A. L., & Dussias, P. E. (2017). Bilingual experience shapes language processing: Evidence from codeswitching. *Journal of Memory and Language, 95,* 173–189. http://dx.doi.org/10.1016/j.jml.2017.04.002

Belazi, H. M., Rubin, E. J., & Toribio, A. J. (1994). Code switching and X-bar theory: The functional head constraint. *Linguistic Inquiry, 25,* 221–237.

Bialystok, E. (2017). The bilingual adaptation: How minds accommodate experience. *Psychological Bulletin, 143,* 233–262. http://dx.doi.org/10.1037/bul0000099

Bialystok, E., Craik, F. I. M., Green, D. W., & Gollan, T. H. (2009). Bilingual minds. *Psychological Science in the Public Interest, 10,* 89–129. http://dx.doi.org/10.1177/1529100610387084

Bialystok, E., Craik, F., & Luk, G. (2008). Cognitive control and lexical access in younger and older bilinguals. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 34,* 859–873. http://dx.doi.org/10.1037/0278-7393.34.4.859

Blanco-Elorrieta, E., & Pylkkänen, L. (2017). Bilingual language switching in the laboratory versus in the wild: The spatiotemporal dynamics of adaptive language control. *The Journal of Neuroscience, 37,* 9022–9036. http://dx.doi.org/10.1523/JNEUROSCI.0553-17.2017

Blokzijl, J., Deuchar, M., & Parafita Couto, M. C. (2017). Determiner asymmetry in mixed nominal constructions: The role of grammatical factors in data from Miami and Nicaragua. *Languages, 2,* 20. http://dx.doi.org/10.3390/languages2040020

Blumenfeld, H. K., & Marian, V. (2013). Parallel language activation and cognitive control during spoken word recognition in bilinguals. *Journal of Cognitive Psychology, 25,* 547–567. http://dx.doi.org/10.1080/20445911.2013.812093

Bock, J. K. (1986a). Meaning, sound, and syntax: Lexical priming in sentence production. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 12,* 575–586. http://dx.doi.org/10.1037/0278-7393.12.4.575

Bock, J. K. (1986b). Syntactic persistence in language production. *Cognitive Psychology, 18,* 355–387. http://dx.doi.org/10.1016/0010-0285(86)90004-6

Botvinick, M. M., Braver, T. S., Barch, D. M., Carter, C. S., & Cohen, J. D. (2001). Conflict monitoring and cognitive control. *Psychological Review, 108,* 624–652. http://dx.doi.org/10.1037/0033-295X.108.3.624

Botvinick, M., Nystrom, L. E., Fissell, K., Carter, C. S., & Cohen, J. D. (1999). Conflict monitoring versus selection-for-action in anterior cingulate cortex. *Nature, 402,* 179–181. http://dx.doi.org/10.1038/46035

Bullock, B. E., & Toribio, A. J. (Eds.). (2009). *The Cambridge handbook of linguistic code-switching*. Cambridge, UK: Cambridge University Press. http://dx.doi.org/10.1017/CBO9780511576331

Byers-Heinlein, K., Morin-Lessard, E., & Lew-Williams, C. (2017). Bilingual infants control their languages as they listen. *Proceedings of the National Academy of Sciences of the United States of America, 114,* 9032–9037. http://dx.doi.org/10.1073/pnas.1703220114

Carter, P. M., & Lynch, A. (2015). Multilingual Miami: Current trends in sociolinguistic research. *Language and Linguistics Compass, 9,* 369–385. http://dx.doi.org/10.1111/lnc3.12157

Cavanagh, J. F., Cohen, M. X., & Allen, J. J. B. (2009). Prelude to and resolution of an error: EEG phase synchrony reveals cognitive control dynamics during action monitoring. *The Journal of Neuroscience, 29,* 98–105. http://dx.doi.org/10.1523/JNEUROSCI.4137-08.2009

Chambers, C. G., & Cooke, H. (2009). Lexical competition during second-language listening: Sentence context, but not proficiency, constrains interference from the native lexicon. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 35,* 1029–1040. http://dx.doi.org/10.1037/a0015901

Colzato, L. S., Bajo, M. T., van den Wildenberg, W., Paolieri, D., Nieuwenhuis, S., La Heij, W., & Hommel, B. (2008). How does bilingualism improve executive control? A comparison of active and reactive inhibition mechanisms. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 34,* 302–312. http://dx.doi.org/10.1037/0278-7393.34.2.302

Costa, A., Hernández, M., Costa-Faidella, J., & Sebastián-Gallés, N. (2009). On the bilingual advantage in conflict processing: Now you see it, now you don't. *Cognition, 113,* 135–149. http://dx.doi.org/10.1016/j.cognition.2009.08.001

Costa, A., Miozzo, M., & Caramazza, A. (1999). Lexical selection in bilinguals: Do words in the bilingual's two lexicons compete for selection? *Journal of Memory and Language, 41,* 365–397. http://dx.doi.org/10.1006/jmla.1999.2651

Costa, A., & Santesteban, M. (2004). Lexical access in bilingual speech production: Evidence from language switching in highly poficient bilinguals and L2 learners. *Journal of Memory and Language, 50,* 491–511. http://dx.doi.org/10.1016/j.jml.2004.02.002

de Bruin, A., Treccani, B., & Della Sala, S. (2015). Cognitive advantage in bilingualism: An example of publication bias? *Psychological Science, 26,* 99–107. http://dx.doi.org/10.1177/0956797614557866

Deuchar, M., Davies, P., Herring, J. R., Parata Cuoto, M. C., & Carter, D. (2014). Building bilingual corpora: Welsh-English, Spanish-English and Spanish-Welsh. In E. M. Thomas & I. Mennen (Eds.), *Advances in the study of Bilingualism* (pp. 93–110). Bristol: Multilingualism Matters. http://dx.doi.org/10.21832/9781783091713-008

Di Sciullo, A., Muysken, P., & Singh, R. (1986). Government and code-mixing. *Journal of Linguistics, 22,* 1–24. http://dx.doi.org/10.1017/S0022226700010537

Duñabeitia, J. A., Hernández, J. A., Antón, E., Macizo, P., Estévez, A., Fuentes, L. J., & Carreiras, M. (2014). The inhibitory advantage in bilingual children revisited: Myth or reality? *Experimental Psychology, 61,* 234–251. http://dx.doi.org/10.1027/1618-3169/a000243

Duthoo, W., Abrahamse, E. L., Braem, S., Boehler, C. N., & Notebaert, W. (2014). The congruency sequence effect 3.0: A critical test of conflict adaptation. *PLoS ONE, 9*(10), e110462. http://dx.doi.org/10.1371/journal.pone.0110462

Duthoo, W., & Notebaert, W. (2012). Conflict adaptation: It is not what you expect. *The Quarterly Journal of Experimental Psychology, 65,* 1993–2007. http://dx.doi.org/10.1080/17470218.2012.676655

English language Institute. (2001). *MELICET—GCVR user's manual*. Ann Arbor, MI: English Language Institute, The University of Michigan.

