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Investigating Local and Global Control Mechanisms in Bilingual Grammatical Processing

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Bilinguals employ both global and local control mechanisms to manage coactivated languages that compete for selection, yet little is known about how they operate on morphosyntactic information. The current study investigated bilingual language control mechanisms for a morphosyntactic production task. Across two experiments, 48 early Spanish–English bilinguals completed rapid instructed task learning paradigms with priming-in-item-recognition manipulations that investigated the extent to which parallel activation was observed across languages and across rules of the same type within a language. The results from the current experiments showed that it was more difficult to reject incorrect responses in the correct target language than to reject incorrect responses that contained the correct grammatical manipulation executed in the nondesired language. These results suggest that global control at the level of target language selection is more effective than local control processes during a bilingual morphosyntactic manipulation.

Keywords: grammatical processing, bilinguals, memory, rapid instructed task learning, global versus local control

Bilingual language use is complicated by the unique demands associated with managing multiple languages. Not only must bilingual individuals store two sets of word forms for communicating ideas, they must also manage two sets of morphosyntactic rules for manipulating them. Being bilingual is further complicated by the fact that when using one language, parallel memory activation occurs in the other language (Jacobs et al., 2016; Kroll et al., 2006; Marian & Spivey, 2003). Thus, to use two languages effectively, bilingual individuals must be able to select the contextually appropriate linguistic information from competing alternatives both within and across languages (Buchweitz & Prat, 2013; Stocco et al., 2014). These processes are commonly referred to as "bilingual language control."

Bilingual language control is a multidimensional construct (Abutalebi & Green, 2016; Gollan & Goldrick, 2016; Green & Abutalebi, 2013; Hoversten et al., 2015; Yamasaki et al., 2018). For example, research has shown that bilingual language control is deployed on a global level (i.e., selecting which language to use), and at a local level (i.e., selecting which words and rules to use; Abutalebi & Green, 2016; Green & Abutalebi, 2013; Seo et al., 2018). Two recent bilingual neuroimaging studies have shown that cues at the global level about which language (e.g., Spanish vs. English) to subsequently use enable bilinguals to deploy global control mechanisms proactively, preparing them to use the target language in advance (Reverberi et al., 2018; Seo et al., 2018). Conversely, when faced with lexical items in the absence of preparatory cues, research has shown that bilinguals quickly extract information about the target language and use this information to modulate the degree of subsequent processing (Hoversten et al., 2015).

Considerable research has shown that bilinguals often rely on local control mechanisms, even when global language information and proactive control may be available or engaged. Parallel memory activation occurs for local items across languages, even under conditions in which a single target language is being used for lengthy periods of time (see Kroll et al., 2012 for review). The vast majority of previous research has focused on lexicosemantic selection processes, and the predominant explanation for this has been that activation spreads automatically from word forms in one language to another through their shared semantic representations (Kroll & Stewart, 1994). Because of the focus on the lexical level, many of these studies have concluded that global control alone is not sufficient and that bilinguals continue to require local control to manage cross-language competition.

While evidence from code-switching and structural priming literature suggests that coactivation also occurs at the morphosyntactic level (Hartsuiker et al., 2004; Hatzidaki et al., 2011; Pickering & Ferreira, 2008), considerably less is known about whether coactivation of morphosyntactic representations requires or engages the same types of bilingual language control. The research on morphosyntactic coactivation suggests that morphosyntactic rules may be organized in the bilingual mind according to their local functions (e.g., the order of direct and indirect objects in use of dative

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Table 1
Age of Acquisition of Second Language (LEAP-Q) and Grammatical Proficiency Test Scores in Experiment 1

Age of acquisition of L2		Spanish grammatical proficiency		English grammatical proficiency	
M (*SEM*)	Range	*M* (*SEM*)	Range	*M* (*SEM*)	Range
3.32 (0.42)	0–7 years	76.26% (2.42%)	50%–96%	90% (1.63%)	50%–92%

Note. Standard error of the mean (*SEM*) is in parentheses. The participants' second language (L2) was typically English ($N = 21$). Four participants reported themselves as Spanish-dominant speakers and 19 reported as English-dominant speakers. The maximum raw scores for Spanish grammatical proficiency test and English grammatical proficiency test are 50 and 20, respectively. LEAP-Q = language experience and proficiency questionnaire.

verbs), and that activation may spread from those local functions to the specific rules for accomplishing them in each language. Evidence supporting this type of organization can be seen in the code-switching and structural priming literature that shows morphosyntactic structures can be primed across languages (Fleischer et al., 2012; Van Gompel & Arai, 2018). Further evidence comes from research on second language learning, which consistently finds that it is more difficult to acquire rules in a second language that do not already exist in your first language (i.e., Khalifa, 2018; Kotz, 2009; Tolentino & Tokowicz, 2011). Much less is known about the processes by which coactivation and selection occur in morphosyntactic rule use, and what they may tell us about the nature of bilingual morphosyntactic rule representation and language control more generally.

The majority of existing bilingual language control studies ensure that global control governs local control by presenting target language information either prior to or concurrent with the stimuli on which it will be applied, with few exceptions (e.g., voluntarily switching; Gollan & Ferreira, 2009; Reverberi et al., 2018). Thus, little is known about how control may operate differently under conditions in which local control constraints (e.g., semantic or morphology processing) precede global control. For instance, in dense code-switching or dual language contexts, both languages are allowed to flow freely in conversation, relaxing the need for strict global language control (Green & Abutalebi, 2013). In the current experiment, as in previous bilingual control rapid instructed task learning (RITL) studies (Seo et al., 2018; Seo & Prat, 2019), global constraints (i.e., target language) were presented before local constraints (i.e., morphosyntactic rules) across subsequent rule phases. Because past studies always presented global language information first, they have been unable to conclude with any certainty whether the pattern of results were due to task order or global language control. Therefore, a novel manipulation in the current study also investigated whether a reversal of this order modulates how bilinguals deploy their global versus local language control. In Experiment 1, as in past RITL studies, target language information is given prior to grammatical rule information. In contrast, in Experiment 2, the rule information appears first. This task order manipulation in Experiment 2 is meant to reduce promoting global control before local control.

One issue with many studies on morphosyntactic coactivation is that it can be hard to isolate the morphosyntax from lexical effects (Schoonbaert et al., 2007). Despite the fact that lexicosemantic and morphosyntactic information is highly integrated and interactive in memory systems (MacDonald et al., 1994), seminal studies have shown that morphosyntactic knowledge can be queried

Table 2
Example Questions and Responses From the Bilingual Switching Questionnaire (BSWQ)

Question	Response options	Response ($N = 23$)
I tend to intentionally switch languages during a conversation (e.g., I switch from English to Spanish).[a]	1 = *never* 2 = *very infrequently* 3 = *occasionally* 4 = *frequently* 5 = *always*	*M* 3 (0.20)
There are situations in which I always switch between the two languages intentionally.	1 = *never* 2 = *very infrequently* 3 = *occasionally* 4 = *frequently* 5 = *always*	3.52 (0.20)
There are certain topics or issues for which I normally switch between the two languages intentionally.	1 = *never* 2 = *very infrequently* 3 = *occasionally* 4 = *frequently* 5 = *always*	2.91 (0.24)

Note. Standard error of the mean (*SEM*) is in parentheses. [a]Response to this question was used for analysis.

Table 3
Sample Stimuli for Spanish and English Trials

	English (#)		Spanish (*)	
Morphosyntactic rule	Stimulus	Response	Stimulus	Response
Past (A)	NESKER	NESKERED	NESKER	NESKIÓ
Present progressive (B)	NESKER	NESKERING	NESKER	NESKIENDO

Note. Sample experimental symbols are in parentheses. Target language symbols: pound (#) and asterisk (*) were switched in version B presentation, that is, English (*), Spanish (#).

independently from lexicosemantics by asking individuals to apply existing rules to novel stimuli (e.g., the Wug tests by Berko, 1958; Bialystok et al., 2014; Cuskley et al., 2015). The Wug tests demonstrate that the human brain is capable of extracting abstract grammatical rules from integrated representations (Berko, 1958). In the original Wug test experiment, participants were asked to pluralize a pseudoword noun. For instance, for a pseudo noun stimuli *wug*, participants reliably know that the correct response is wugs. By using pseudowords, the influence from semantic processing can be removed. The current study employs pseudowords as the target of the global and local constraints to investigate how Spanish–English bilinguals apply morphosyntactic rules, and how they experience or manage the coactivation within or across languages.

Another limitation of the previous research on bilingual language control is that global and local influences are not readily separable, as global information about the target language is often cued by lexical representations in the target language (e.g., auditory cue "Say" and "Diga" for English and Spanish, respectively; e.g., Hernandez et al., 2001). A feature of the RITL paradigm used in the current study is that it uses abstract symbols to cue global (i.e., target language) and local (i.e., morphosyntactic rule) constraints. This allows for the unique opportunity to isolate how language control mechanisms are engaged proactively in the absence of any lexical items that may trigger the involvement of bottom-up mechanisms reactively (e.g., Hoversten et al., 2015). The use of pseudoverbs in the current experiment further removes the bottom-up influences of lexical stimuli even at the production phase. This also allows us to control for the fact that morphosyntactic rules in a particular language may be preferentially activated when a word is presented in that language, irrespective of what control processes are under way.

The RITL task was originally devised to assess nonlinguistic, *rule-based* behaviors. In contrast to traditional cognitive tasks that typically employ a single set of rules applied to multiple stimuli, RITL tasks require participants to apply different rules to the stimuli on a trial-by-trial basis, such that a new different task is executed on each trial (Cole et al., 2013). Such tasks have been recently used to study bilingual cognition in both linguistic (e.g., Seo et al., 2018) and nonlinguistic contexts (e.g., Becker et al., 2016).

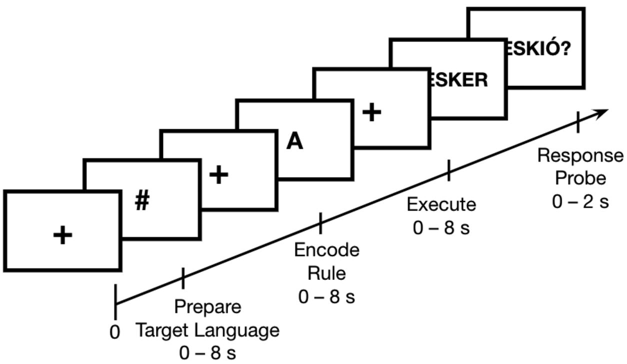
Recently used *bilingual* RITL tasks also involve a subvocal production phase in which participants must generate the answer that would occur from applying the grammatical rule (e.g., target language = English, and rule = to pluralize) to the word. Participants are instructed to press a button when they have generated an answer in mind, and are then given a short period of time (typically 1–2 s) to decide whether a response probe is correct or incorrect based on the answer they generated subvocally. The purpose of having participants subvocalize their final response and subsequently check their answer against the probe was to enable a priming-in-item-recognition approach (Ratcliff & McKoon, 1978). In short, priming-in-item-recognition assumes that if a participant's subvocalized response matches the probe, they should be faster to recognize it. However, if the probe differs in plausible ways, they should be particularly slowed in rejecting it. Therefore, when the probe matches a participant's subvocalized response, they should be faster to recognize the probe, but when the probe differs in plausible ways, they should be particularly slowed in rejecting it. To employ the priming-in-item-recognition approach, it is also important that the speed of recognition or rejection is not influenced by overall lexical retrieval. The use of pseudowords, therefore, serves two purposes: to reduce the efficacy of the priming-in-item-recognition approach by eliminating lexical features that influence word retrieval latencies, and to isolate an individual's independent syntactic representation irrespective of bottom-up lexical activation.