Fricke, M., & Kootstra, G. J. (2016). Primed codeswitches in spontaneous bilingual dialogue. *Journal of Memory and Language, 91,* 181–201. http://dx.doi.org/10.1016/j.jml.2016.04.003

Fricke, M., Kroll, J. F., & Dussias, P. E. (2016). Phonetic variation in bilingual speech: A lens for studying the production-comprehension link. *Journal of Memory and Language, 89,* 110–137. http://dx.doi.org/10.1016/j.jml.2015.10.001

Friederici, A., & Jacobsen, T. (1999). Processing grammatical gender during language comprehension. *Journal of Psycholinguistic Research, 28,* 467–484. http://dx.doi.org/10.1023/A:1023264209610

Gardner-Chloros, P. (2009). *Code-switching*. Cambridge, UK: Cambridge University Press. http://dx.doi.org/10.1017/CBO9780511609787

Gleitman, L. R., January, D., Nappa, R., & Trueswell, J. C. (2007). On the give and take between event apprehension and utterance formulation. *Journal of Memory and Language, 57,* 544–569. http://dx.doi.org/10.1016/j.jml.2007.01.007

Gollan, T. H., & Ferreira, V. S. (2009). Should I stay or should I switch? A cost-benefit analysis of voluntary language switching in young and aging bilinguals. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 35,* 640–665. http://dx.doi.org/10.1037/a0014981

Gollan, T. H., & Goldrick, M. (2018). A switch is not a switch: Syntactically-driven bilingual language control. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 44,* 143–156. http://dx.doi.org/10.1037/xlm0000462

Gollan, T. H., Montoya, R. I., Cera, C., & Sandoval, T. C. (2008). More use almost always a means a smaller frequency effect: Aging, bilingualism, and the weaker links hypothesis. *Journal of Memory and Language, 58,* 787–814. http://dx.doi.org/10.1016/j.jml.2007.07.001

Gollan, T. H., Sandoval, T., & Salmon, D. P. (2011). Cross-language intrusion errors in aging bilinguals reveal the link between executive control and language selection. *Psychological Science, 22,* 1155–1164. http://dx.doi.org/10.1177/0956797611417002

Gollan, T. H., Schotter, E. R., Gomez, J., Murillo, M., & Rayner, K. (2014). Multiple levels of bilingual language control: Evidence from language intrusions in reading aloud. *Psychological Science, 25,* 585–595. http://dx.doi.org/10.1177/0956797613512661

Gollan, T. H., Slattery, T. J., Goldenberg, D., Van Assche, E., Duyck, W., & Rayner, K. (2011). Frequency drives lexical access in reading but not in speaking: The frequency-lag hypothesis. *Journal of Experimental Psychology: General, 140,* 186–209. http://dx.doi.org/10.1037/a0022256

Grainger, J., & Frenck-Mestre, C. (1998). Masked priming by translation equivalents in proficient bilinguals. *Language and Cognitive Processes, 13,* 601–623. http://dx.doi.org/10.1080/016909698386393

Gratton, G., Coles, M. G., & Donchin, E. (1992). Optimizing the use of information: Strategic control of activation of responses. *Journal of Experimental Psychology: General, 121,* 480–506. http://dx.doi.org/10.1037/0096-3445.121.4.480

Green, D. W., & Abutalebi, J. (2013). Language control in bilinguals: The adaptive control hypothesis. *Journal of Cognitive Psychology, 25,* 515–530. http://dx.doi.org/10.1080/20445911.2013.796377

Green, D. W., & Wei, L. (2014). A control process model of code-switching. *Language, Cognition and Neuroscience, 29,* 499–511. http://dx.doi.org/10.1080/23273798.2014.882515

Grundy, J. G., Chung-Fat-Yim, A., Friesen, D. C., Mak, L., & Bialystok, E. (2017). Sequential congruency effects reveal differences in disengagement of attention for monolingual and bilingual young adults. *Cognition, 163,* 42–55. http://dx.doi.org/10.1016/j.cognition.2017.02.010

Gullifer, J. W., & Titone, D. (2019). The impact of a momentary language switch on bilingual reading: Intense at the switch but merciful downstream for L2 but not L1 readers. *Journal of Experimental Psychology: Learning, Memory, and Cognition*. Advance online publication. http://dx.doi.org/10.1037/xlm0000695

Guzzardo Tamargo, R. E., Valdés Kroff, J. R., & Dussias, P. E. (2016). Examining the relationship between comprehension and production processes in code-switched language. *Journal of Memory and Language, 89,* 138–161. http://dx.doi.org/10.1016/j.jml.2015.12.002

Hagoort, P., & Brown, C. M. (1999). Gender electrified: ERP evidence on the syntactic nature of gender processing. *Journal of Psycholinguistic Research, 28,* 715–728. http://dx.doi.org/10.1023/A:1023277213129

Hartanto, A., & Yang, H. (2016). Disparate bilingual experiences modulate task-switching advantages: A diffusion-model analysis of the effects of interactional context on switch costs. *Cognition, 150,* 10–19. http://dx.doi.org/10.1016/j.cognition.2016.01.016

Hernandez, A. E., Dapretto, M., Mazziotta, J., & Bookheimer, S. (2001). Language switching and language representation in Spanish-English bilinguals: An fMRI study. *NeuroImage, 14,* 510–520. http://dx.doi.org/10.1006/nimg.2001.0810

Hernandez, A. E., Martinez, A., & Kohnert, K. (2000). In search of the language switch: An fMRI study of picture naming in Spanish-English bilinguals. *Brain and Language, 73,* 421–431. http://dx.doi.org/10.1006/brln.1999.2278

Herring, J. R., Deuchar, M., Parafita Couto, M. C., & Moro Quintanilla, M. (2010). "I saw the madre": Evaluating predictions about codeswitched determiner-noun sequences using Spanish-English and Welsh-English data. *International Journal of Bilingual Education and Bilingualism, 13,* 553–573. http://dx.doi.org/10.1080/13670050.2010.488286

Hilchey, M. D., & Klein, R. M. (2011). Are there bilingual advantages on nonlinguistic interference tasks? Implications for the plasticity of executive control processes. *Psychonomic Bulletin & Review, 18,* 625–658. http://dx.doi.org/10.3758/s13423-011-0116-7

Hofweber, J., Marinis, T., & Treffers-Daller, J. (2016). Effects of dense code-switching on executive control. *Linguistic Approaches to Bilingualism, 6,* 648–668. http://dx.doi.org/10.1075/lab.15052.hof

Hsu, N. S., & Novick, J. M. (2016). Dynamic engagement of cognitive control modulates recovery from misinterpretation during real-time language processing. *Psychological Science, 27,* 572–582. http://dx.doi.org/10.1177/0956797615625223

Ivanova, I., & Costa, A. (2008). Does bilingualism hamper lexical access in speech production? *Acta Psychologica, 127,* 277–288. http://dx.doi.org/10.1016/j.actpsy.2007.06.003

Jake, J., Myers-Scotton, C., & Gross, S. (2002). Making a minimalist approach to code-switching work: Adding the matrix language. *Bilingualism: Language and Cognition, 5,* 69–91. http://dx.doi.org/10.1017/S1366728902000147

January, D., Trueswell, J. C., & Thompson-Schill, S. L. (2009). Co-localization of stroop and syntactic ambiguity resolution in Broca's area: Implications for the neural basis of sentence processing. *Journal of Cognitive Neuroscience, 21,* 2434–2444. http://dx.doi.org/10.1162/jocn.2008.21179

Just, M. A., Carpenter, P. A., & Woolley, J. D. (1982). Paradigms and processes in reading comprehension. *Journal of Experimental Psychology: General, 111,* 228–238. http://dx.doi.org/10.1037/0096-3445.111.2.228

Kan, I. P., Teubner-Rhodes, S., Drummey, A. B., Nutile, L., Krupa, L., & Novick, J. M. (2013). To adapt or not to adapt: The question of domain-general cognitive control. *Cognition, 129,* 637–651. http://dx.doi.org/10.1016/j.cognition.2013.09.001

Kaplan, E., Goodglass, H., Weintraub, S., & Segal, O. (1983). *The Boston Naming Test*. Philadelphia, PA: Lea & Febiger.

Kerns, J. G., Cohen, J. D., MacDonald, A. W., III, Cho, R. Y., Stenger, V. A., & Carter, C. S. (2004). Anterior cingulate conflict monitoring and adjustments in control. *Science, 303,* 1023–1026. http://dx.doi.org/10.1126/science.1089910

Kim, C., Johnson, N. F., & Gold, B. T. (2014). Conflict adaptation in prefrontal cortex: Now you see it, now you don't. *Cortex: A Journal Devoted to the Study of the Nervous System and Behavior, 50,* 76–85. http://dx.doi.org/10.1016/j.cortex.2013.08.011

Kleinman, D., & Gollan, T. H. (2016). Speaking two languages for the price of one: Bypassing language control mechanisms via accessibility-driven switches. *Psychological Science, 27,* 700–714. http://dx.doi.org/10.1177/0956797616634633

Kootstra, G. J., Van Hell, J. G., & Dijkstra, T. (2012). Priming of code-switches in sentences: The role of lexical repetition, cognates, and language proficiency. *Bilingualism: Language and Cognition, 15,* 797–819. http://dx.doi.org/10.1017/S136672891100068X

Kroll, J. F., & Bialystok, E. (2013). Understanding the consequences of bilingualism for language processing and cognition. *Journal of Cognitive Psychology, 25,* 497–514. http://dx.doi.org/10.1080/20445911.2013.799170

Kroll, J. F., Dussias, P. E., Bice, K., & Perrotti, L. (2015). Bilingualism, mind, and brain. *Annual Review of Linguistics, 1,* 377–394.

Kuznetsova, A., Brockhoff, P. B., & Christensen, R. H. B. (2017). lmerTest package: Tests in linear mixed effects models. *Journal of Statistical Software, 82,* 1–26. http://dx.doi.org/10.18637/jss.v082.i13

Lew-Williams, C., & Fernald, A. (2007). Young children learning Spanish make rapid use of grammatical gender in spoken word recognition. *Psychological Science, 18,* 193–198. http://dx.doi.org/10.1111/j.1467-9280.2007.01871.x

Litcofsky, K. A., & Van Hell, J. G. (2017). Switching direction affects switching costs: Behavioral, ERP and time-frequency analyses of intra-sentential codeswitching. *Neuropsychologia, 97,* 112–139. http://dx.doi.org/10.1016/j.neuropsychologia.2017.02.002

Luk, G., Green, D. W., Abutalebi, J., & Grady, C. (2012). Cognitive control for language switching in bilinguals: A quantitative meta-analysis of functional neuroimaging studies. *Language and Cognitive Processes, 27,* 1479–1488. http://dx.doi.org/10.1080/01690965.2011.613209

MacDonald, M. C., Pearlmutter, N. J., & Seidenberg, M. S. (1994). The lexical nature of syntactic ambiguity resolution. *Psychological Review, 101,* 676–703. http://dx.doi.org/10.1037/0033-295X.101.4.676

Martin-Rhee, M. M., & Bialystok, E. (2008). The development of two types of inhibitory control in monolingual and bilingual children. *Bilingualism: Language and Cognition, 11,* 81–93. http://dx.doi.org/10.1017/S1366728907003227

Meuter, R. F. I., & Allport, A. (1999). Bilingual language switching in naming: Asymmetrical costs of language selection. *Journal of Memory and Language, 40,* 25–40. http://dx.doi.org/10.1006/jmla.1998.2602