The current study investigates the effects of global and local control processes by examining behavior in the face of three types of response probe foils. Note that each of these probe foils has one wrong part meant to operationalize the efficacy (or, to put it simply, the relative strength) of global and local controls, namely: (a) *Wrong Language* probes, which consist of an correct morphosyntactic rule in the incorrect target language, (b) *Wrong Rule* probes, which consist of an incorrect morphosyntactic rule in the correct target language, and finally (c) *Wrong Both* probes, which consist of an incorrect morphosyntactic rule in the nontarget language. Again, each of these three conditions is incorrect and is therefore meant to elicit a "NO" response from the participants. For example, in Experiment 1, participants are first cued to use English, then cued to use past tense, and then provided with the pseudoword "NESKER." They should subvocalize their response (i.e., "NESKERED"), and then proceed to the probe. A *Wrong Language* probe would display "NESKIÓ" (Spanish, past tense). A *Wrong Rule* probe would display NESKERING (English, present progressive). A *Wrong Both* probe would display "NESKIENDO" (Spanish, present progressive). Finally, there are also correct probes, which would display "NESKERED." The rationale behind these foils are as follows. Previous research has shown that rejecting items that are active in memory is more difficult (as indexed by slower response times and poorer accuracy) than rejecting items that are not active in memory (Long & Baynes, 2002; Long et al., 2005; Prat et al., 2007). Hence, the extent to which participants are slower or less accurate to reject probes that are globally related (correct language, but incorrect rule) versus locally related (correct rule, but incorrect language) will be taken to reflect their coactivation in memory. A more detailed description of the RITL paradigm is included under the Method section.

In summary, with the novel modifications to an RITL paradigm employed across two experiments, the current research investigates the nature of global and local bilingual language control mechanisms, with the goal of answering three interrelated questions: (a)

Figure 1

Schematic of a Sample Trial in Experiment 1 Displaying Prepare Target Language, Encode Rule, Execute, and Response Verification Probe Phases



Note. Within the maximum time length (e.g., 0–8 for Preparation Target Language, Encode Rule, and Execute or 0–2 s for Response Verification), participants can move forward to the next phases in self-paced.

Does coactivation of morphosyntactic structures occur? (b) Are global and local selection mechanisms equally efficacious as evidenced by coactivation of interfering items from within and between languages? And (c) Does bilingual language control structure, as manipulated by task order, modulate the efficacy of global and local selection mechanisms?

The answers to these questions will be obtained by comparing the speed and accuracy with which participants reject the three different types of response foils. For example, slower and/or less-accurate responses when rejecting wrong language trials than wrong rule trials would provide evidence for coactivation of morphosyntactic structures across languages; whereas the reverse pattern, slower and/or less-accurate responses to wrong language trials would provide evidence for better global selection mechanisms. Critically, changes to the response patterns for different foil types associated with task order will provide evidence that the relative efficacy of local and global selection mechanisms can change, dynamically, as a function of task demands.

Experiment 1: Method

Participants

Twenty-five early Spanish–English bilingual speakers (18 female, $M_{\text{age}} = 19.16$ years) who learned both languages before the age of 7 were recruited for Experiment 1 using the University of Washington Psychology Subject Pool. All participants provided informed consent according to the guidelines of the Institutional Review Board

Table 5

Mean Response Times and Standard Errors of the Means in Each Phase

Exp. 1	Prepare language	Encode rule	Execute
Response time (ms)	1,445 (157)	1,807 (153)	2,748 (196)

Note. Standard errors of the means are in parenthesis. The maximum time for time out in each phase was 8 s.

at the University of Washington, and received course credit for their participation. Two participants were excluded based on poor performance on the Spanish grammatical proficiency test (<50% accuracy). Data from the remaining 23 participants are reported herein. Four participants reported that their dominant language is Spanish and 19 participants reported their dominant language as English. Participants' language profiles and proficiency scores are summarized in Tables 1 and 2.

Materials

Paper-and-Pencil Tests

English Proficiency Measure. The English grammatical proficiency test is a subtest of the "Examination for the Certificate of Proficiency in English" test developed at the University of Michigan (English Language Institute, 2006). It has previously been used in bilingual investigations as a measure of English proficiency (e.g., van Hell & Tanner, 2012) as it is sensitive to subtleties in English grammatical proficiency. The subtest consists of 20 multiple-choice questions, and participants were given as much time as needed for completion. The percentage reported in Tables 1 and 2 was calculated by dividing the individuals' obtained scores by the maximum possible score (20), then multiplied by 100.

Spanish Proficiency Measure. The Spanish grammatical proficiency test is a subtest of the standardized Spanish proficiency test issued from the ministry of Spanish education for Diplomas in Spanish as a Foreign Language (el Ministerio de Educacion, 1998). This multiple-choice, paper-and-pencil test has also been previously used to assess Spanish proficiency in bilingual research (e.g., Montrul & Bowles, 2009). The first 30 multiple-choice questions are individual sentence completion tasks with one word missing. Participants select the correct word out of four options. The second 20 multiple-choice questions are contextual, consisting of numbered gaps placed throughout a passage. Individuals are instructed to read the entire passage and then choose which of three options best completed each omission. Participants were given as much time as they needed to complete the test. The percentage reported in Tables 1 and 2 was calculated by dividing

Table 4

Mean Accuracy and Response Times by Types of Probes in Experiment 1

Exp. 1	Wrong language	Wrong rule	Wrong both	Wrong root (catch trial)	Correct
Response time (ms)	779 (26.3)	825 (41.2)	760 (21.3)	1,011 (39.5)	859 (37.8)
Accuracy	1.51 (0.03)	1.41 (0.05)	1.53 (0.02)	1.02 (0.06)	1.28 (0.03)

Note. Standard errors of the means are in parenthesis.