Miccio, A. W., Scheffner-Hammer, C., & Rodríguez, B. (2009). Code-switching and language disorders in bilingual children. In B. E. Bullock & A. J. Toribio (Eds.), *The Cambridge handbook of linguistic code-switching* (pp. 241–270). Cambridge, UK: Cambridge University Press. http://dx.doi.org/10.1017/CBO9780511576331.015

Miller, E. K., & Cohen, J. D. (2001). An integrative theory of prefrontal cortex function. *Annual Review of Neuroscience, 24,* 167–202. http://dx.doi.org/10.1146/annurev.neuro.24.1.167

Ministry of Education, Culture, and Sport of Spain. (2006). *Diploma de español como lengua extranjera examination*. Retrieved from http://dele.org

Montes-Alcalá, C. (2000). Written code-switching: Powerful bilingual images. In R. Jacobson (Ed.), *Codeswitching Worldwide II* (pp. 193–219). Berlin, Germany: Mouton de Gruyter.

Moreno, E. M., Federmeier, K. D., & Kutas, M. (2002). Switching languages, switching palabras (words): An electrophysiological study of code switching. *Brain and Language, 80,* 188–207. http://dx.doi.org/10.1006/brln.2001.2588

Morton, J. B., & Harper, S. N. (2007). What did Simon say? Revisiting the bilingual advantage. *Developmental Science, 10,* 719–726. http://dx.doi.org/10.1111/j.1467-7687.2007.00623.x

Muysken, P. (2000). *Bilingual speech: A typology of code-mixing*. Cambridge, UK: Cambridge University Press.

Novick, J. M., Trueswell, J. C., & Thompson-Schill, S. L. (2005). Cognitive control and parsing: Reexamining the role of Broca's area in sentence comprehension. *Cognitive, Affective & Behavioral Neuroscience, 5,* 263–281. http://dx.doi.org/10.3758/CABN.5.3.263

Nozari, N., & Novick, J. M. (2017). Monitoring and control in language production. *Current Directions in Psychological Science, 26,* 403–410. http://dx.doi.org/10.1177/0963721417702419

Olson, D. (2016). The gradient effect of context on language switching and lexical access in bilingual production. *Applied Psycholinguistics, 37,* 725–756. http://dx.doi.org/10.1017/S0142716415000223

Paap, K. R., & Greenberg, Z. I. (2013). There is no coherent evidence for a bilingual advantage in executive processing. *Cognitive Psychology, 66,* 232–258. http://dx.doi.org/10.1016/j.cogpsych.2012.12.002

Paap, K., Sawi, O., Dalibar, C., Darrow, J., & Myüz, H. (2014). The brain mechanisms underlying the cognitive benefits of bilingualism may be extraordinarily difficult to discover. *AIMS Neuroscience, 1,* 245–256. http://dx.doi.org/10.3934/Neuroscience.2014.3.245

Pelham, S. D., & Abrams, L. (2014). Cognitive advantages and disadvantages in early and late bilinguals. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 40,* 313–325. http://dx.doi.org/10.1037/a0035224

Pivneva, I., Mercier, J., & Titone, D. (2014). Executive control modulates cross-language lexical activation during L2 reading: Evidence from eye movements. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 40,* 787–796. http://dx.doi.org/10.1037/a0035583

Poplack, S. (1980). Sometimes I'll start a sentence in Spanish y termino en español: Towards a typology of code-switching. *Linguistics, 18,* 581–618. http://dx.doi.org/10.1515/ling.1980.18.7-8.581

Prada Pérez, A., & Hernández, A. (2017). Examining code-switching performance theories: Copula choice in Spanish among Cuban heritage speakers. In A. Cuza (Ed.), *Cuban Spanish dialectology: Variation, contact, and change* (pp. 271–289). Washington, DC: Georgetown University Press.

Prior, A., Degani, T., Awawdy, S., Yassin, R., & Korem, N. (2017). Is susceptibility to cross-language interference domain specific? *Cognition, 165,* 10–25. http://dx.doi.org/10.1016/j.cognition.2017.04.006

Prior, A., & Gollan, T. H. (2011). Good language-switchers are good task-switchers: Evidence from Spanish-English and Mandarin-English bilinguals. *Journal of the International Neuropsychological Society, 17,* 682–691. http://dx.doi.org/10.1017/S1355617711000580

Prior, A., & MacWhinney, B. (2010). A bilingual advantage in task switching. *Bilingualism: Language and Cognition, 13,* 253–262. http://dx.doi.org/10.1017/S1366728909990526

R Core Team. (2017). *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. Retrieved from http://www.R-project.org/

Schmidt, J. (2018). Evidence against conflict monitoring and adaptation: An updated review. *Psychonomic Bulletin & Review, 26,* 753–771.

Schwartz, A. I., & Kroll, J. F. (2006). Bilingual lexical activation in sentence context. *Journal of Memory and Language, 55,* 197–212. http://dx.doi.org/10.1016/j.jml.2006.03.004

Spivey, M., & Marian, V. (1999). Crosstalk between native and second languages: Partial activation of an irrelevant lexicon. *Psychological Science, 10,* 281–284. http://dx.doi.org/10.1111/1467-9280.00151

Stasenko, A., Matt, G. E., & Gollan, T. H. (2017). A relative bilingual advantage in switching with preparation: Nuanced explorations of the proposed association between bilingualism and task switching. *Journal of Experimental Psychology: General, 146,* 1527–1550. http://dx.doi.org/10.1037/xge0000340

Tanenhaus, M. K., Spivey-Knowlton, M. J., Eberhard, K. M., & Sedivy, J. C. (1995). Integration of visual and linguistic information in spoken language comprehension. *Science, 268,* 1632–1634. http://dx.doi.org/10.1126/science.7777863

Teubner-Rhodes, S. E., Bolger, D. J., & Novick, J. M. (2019). Conflict monitoring and detection in the bilingual brain. *Bilingualism: Language and Cognition, 22,* 228–252. http://dx.doi.org/10.1017/S1366728917000670

Teubner-Rhodes, S. E., Mishler, A., Corbett, R., Andreu, L., Sanz-Torrent, M., Trueswell, J. C., & Novick, J. M. (2016). The effects of bilingualism on conflict monitoring, cognitive control, and garden-path recovery. *Cognition, 150,* 213–231. http://dx.doi.org/10.1016/j.cognition.2016.02.011

Thothathiri, M., Asaro, C. T., Hsu, N. S., & Novick, J. M. (2018). Who did what? A causal role for cognitive control in thematic role assignment during sentence comprehension. *Cognition, 178,* 162–177. http://dx.doi.org/10.1016/j.cognition.2018.05.014

Treffers-Daller, J. (2009). Code-switching and transfer: An exploration of similarities and differences. In B. E. Bullock & A. J. Toribio (Eds.), *The Cambridge handbook of linguistic code-switching* (pp. 58–74). Cambridge, UK: Cambridge University Press. http://dx.doi.org/10.1017/CBO9780511576331.005

Ullsperger, M., Bylsma, L. M., & Botvinick, M. M. (2005). The conflict adaptation effect: It's not just priming. *Cognitive, Affective & Behavioral Neuroscience, 5,* 467–472. http://dx.doi.org/10.3758/CABN.5.4.467

Valdés Kroff, J. R. (2016). Mixed NPs in Spanish-English bilingual speech: Using a corpus-based approach to inform models of sentence processing. In R. E. Guzzardo Tamargo, C. Mazak, & M. C. Parafita Couto (Eds.), *Spanish-English code-switching in the Caribbean and the U.S.* (pp. 281–300). Amsterdam, the Netherlands: John Benjamins. http://dx.doi.org/10.1075/ihll.11.12val

Valdés Kroff, J. R., Dussias, P. E., Gerfen, C., Perrotti, L., & Bajo, M. T. (2017). Experience with code-switching modulates the use of grammatical gender during sentence processing. *Linguistic Approaches to Bilingualism, 7,* 163–198. http://dx.doi.org/10.1075/lab.15010.val

Valdés Kroff, J. R., Guzzardo Tamargo, R. E., & Dussias, P. E. (2018). Experimental contributions of eye-tracking to the understanding of comprehension processes while hearing and reading code-switches. *Linguistic Approaches to Bilingualism, 98,* 66–101. http://dx.doi.org/10.1075/lab.16011.val

Valian, V. (2015). Bilingualism and cognition. *Bilingualism: Language and Cognition, 18,* 3–24. http://dx.doi.org/10.1017/S1366728914000522

Van Assche, E., Duyck, W., Hartsuiker, R. J., & Diependaele, K. (2009). Does bilingualism change native-language reading? Cognate effects in a sentence context. *Psychological Science, 20,* 923–927. http://dx.doi.org/10.1111/j.1467-9280.2009.02389.x

Verreyt, N., Woumans, E., Vandelanotte, D., Szmalec, A., & Duyck, W. (2016). The influence of language-switching experience on the bilingual executive control advantage. *Bilingualism: Language and Cognition, 19,* 181–190. http://dx.doi.org/10.1017/S1366728914000352

von Bastian, C. C., Souza, A. S., & Gade, M. (2016). No evidence for bilingual cognitive advantages: A test of four hypotheses. *Journal of Experimental Psychology: General, 145,* 246–258. http://dx.doi.org/10.1037/xge0000120

Weissman, D. H., Colter, K. M., Grant, L. D., & Bissett, P. G. (2017). Identifying stimuli that cue multiple responses triggers the congruency sequence effect independent of response conflict. *Journal of Experimental Psychology: Human Perception and Performance, 43,* 677–689. http://dx.doi.org/10.1037/xhp0000350

Yang, H., Hartanto, A., & Yang, S. (2016). The complex nature of bilinguals' language usage modulates task-switching outcomes. *Frontiers in Psychology, 7,* 560. http://dx.doi.org/10.3389/fpsyg.2016.00560

(*Appendices follow*)

Appendix A

Monolingual and Code-Switched Sentence Materials

Table A1
Sentence Materials

Item	Sentence
	Monolingual sentences[a]
1	Afortunadamente el sofá en la puerta está en perfectas condiciones en comparación con otros muebles. Luckily the sofa by the door is in perfect condition compared to the other furniture.
2	Al principio del semestre la estudiante de arquitectura se registró en varios cursos. At the beginning of the semester the architecture student registered for several courses.
3	Desde el verano pasado el jardinero siempre ve a la mujer paseando por la fuente. Since last summer the gardener frequently sees the woman walking by the fountain.
4	En la fiesta la joven pidió una copa de vino de la anfitriona. At the party the young woman asked for a glass of wine from the hostess.
5	Los estudiantes de posgrado notan que el curso de matemáticas avanzadas se cancela mucho. The graduate students have observed that the advanced math course is usually cancelled.
6	El decano no está seguro si la beca es para cinco años. The dean is not certain if the fellowship is for five years.
7	El agente dice que los turistas están disfrutando del crucero que los llevó a México. The agent says that the tourists are enjoying the cruise that took them to Mexico.
8	El rey confirma que el palacio se completa a finales de verano. The king confirms that the palace will be completed by the end of summer.
9	Los diputados admiten que los jueces están empeorando la crisis. The congressmen admit that the judges are making the crisis worse.
10	El entrenador intentó de cambiar el horario del equipo para el próximo partido. The coach tried to change his team schedule for the next match.
11	Los obreros dudan que el nuevo estadio se complete en dos años. The construction workers doubt that the new stadium will be completed in two years.
12	La actriz acusa a los empleados del hotel elegante de no respetar a los clientes. The actress accuses the employees at the fancy hotel of not respecting their customers.
13	El cura no pudo dormir anoche porque el perro del vecino ladró toda la noche. The priest could not sleep last night because the neighbor dog barked all night.
14	Después de jugar en los columpios los niños corrieron alegremente a su casa. After playing on the swings the children happily ran towards their house.
15	La bibliotecaria del colegio decidió irse a Polonia a finales del año escolar. The school librarian decided to go to Poland at the end of the school year.
16	Todas las mañanas el granjero ordeña las vacas en la granja roja. Every morning the farmer milks the cows in the red barn.
17	Cuando la alumna se graduó del instituto consiguió todo lo que pidió. When the student graduated from high school she received everything that she asked for.
18	El abogado está agradecido por el apoyo que recibió del testigo. The lawyer is thankful for the support that he recieved from the witness.
19	El taxista tomó un desvío en vez de cruzar la carretera a estas horas. The taxi driver took a detour instead of crossing the highway at this hour.
20	La psíquica pronosticó que el hombre consiguiera riqueza y éxito. The psychic predicted that the man would gain wealth and success.
21	El gato tricolor no pudo atrapar el ratón porque se metió dentro del agujero. The calico cat couldn't catch the mouse because it ran into a hole.
22	Después de que el chef inauguró su restaurante dejó de cocinar por sí mismo. After the chef opened his restaurant he stopped cooking for himself.
23	Los niños del barrio vendieron diez copas de limonada en menos de una hora. The neighborhood children sold ten cups of lemonade in under an hour.
24	El futbolista marcó el gol de la victoria en el último minuto del partido. The soccer player scored the winning goal in the last minute of the game.
25	El césped está disparejo porque la cortadora se rompió en medio de cortar el pasto. The lawn is uneven because the lawnmower broke in the middle of cutting the grass.