Table 6
Experiment 1: Best Fit for Reaction Time

Variable	Correlation coefficient	*SE*	*t*	*df*	*p*
Intercept	797.32	38.65	20.63	49.37	<.001***
Trial	−0.99	0.39	−2.53	31.12	.02*
Probe type (language incorrect)	4.87	26.32	0.19	29.97	.85
Probe type (rule incorrect)	74.17	26.08	2.84	30.44	.01**
Language (Spanish)	44.53	21.67	2.06	30.46	.05*

* $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$.

the individuals' obtained scores by the maximum possible score (50), then multiplied by 100.

Bilingual Language Experience Questionnaire. A modified version of the Language Experience and Proficiency Questionnaire (Marian et al., 2007) was used as a self-report measure of bilingual language experience and proficiency. The test asks participants to self-rate language comprehension, production, and reading proficiency. It also asks explicit questions about age of acquisition and background language experience. The modified version of this test has been used to characterize language experience in studies investigating individual differences in bilingual language experience (e.g., Yamasaki & Prat, 2014). This survey takes approximately 20–30 min.

Bilingual Language Switching Questionnaire. The Bilingual Language Switching Questionnaire is a self-reported assessment of bilingual language use that specifically asks questions investigating switching tendencies between languages (Rodriguez-Fornells et al., 2012). An example question from the questionnaire is: *I tend to switch language during a conversation* (*for example, I switch from English to [Second Language] or vice versa*). The answer choices are provided on a Likert scale of 5 (i.e., 1 = *never*; 2 = *very infrequently*; 3 = *occasionally*; 4 = *frequently*; 5 = *always*). This survey takes approximately 5–10 min.

Stimuli

The pseudowords manipulated in the RITL task were generated through the Australian Research Council Nonword Database (Rastle et al., 2002). All pseudowords had orthographically existing onsets and bodies, ranging in length from 4 to 7 letters. To maximize the likelihood that our pseudowords would not be distinctively Spanish or English sounding, the word ending *-er* (common in both English and Spanish verbs) was added to the pseudowords. Each pseudoword was then tested in a norming study. Six early, proficient, Spanish–English bilingual speakers read and rated each word on a scale of 1–5 with 1 being *English sounding word*, 3 being *neutral*, and 5 being *Spanish sounding word*. Raters also confirmed that none of the words existed as real words in either Spanish or English. The final list was selected by choosing the 96 pseudowords with the most neutral ratings. The resulting stimulus list had a mean rating of 2.93, with a range between 2.17 and 4.3 and a standard deviation of 0.52. Sample pseudowords and their conjugations in each language are listed in Table 3. The complete list of the pseudowords is provided in the Appendix.

Research Design and Procedure

Research Design

Rapid Instructed Task Learning Paradigm. The RITL paradigm allows the experimenter to present instructions on how to conjugate a pseudoword in English or Spanish sequentially across three phases (i.e., "Prepare Target Language," "Encode Rule," and "Execution") and there is a probe (i.e., "Response Verification") at the end of each trial. The first "Prepare Target Language" phase instructed the participant to either use Spanish or English rules depending on the instruction given via a symbolic code (# or *). The specific symbol–language mapping was counterbalanced across participants. Some of the participants learned to map a pound (#) sign to English and an asterisk (*) to Spanish, while other participants learned to map a pound sign (#) to Spanish and an asterisk (*) to English. This counterbalance was introduced to reduce any potential confounding factors stemming from an association between a particular sign to a particular language. The second "Encode Rule" phase involved the presentation of one of two codes indicating morphosyntactic rules for manipulating verbs. The two rules used in the experiment were past tense or present progressive tense. All rules were cued using alphabetic symbols common to both languages ("A": past tense, "B": present progressive tense). Each type of rule and target language was presented an equal number of times across the experiment (24 Spanish

Table 7
Experiment 1: Model Comparison for Response Times

Models	AIC	BIC	LogLik	Deviance	χ^2	*df*	*p*
Base model versus base model + probe type	−6.00	3.00	5.10	−10.00	10.19	2	.01**
Base model + probe type versus base model + probe type + language	−2.00	2.00	2.20	−4.00	4.49	1	.03*
Base model versus base model + language	−2.00	2.00	2.40	−4.00	4.70	1	.03*
Base model + language versus base model + probe type + language	−6.00	3.00	4.90	−10.00	9.98	2	.01**

Note. All tested models include random intercepts for subjects and items. "Base model" includes a fixed effect of "trial" only. AIC = Akaike information criterion; BIC = Bayesian information criterion; LogLik = log-likelihood.
* $p \leq .05$. ** $p \leq .01$.

Table 8
Best Fit for Accuracy for Experiment 1

Variable	Correlation coefficient	*SE*	*z*	*p*
Intercept	5.22	0.89	5.87	<.001***
Trial	0.02	0.01	2.61	.01**
Probe type (incorrect language)	−0.44	0.73	−0.60	.55
Probe type (incorrect rule)	−1.77	0.65	−2.71	.01**
Language (Spanish)	−1.58	0.50	−3.13	.002**

** $p \leq .01$. *** $p \leq .001$.

past, 24 Spanish present progressive, 24 English past, and 24 English present progressive) in pseudorandom order. The third, "Execution" phase of the paradigm involved the presentation of a pseudoword which the participants were asked to manipulate according to the rules presented in the previous phases. Participants were asked to remain in the execution phase until they had finished applying the rules and had their final answer in mind, before continuing to the "Response Verification" phase. During the "Response Verification" phase of the experiment, a verification probe was presented. Participants were asked to indicate whether the verb conjugation they had generated subvocally matched the response indicated on the screen. "YES" and "NO" responses corresponded to left and right key presses. The precise hand-key mapping was counterbalanced across participants. Half of the response probes were correct, reflecting the answer that would be achieved if the correct language and correct rule were applied to the stimuli presented. The other half of the probes were incorrect, corresponding either to the application of the incorrect language but correct rule (16 items), incorrect rule but correct language (16 items), or both incorrect rule and incorrect language (16 items). An additional 16 catch items were added in which the appropriate verb ending occurred, but the spelling of the word root was incorrect. These item types were added so that participants would have to pay attention both to the word roots and to the word endings. Response times were recorded for the first three phases, which were self-paced within a maximum window of 8 s each. Both accuracy and response times were recorded during the "Response Verification" probe, which timed out after 2 s to prevent participants from using the verification time to generate answers.

The complete RITL paradigm consisted of 96 trials which were presented in four blocks of 24 trials each. A schematic RITL trial presentation is depicted in Figure 1. As explained above, in Experiment 1, the target language information was present first. It is to encourage participants in Experiment 1 to adopt a global control strategy.

Procedure

All participants were tested individually. The experiment consisted of a battery of paper-and-pencil tests and computerized tests, which took about 1 hr and 20 min to complete for each participant. The tests were presented in randomized orders.

Memory Tests and Practice Tests. Participants received systematic memory training before participating in the RITL experiment to learn the mapping between the symbols and their corresponding rules. As is consistent in the field (Seo et al., 2018; Stocco & Prat, 2014), training was composed of two memory tasks (each written in Spanish and English) and a practice task. The order of the language used in presenting the memory tasks was counterbalanced across participants. The tasks presented four symbols and their corresponding rules in pairs (e.g., "#=English") three times in a random order. After this learning phase, participants were asked to type the corresponding symbol when a rule was presented and to type the corresponding rule when a symbol was presented. The participants had to type the correct corresponding symbols and rules two times in a row without errors to complete the task. After the memory tasks, participants performed a practice task. The practice task consisted of 16 sample trials and was designed to acclimate the participants to the paradigm. Unlike the actual experimental paradigm, in the practice tests, accuracy and response time were provided after each trial to give participants feedback on their performance. Each participant was given the opportunity to complete the practice as many times to ensure that they were facile with the paradigm.

Data Analysis

Accuracy rates and response times were analyzed separately. Response times were analyzed for correct trials only for the conditions of interest (i.e., *Wrong Language*, *Wrong Rule*, *Wrong Both* trials, not including "yes" response trials or filler trials).

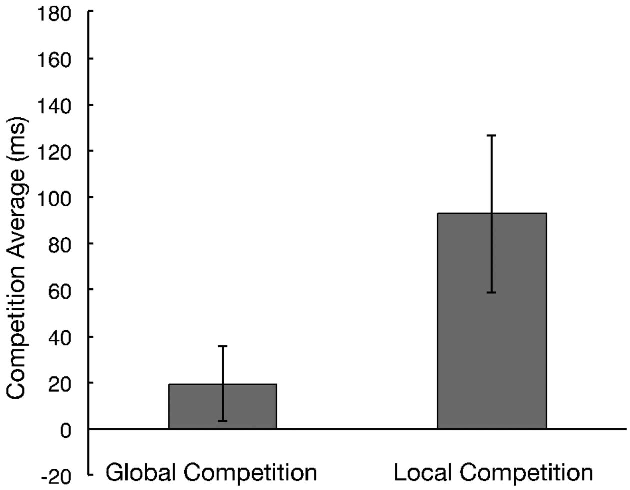
Table 9
Experiment 1: Model Comparison for Accuracy

Models	AIC	BIC	LogLik	Deviance	χ^2	*df*	*p*
Base model versus base model + language	−11.17	−6.46	6.59	−13.17	13.17	1	<.001***
Base model + language versus base model + language + probe type	−9.07	0.36	6.53	−13.07	13.10	2	<.005**
Base model versus base model + probe	−10.38	−0.96	7.20	−14.38	14.38	2	<.001***
Base model + probe versus base model + probe + language	−9.86	−5.14	5.92	−11.86	11.85	1	<.001***

Note. All tested models include random intercepts for subjects and items. "Base model" includes a fixed effect of "trial" only. AIC = Akaike information criterion; BIC = Bayesian information criterion; LogLik = log-likelihood.
** $p \leq .01$. *** $p \leq .001$.

Figure 2

Global Competition Effect (Left) and Local Competition Effect (Right) in Experiment 1



Note. The global competition effect is the difference in reaction times between the *Wrong Language* condition and the *Wrong Both* condition. The local competition effect is the difference in reaction times between the *Wrong Rule* condition and *Wrong Both* condition. The error bars are the standard errors of the means.

Responses that were more than three standard deviations from an individual participant's mean were removed. Outliers constituted approximately 0.11% of the data. Trial-level response times and accuracies were then modeled using multilevel mixed-effects analyses.

With the multiple predictors, we used a model comparison approach, starting with a bare-bones base model and adding variables as justified by a statistical comparison of model fit. The base model had a fixed effect of trial order (to account for overall speeding of response times with increased practice), and random intercepts for subjects and items. The model comparisons were performed using the analysis of variance function in R (Bates et al., 2015; R Core Team, 2017). For the first-order models, we added one predictor at a time and compared the model fit against the base model. Then, second-order models were fit by adding the significant predictors in the first-order models and comparing the model fit to the simpler first-order models. Models increased in complexity until the following conditions were met: A given model had a significantly better fit than all lower-order models, and the fit of the model was not significantly improved by adding other variables or interaction terms.