(*Appendices continue*)

Table A1 (*continued*)

Item	Sentence
26	Aunque el letrero prohíbe dejar bicicletas en la entrada se encuentran tres bicicletas encadenadas allí. Although the sign prohibits leaving bikes near the entrance three bikes are chained there.
27	Los dueños nuevos decidieron derrumbar la casa vieja y construir una nueva. The new owners decided to bulldoze the old house and build a brand new one.
28	Es más fácil conseguir un buen trabajo después de la universidad si uno conoce programación. It easier to get a job after college if you are skilled with computers.
29	Colocaron letreros por toda la comunidad advirtiendo el uso de pesticidas en el pasto. Signs are posted around the community warning about the use of pesticides on the grass.
30	Las raíces del árbol se extendieron por los senderos y tropiezan a la gente. The tree roots have extended across the paths and are making people trip.
31	Los seguidores se animaron cuando el jugador quitó la pelota del otro equipo. The fans cheered when the player stole the ball from the other team.
32	Mientras que viajaban los turistas dejaron sus pasaportes dentro de su cuarto de hotel. While traveling the tourists left their passports inside of their hotel room.
33	El museo de arte está estrenando una nueva exposición de un pintor famoso. The art museum is displaying a new exhibit by a famous painter.
34	Un estudio reciente reveló que la dieta popular realmente perjudica la salud. A recent study showed that the popular diet was actually harmful to people health.
35	Durante la tormenta el viento sopló la rama de un árbol hacia un cable eléctrico. During the storm the wind blew a tree branch into a power line.
36	Cuando lo terminó el artista grabó su nombre debajo del mural en la municipalidad. Once he had finished the artist engraved his name below the mural in town hall.
37	La niña cariñosa adoptó al gatito enfermo y lo cuidó hasta que se repuso. The affectionate girl adopted the sick kitten and nursed it back to health.
38	El alcalde animó a los ciudadanos a utilizar los buses para luchar contra la contaminación. The mayor encouraged citizens to use buses in order to fight pollution.
39	Los padres compraron una tarjeta de regalo para la maestra a fin de año. The parents bought a gift card for the teacher at the end of the year.
40	El jabón no fue suficiente para quitar la mancha de vino tinto de la alfombra. The soap was not enough to remove the red wine stain from the carpet.
41	La recepcionista de la oficina se cayó en el pasillo durante la tormenta extrema. The receptionist at the office fell in the hallway during the fierce storm.
42	El retrato era tan bello que el médico decidió colgarlo en la pared. The portrait was so beautiful the doctor decided to hang it on the wall.
43	Los vecinos chismearon sobre el desconocido misterioso de la próxima cuadra. The neighbors gossiped about the mysterious stranger from the next block.
44	El pescador esperó tres meses para trabajar después del naufragio desafortunado. The fisherman waited three months to work after the unfortunate shipwreck.
45	Los contemporáneos del conductor notan aunque es extravagante es sin duda brillante. Contemporaries of the composer note that although he is eccentric he is undeniably brilliant.
46	Mientras que el toro cargaba el matador se sintió poderoso por los ánimos del público. As the bull charged the matador felt empowered by the cheers of the crowd.
47	La profesora pudo olvidarse de su trabajo y sentirse relajada mientras cuidaba el jardín. The professor was able to forget work and feel relaxed while tending her garden.
48	El cocinero volteaba las tortillas con ambas manos pero solo firmaba con su mano derecha. The cook flipped omelets with either hand but only signed with his right hand.
49	El bibliotecario habló por tantas horas que impidió al grupo de estudio completar su tarea. The librarian talked for hours which prevented the study group from doing their homework.
50	Las esculturas en el césped impresionaron a la pareja durante el recorrido por la casa. The sculptures on the lawn impressed the couple during the house tour.
51	Distraído por un problema desafiante el matemático se pegó con la esquina de su escritorio. Distracted by a challenging problem the mathematician hit himself on the corner of his desk.
52	Cada miércoles el camión blindado pasa por el pueblo y hace varias paradas. Every Wednesday the armored truck drives through the town and makes several stops.
53	El dueño estaba furioso cuando los manifestantes se detuvieron en frente de la tienda. The owner was furious when the protesters stopped in front of the store.

(*Appendices continue*)

Table A1 (*continued*)