Experiment 1: Results

The mean accuracy rate for Experiment 1 across the conditions of interest was high ($M = 89.6\%$, $SEM = 1.41\%$). The mean accuracies and response times to the various probe types including nonfoil, correct trials are reported in Table 4. In addition, the mean response times for each phase are reported in Table 5.

The best-fit multilevel mixed-effects model of response times included fixed effects of trial order, probe type, and language (no interactions), and random intercepts for subjects and items. The probe type was fit with a reference level of *Wrong Both*, which was expected to yield the fastest response times due to the confluence of both cues (i.e., wrong language and wrong rule) and therefore make it easier to observe the effect of each cue independently. The model parameters can be found in Table 6, and the results of the model comparison with all lower-order models can be found in Table 7. The results showed that the *Wrong Rule* condition produced significantly longer response times compared to the *Wrong Both* probe, $\beta = 74.17$ ms, $t(30.44) = 2.84$, $p = .01$; Table 6. The effect of language, although only approaching significance in the best-fit model, significantly improved the model fit when compared to a lower-order model without language, $\chi^2(1) = 4.49$, $p = .03$; Table 7. When participants executed their response in Spanish, their responses to the probes were slower ($p = .05$). Finally, the effect of trial order showed that participants' responses became significantly faster ($p = .02$) over the course of the experiment (practice effect). On an additional note, we tested whether the variance of participants' language profile influences the performance by adding the participants' language proficiency or switching behaviors as the mixed-effects model. We conducted a chi-square test to justify if their inclusion was warranted. No significant improvement was observed when the items of participants' language profile were added as fixed effect variables.

For the accuracy model, the best-fit model contained identical predictors as the response time model, with the exception that random intercepts for items were excluded; the very high accuracy rates for most items (and therefore low variance) eliminated the need for random intercepts such that adding random intercepts for items resulted in warnings of singular fits. The effects of the probe type and language with the trial order variables were observed (see Table 8). When suggested probes were incorrect in rule and the probe language was in Spanish, participants' accuracy rate went down significantly (both, $p < .005$; Tables 8 and 9).

Taken together, these results suggest that global control processes largely prevented coactivation of the parallel morphosyntactic rule structures across languages, whereas interference was observed for probes consisting of different morphosyntactic rules within the target language (as indexed by slower response times and poorer

Table 10

Age of Acquisition of Second Language (LEAP-Q) and Grammatical Proficiency Test Scores in Experiment 2

Age of acquisition of L2		Spanish grammatical proficiency		English grammatical proficiency	
M (*SEM*)	Range	*M* (*SEM*)	Range	*M* (*SEM*)	Range
4.36 (0.32)	1–7 years	75.36% (2.17)	50%–92%	88.80% (1.98)	60%–100%

Note. Standard error of the mean (*SEM*) is in parentheses. The participants' second languages (L2) were either Spanish ($N = 1$) or English. Three participants reported themselves as Spanish-dominant speakers and 22 reported as English-dominant speakers. Raw scores for Spanish grammatical proficiency test and English grammatical proficiency test are 50 and 20, respectively. LEAP-Q = language experience and proficiency questionnaire.

Table 11
Example Questions and Responses From the Bilingual Switching Questionnaire (BSWQ)

Question	Exp. 1 ($N = 23$)	Exp. 2 ($N = 25$)
I tend to intentionally switch languages during a conversation (e.g., I switch from English to Spanish).[a]	*M* 3 (0.20) 1 = *never* 2 = *very infrequently* 3 = *occasionally* 4 = *frequently* 5 = *always*	*M* 3.12 (0.21)
There are situations in which I always switch between the two languages intentionally.	3.52 (0.20)	2.88 (0.18)
There are certain topics or issues for which I normally switch between the two languages intentionally.	2.91 (0.24)	3.2 (0.17)

Note. Standard error of the mean (*SEM*) is in parentheses.
[a]Response to this question was used for analysis.

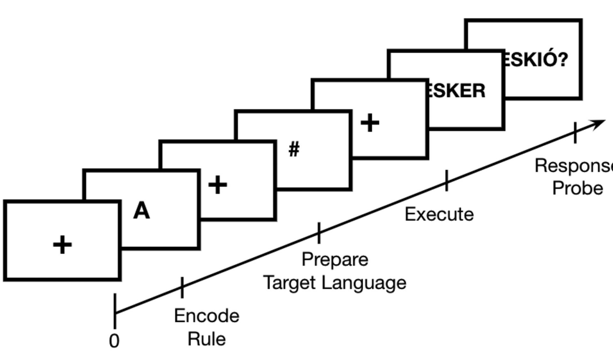
accuracy). To illustrate the magnitude of memory interference in the two probe conditions of interest, we operationalized interference as the difference in response times between each condition and the *Wrong Both* condition, and presented the results in Figure 2.

Experiment 1: Discussion

To the best of our knowledge, this is the first experiment to investigate local versus global bilingual language control using an abstract, morphosyntactic rule production paradigm. The implications of Experiment 1 are discussed herein, as outlined by the research questions posited in the introduction.

Does coactivation of morphosyntactic structures occur? In the absence of lexicosemantic information, we observed that it was more difficult to reject a verb conjugation violation within a language than to reject the verb conjugation across languages. The findings suggest that morphosyntactic rule application within a language results in a spreading memory activation to other rules. Given these conditions, the results suggest that retrieval of grammatical rules within a language facilitates retrieval of other rules with similar goals within that language (see Experiment 2: Discussion).

Figure 3
Schematic of a Sample Trial in Experiment 2 Displaying Encode Rule, Prepare Target Language, Execute, and Response Probe Phases



Note. The order of Prepare Target Language and Encode Rule presentation was reversed in Experiment 2.

In the current study, however, *Wrong Rule* foils only included verb conjugation rules which were also used in the experiment on other trials. Future studies might investigate the extent to which similarity of the morphosyntactic rules (e.g., pluralization or gender rules vs. verb conjugation rules) drives coactivation within the language. Additionally, the extent to which a particular rule becomes activated in response to the task should also be examined by including foils with rules that are never used in the task (e.g., future verb tense). It is possible that coactivation of alternate rules is driven by their use on previous trials, more so than by the use of a similar rule on the current trial. This possibility does not account for the fact that *Wrong Rule* probes were more difficult to reject than *Wrong Language* probes, which were also used in different trials across tasks (see below for further discussion).

Are global and local selection mechanisms equally efficacious as evidenced by coactivation of interferencing items from within and between languages? Results from Experiment 1 suggest that global control mechanisms are more strongly deployed during bilingual morphosyntactic rule production than are local control mechanisms. In the current study, the degree of effort to reject foils of varying types was taken to reflect the strength of activation of that particular rule in the memory trace. However, it is not clear to what extent the dominance of global control mechanisms in the current experiment is driven by the structure of the task. In Experiment 1, the target language was the first instruction given in all trials. This manipulation may facilitate global control mechanisms in two ways: (a) by increasing the salience of target language selection and (b) by providing more time for target language selection mechanisms to operate before the probe is presented. To control the effects of task structure, a second experiment was run in which local, morphosyntactic rules were provided before target language in the task instructions.

Experiment 2: Method

Participants

Thirty-seven Spanish–English bilingual speakers ($M_{\text{age}} =$ 19.05 years; 27 female) were recruited for Experiment 2 using

Table 12
Mean Accuracy and Response Times by Types of Probes in Experiment 2

Experiment 2	Wrong language	Wrong rule	Wrong both	Wrong root	Correct
Response time (ms)	804 (27.7)	904 (37.3)	795 (27.1)	1,005 (39.3)	838 (41.8)
Accuracy	1.50 (0.03)	1.32 (0.04)	1.50 (0.03)	1.09 (0.08)	1.32 (0.03)

Note. Standard errors of the means are in parenthesis.

the University of Washington Psychology Subject Pool. All participants provided informed consent according to the guidelines of the Institutional Review Board at the University of Washington and received course credit for their participation. Data from six participants were discarded because they did not meet the age of acquisition (<7 years old, three subjects) or Spanish proficiency (>50%, three participants) requirements. Another four participants were excluded because of poor performance on the task (below 75%), and data from two participants were excluded due to technical issues with hardware. Data from the remaining 25 participants are reported herein. Three participants reported their dominant language as Spanish and 22 participants as English. Participants' language profiles and proficiency scores are summarized in Tables 10 and 11.

Materials

In Experiment 2, the Materials and Procedures used were identical to those used in Experiment 1, with the exception of the order of instructions presented in RITL paradigm. Specifically, the morphosyntactic rule instruction was presented before the language rule. Figure 3 illustrates a schematic trial presentation.

Data Analysis

The analyses for Experiment 2 proceeded exactly as in Experiment 1. The analyzed response times included correctly answered responses by participants and the probe types of interest (i.e., *Wrong Language*, *Wrong Rule*, and *Wrong Both*). The correctly suggested probes and filler trials were excluded from the analysis, as were incorrectly answered responses for the analysis of response times. Outliers defined as three standard deviations above or below the mean were removed (1.08% of the data). Then, trial-level response times and accuracies were modeled using multilevel mixed-effects analysis using the same model comparison process and predictors. The base model included trial order as a fixed effect and random intercepts for subjects (response times and accuracies) and items (response times only).

Experiment 2: Results

The mean accuracy rate for Experiment 2 was 90.8% with a standard error of the mean of 1.25%. The mean accuracies and response times of the probes are reported in Table 12, and the mean response time for each phase is reported in Table 13, separately.

Table 13
Mean Response Times and Standard Errors of the Means in Each Phase

Experiment 2	Prepare language	Encode rule	Execute
Response time (ms)	1,515 (166)	1,977 (212)	2,813 (292)

Note. Standard errors of the means are in parenthesis. The maximum time for time out in each phase was 8 s.

As observed in Experiment 1, the best-fit multilevel mixed-effects model of response times included fixed effects of trial order, probe type and language (no interactions), and random intercepts for subjects and items. The effect of language (i.e., *English*, *Spanish*) was significant, $\chi^2(1) = 9.40$, $p = .002$, as well as the effect of probe types (i.e., *Wrong Language*, *Wrong Rule*, *Wrong Both*), $\chi^2(2) = 13.87$, $p < .001$. However, when these two predictors, language and probe type, were included, the model fit significantly improved (both, $p < .001$; see Table 14). When the probes were incorrect in rule, participants' response times were significantly slower, $\beta = 96.33$ ms, $t(30.38) = 3.41$, $p = .002$, than incorrect in both language and rule. In addition, when the probes were in Spanish, participants' performance was slower than English, $\beta = 79.17$ ms, $t(30.07) = 3.38$, $p = .002$; Table 15. As in Experiment 1, we also tested whether the variance of participants' language profile influences the performance by adding the participants' language proficiency or switching behaviors as the mixed-effects model. We used a chi-square test to determine if their inclusion was warranted. Adding the participants' language profile items as fixed effect variables did not significantly improve the model fit.

For the accuracies, the best model included the probe type only, in contrast to the best-fit accuracy model in Experiment 1 and the best-fit response time models in both experiments (Tables 8 and 15). The effect of language only marginally improved the model fit over the base model ($p = .06$), and when the two predictors (i.e., probe type and language) were added together and compared to the probe only model, the fit was not improved ($p = .15$). When probes were incorrect in rule participants' accuracy rate went down significantly ($p < .001$; Tables 16 and 17).