Item	Sentence
54	La pianista profesional no se encogió cuando sonó el móvil de un miembro del público. The professional pianist did not flinch when an audience member cell phone rang.
55	El cómico inexperto estaba emocionado de representar el comienzo del programa. The inexperienced comedian was thrilled to perform the opening act of the show.
56	Cuando el aire está sumamente seco con vientos fuertes los incendios son una amenaza grave. When the air is especially dry with strong winds fires are a serious threat.
57	La arrogancia y avaricia de la banda crecía con la publicación de cada entrevista nueva. The band arrogance and greed grew with the publication of each new interview.
58	La nueva arrendataria colgó su cartel favorito en el salón de su apartamento. The new tenant hung her favorite poster in the living room of her apartment.
59	Para aumentar ventas para su cliente el consejero sugirió que colocara anuncios en la red. To increase sales for his client the consultant suggested placing ads on the internet.
60	Los aventureros estaban todos enfermos en la primera noche de la excursión. The adventurers were all sick on the first night of the excursion.
61	El nuevo libro del escritor era muy similar a otro libro recién publicado. The author new book was very similar to another recently published book.
62	El riel de cortina es demasiado largo para las ventanas de la casa nueva. The curtain rod is too long for the windows in the new house.
63	La mamá agotada recogió los juguetes del bebé que estaban desparramados por el piso. The exhausted mother gathered the infant toys that were scattered across the floor.
64	El novio tuvo éxito en su tercer intento de ganar un premio en el circo. The boyfriend was successful on his third attempt to win a prize at the circus.
65	La escuela de artes ofrece cursos baratos de arte que son abiertos al público. The art school offers inexpensive art classes that are open to the public.
	Code-switched sentences[b]
1	Asombrosamente el detective encontró el violín que perdió en el south of Italy. "Surprisingly, the detective found the violin that he lost in the south of Italy."
2	El horno de mi apartamento es definitivamente eléctrico to save energy. "The oven from my apartment is definitely electric to save energy."
3	Realmente la silla de la cocina está sellada porque los owners bought it yesterday. "Actually, the chair from the kitchen is sealed because the owners bought it yesterday."
4	Honestamente la catedral que vimos se vio impresionante but it was not ancient. "Honestly, the cathedral that we saw yesterday was impressive but it was not ancient."
5	Cada domingo el veterinario va al parque zoológico to visit the animals. "Each Sunday the vet goes to the zoological park to visit the animals."
6	En nochebuena el grupo de amigos compraron mucha bebida to celebrate. "On Christmas Eve, the group of friends bought a lot of alcohol to celebrate."
7	Cuando el niño cariñoso tiene tiempo escribe una letter to his grandparents. "When the caring child has time, he writes a letter to his grandparents."
8	Porque se lo merecía su mother sent her a birthday gift. "Because she deserved it, her mother sent her a birthday gift."
9	El mes que viene la enfermera se va de vacaciones to the Caribbean island. "In the upcoming month the nurse will go on vacation to the Caribbean island."
10	Los maestros aseguran que los estudiantes de español respect them in the classroom. "The teachers assure that the Spanish students respect them in the classroom."
11	Los científicos saben que los experimentos are increasing the expenses. "The scientists know that the experiments are increasing the expenses."
12	El mesero está preocupado porque su compañero is frequently sick. "The waiter is worried because his coworker is frequently sick."
13	La madre sabe que los chicos fueron al parque to play soccer. "The mother knows that the kids went to the park to play soccer."
14	La secretaria confirmó que el nuevo hotel de playa will be completed next May. "The secretary confirmed that the new beach hotel will be completed next May."
15	El autor supuso que los empleados de la librería were selling his book. "The author imagined that the employees from the bookstore were selling his book."
16	El técnico sabe que las torres están mejorando phone calls in the area. "The technician knows that the towers are improving phone calls in the area."

(*Appendices continue*)

Table A1 (*continued*)

Item	Sentence
17	El astrónomo confirma que los asteroides are changing the weather. "The astronomer confirms that the asteroids are changing the weather."
18	Inconscientemente el piloto ansioso cerró la puerta before grabbing the keys. "Unwittingly the anxious pilot closed the door before grabbing the keys."
19	El nuevo cliente no dejó mucha propina for the desperate hairdresser. "The new client did not leave a lot of tip for the desperate hairdresser."
20	El panadero amasó la masa al mismo tiempo que the telephone rang. "The baker kneaded the dough at the same time that the telephone rang."
21	Todas las modelos rodearon a la diseñadora al end of the show. "All of the models surrounded the designer at the end of the show."
22	La temperatura estaba puesta muy alta entonces el abrigo shrank in the dryer. "The temperature was set too high so the coat shrank in the dryer."
23	Una de las patas de la mesa es más pequeña so it always wobbles. "One of the table legs is shorter so it always wobbles."
24	No pudimos ver la televisión por el apagón but we played cards. "We could not watch television because of the blackout but we played cards."
25	El vendedor convenció a la pareja que compraran una aspiradora for their new apartment. "The salesman convinced the couple that they should be a vacuum cleaner for their new apartment."
26	Por desgracia el cajero se equivocó con el cambio del cliente and was quickly fired. "Unfortunately the cashier made a mistake with the client's change and was quickly fired."
27	El piloto aterrizó el avión en el campo porque la pista was covered in ice. "The pilot landed the airplane in the field because the runway was covered in ice."
28	La planta suministra electricidad y contrata a muchos de los residents in the city. "The plant supplies electricity and hires many of the residents in the city."
29	La película era tan monótona que el público began to yawn. "The movie was so monotonous that the crowd began to yawn."
30	Los novios estaban agradecidos por los cubiertos hermosos that they received. "The newlyweds were grateful for the beautiful silverware that they received."
31	El chillido del águila sorprendió a los campistas mientras que intentaban a armar the tent. "The shriek of the eagle startled the campers while they tried to assemble the tent."
32	La carrera estaba competitiva hasta que un runner tripped and fell. "The race was competitive until a runner tripped and fell."
33	A causa del apagón el hielo melted in the freezer. "Due to the blackout the ice melted in the freezer."
34	Una avalancha en la montaña casi atrapa a los hikers in their shelter. "An avalanche on the mountain almost traps the hikers in their shelter."
35	La estudiante estaba angustiada cuando una sobrecarga eléctrica destroyed her computer. "The student was anxious when an electrical surge destroyed her computer."
36	La oruga creó un capullo y se convirtió into a beautiful butterfly. "The caterpillar created a cacoon and changed into a beautiful butterfly."
37	Los paleontólogos descubrieron una especie nueva de dinosauro during the excavation. "The paleontologists discovered a new species of dinosaur during the excavation."
38	La cafetería empezó a cocinar platos más saludables después de que los parents complained. "The cafeteria began to cook more healthy dishes after the parents complained."
39	Nevó tanto ayer que retrasaron todos los vuelos at least six hours. "It snowed so much yesterday the flights were delayed at least six hours."
40	Los ciervos se asustaron por la bocina fuerte y se escondieron in the woods. "The deer were frightened by the loud honk and hid in the woods."
41	Las botas de lluvia eran muy pequeñas y las tuve que cambiar for another pair. "The rain boots were too small and I had to change them for another pair."
42	En medio del concierto de rock el guitarrista rompió una cuerda and stopped playing. "In the middle of the rock concert the guitarist broke a string and stopped playing."
43	La construcción del puente se detuvo temporariamente porque el envío de cemento was delayed. "The construction of the bridge was detained temporarily because the shipment of cement was delayed."
44	Muchos pacientes recomiendan al dentista porque es meticuloso with his patients. "Many patients recommend the dentist because he is meticulous with his patients."
45	Los niños se rieron mientras corrían al playground during recess. "The children were laughing as they ran to the playground during recess."

(*Appendices continue*)

Table A1 (*continued*)

Item	Sentence
46	El niño educado esperó hasta que todos en la mesa fueron servidos before eating. "The well-educated boy waited until everyone at the table was served before eating."
47	El día del eclipse solar el meteorólogo estaba muy ocupado and missed it. "The day of the solar eclipse the meteorologist was very busy and missed it."
48	Con la llegada de la primavera las flores están saliendo y las aves are returning. "With the arrival of spring the flowers are emerging and the birds are returning."
49	El agente inmobiliario se preocupó de que dejó documentos importantes in the building. "The real estate agent was worried that he left important documents in the building."
50	Organizar una buena fiesta de Navidad es un trabajo duro y caro por the decorations. "To organize a good Christmas party is hard work and expensive because of the decorations."
51	Al norte del pueblo hay un campo bello lleno de flowers every spring. "To the north of the of the village is a beautiful field full of flowers every spring."
52	En la fiesta de disfraces el disfraz más popular was a witch. "At the costume party the most popular costume was a witch."

[a] Monolingual sentences are presented with their Spanish and English equivalent. Monolingual sentences were presented as a between-subjects manipulation. [b] Code-switched stimuli used in the experiment. All participants read the code-switched stimuli. A monolingual English gloss is presented below each sentence.

Appendix B

Supplementary Data and Manipulation Checks for List and Dominance Effects

As can be seen in Table B1 for the self-paced reading trials, mean reading time per word was not affected by sentence trial type across lists with the exception of the English-dominant group reading in the English lists. However, despite code-switched sentences being uniquely signaled by the start of the sentence occurring in Spanish, this group was slower when reading code-switched sentences as compared to monolingual English sentences. All other within-list differences are within 10 ms for a given dominance group. Note, this descriptive table includes 46 participants because 2 participants did not complete the proficiency battery of tests in a separate session.

On Flanker trials to illustrate the lack of interaction with list, the response times (RTs) are 604 ms (SE = 3.57) for lists where the monolingual condition is English, and 610 ms (SE = 4.03) for lists where the monolingual condition is Spanish. Clearly, there is a very small 6-ms difference in overall Flanker performance across lists. When we break lists down by Flanker congruency, the mean Flanker RTs are as follows: English monolingual sentences, Congruent Flankers: 560 ms (SE = 4.51); English monolingual sentences, Incongruent Flankers: 651 ms (SE = 4.83); Spanish monolingual sentences, Congruent Flankers: 563 ms (SE = 5.04); Spanish monolingual sentences, Incongruent Flankers: 660 ms (SE = 5.54). Notably, there is just a 3-ms difference for Congruent Flanker trials across lists where the monolingual sentences are in English vs. Spanish, and just a 9-ms difference for Incongruent Flanker trials across the lists. This should provide convincing evidence that Flanker performance does not differ depending on the language of a list's monolingual sentences, hence the lack of interaction with list. For descriptive statistics split by list and dominance, see Table B2.

Table B1
Descriptive Statistics for the Self-Paced Reading Trials by List (Monolingual Language), Trial Type (Monolingual Versus Code-Switched) and Participants' Language Dominance

Monolingual language of "congruent" sentences in list	Number of participants	Participant dominance	Sentence trial type	Mean RT	*SD*
EN	16	EN	EN	338	103
EN	16	EN	CS	404	128
EN	8	SP	EN	429	173
EN	8	SP	CS	418	108
SP	10	EN	SP	518	147
SP	10	EN	CS	515	134
SP	12	SP	SP	471	231
SP	12	SP	CS	475	303

Note. RT = reaction time; EN = English; SP = Spanish; CS = code-switching.

As can be seen in Table B2, the Flanker effect (Incongruent minus Congruent) is present no matter the list, and no matter the participant's dominance.

Moreover, regarding conflict adaptation in Table B3, the Condition = "II" (incongruent Flanker following "incongruent" code-switched sentences) is always numerically faster than the Condition = "CI" (incongruent Flanker following "congruent" monolingual sentences) *for all groups* regardless of list or dominance, once again clearly explaining the lack of a Condition × List interaction reported in the main text:

Thus, the monolingual sentences (by list) appear not to be modulating the overall effects we observe.

(*Appendices continue*)

Table B2
Descriptive Statistics for Flanker Trials by List (Monolingual Language) and Participants' Language Dominance

Monolingual language of "congruent" sentences in list	Participant dominance	Flanker congruency	Mean RT	*SE*
EN	EN	Congruent	542	5.76
EN	EN	Incongruent	629	5.97
EN	SP	Congruent	592	7.22
EN	SP	Incongruent	686	8.13
SP	EN	Congruent	566	7.22
SP	EN	Incongruent	677	8.59
SP	SP	Congruent	561	7.41
SP	SP	Incongruent	653	7.48

Note. RT = reaction time; EN = English; SP = Spanish; CS = code-switching.

Table B3
Descriptive Statistics for Flanker Trials by List (Monolingual Language), Participants' Language Dominance, and Experimental Condition

Monolingual language of "congruent" sentences in list	Participant dominance	Condition	Mean RT	*SE*
EN	EN	CI	636	9.09
EN	EN	II	622	7.73
EN	SP	CI	695	11.4
EN	SP	II	676	11.5
SP	EN	CI	679	13.0
SP	EN	II	675	11.3
SP	SP	CI	662	10.2
SP	SP	II	645	10.9

Note. RT = reaction time; EN = English; SP = Spanish; CS = code-switching. For Condition, the first C/I refers to sentence type where C = monolingual, I = code-switched, and the second C/I refers to Flanker trial type where C = congruent and I = incongruent.

Received January 31, 2018
Revision received July 10, 2019
Accepted July 11, 2019 ■