As in Experiment 1, we illustrated interference as the difference in response times between each condition and the *Wrong Both* condition as shown in Figure 4.

Experiment 2: Discussion

The primary goal of Experiment 2 was to explore the answer to the third research question: *Does bilingual language control structure, as manipulated by task order, modulate the efficacy of global and local selection mechanisms?* In doing so, we were able to ascertain whether the dominance of global control mechanisms observed in Experiment 1 was driven by the order in which global and local selection cues were presented in the task. Results from Experiment 2 largely replicate those from Experiment 1, with the exception of accuracy. The accuracy analysis revealed that the probe type alone matters the most for the accuracy rate in Experiment 2, in contrast to the finding that language along with probe type predicts the reaction times and accuracy rate in Experiment 1 and reaction times in Experiment 2. This is

Table 14
Experiment 2: Model Comparison for Response Time

Models	AIC	BIC	LogLik	Deviance	χ^2	*df*	*p*
Base model versus base model + language	−8.00	−2.00	4.70	−10.00	9.40	1	.002**
Base model + language versus base model + language + probe type	−11.00	−2.00	7.80	−15.00	15.54	2	<.001***
Base model versus base model + probe type	−10.00	0.00	6.90	−14.00	13.87	2	<.001***
Base model + probe type versus base model + language + probe type	−9.00	−4.00	5.60	−11.00	11.06	1	<.001***

Note. All tested models include random intercepts for subjects and items. "Base model" includes a fixed effect of "trial" only. AIC = Akaike information criterion; BIC = Bayesian information criterion; LogLik = log-likelihood.
** $p \leq .01$. *** $p \leq .001$.

particularly interesting given that Experiment 2 increased the salience of local control mechanisms. A possible explanation for why language did not predict accuracy in Experiment 2 is that although the number of languages (i.e., two: Spanish and English) and the rules (i.e., two: present progressive, past) were both limited to two options in both experiments, it is possible that additional rules in each language were activated in Experiment 1 after the language cue was presented. That is, in Experiment 1, participants saw the language cue, at which point multiple rules in the cued language were coactivated, not only the two rules used in the current experiments (past and present progressive), and all associated rule representations would get activated and compete for selection. On the other hand, in Experiment 2 where the rule instruction was first provided, the rule cue constrained the spreading activation within each language, at which point the target language information was cued and limited the competition for selection even further. Therefore, the degree of within-language spreading activation would have a stronger impact on both response times and accuracy rates in Experiment 1, but not as much as in Experiment 2.

Nevertheless, the overall pattern of results across both experiments was strikingly similar, with the majority of effects present across experiments and in the same direction. Taken together, the results from Experiments 1 and 2 provide evidence that control structure, as manipulated by rule order on a RITL task, does not modulate the efficacy of global versus local bilingual control mechanisms.

General Discussion

The current study is the very first study to quantify the efficacy of global and local bilingual language control on morphosyntactic processes. We found highly consistent results across two experiments using two independent groups of bilingual participants suggesting that: (a) coactivation of morphosyntactic rules within a language occurred in the absence of lexicosemantic information, (b) coactivation was found to be stronger across rules within a language than for the same rule across languages, and (c) this global selection bias occurred irrespective of the task structure. It is also worth noting that global language control preparation was easier than local preparation, as indexed by faster response times to target language instructions than to rule instructions, despite the fact that there were only two grammatical rule instructions to select from in each phase (see Figure 5).

One novel finding across the current experiments is that global and local control mechanisms did not appear to change as a function of task structure. Specifically, the adaptive control hypothesis posits that different language control mechanisms arise as a function of varying linguistic environments. For instance, much less (or possibly no) global language control would be recruited in dense code-switching environments as opposed to in single-language circumstances (Green & Abutalebi, 2013). In the current experiment, bilingual individuals were always required to maintain a single language across an individual trial, but languages were mixed from trial to trial at random. Interestingly, we found that when a morphosyntactic structure was given first and then then target language information came later, the language itself (i.e., whether the target language is Spanish or English) was not as important as when the target language information comes prior to a morphosyntactic rule. It is possible that in a dense code-switching environment, where global control seems relaxed, the local control works more efficiently to select a target rule. Indeed, the results in terms of accuracy from Experiment 2 suggested that this may be the case, which demonstrating that the language in use is not as important because any available language could be used in such a linguistic environment. Future research may want to create larger variations in local versus global demands, such that language stays constant across blocks, or even varies even within a trial. Due to the artificial nature of these tasks, however, it is unclear whether our manipulations are related to the differing demands of bilingual language use as outlined in the adaptive control hypothesis (Abutalebi & Green, 2016; Green & Abutalebi, 2013).

Table 15
Experiment 2: Best Fit for Response Time

Variable	Correlation coefficient	*SE*	*t*	*df*	*p*
Intercept	824.02	42.60	19.34	51.89	<.001***
Trial	−1.15	0.42	−2.72	30.27	.01*
Probe type (language incorrect)	−8.72	28.44	−0.31	29.54	.76
Probe type (rule incorrect)	96.33	28.27	3.41	30.38	.002**
Language (Spanish)	79.17	23.42	3.38	30.07	.002**

* $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$.

Table 16
Experiment 2: Best Fit for Accuracy

Variable	Correlation coefficient	*SE*	*z*	*p*
Intercept	3.80	0.52	7.29	<.001***
Trial	−0.002	0.01	−0.04	.68
Probe type (incorrect language)	0.27	0.55	0.49	.63
Probe type (incorrect rule)	−1.36	0.41	−3.31	<.001***

*** $p \leq .001$.

The current results lend support to the findings from a recent neuroimaging study that compared patterns of activation when bilingual individuals deployed global versus local control mechanisms in a similar RITL task using morphosyntactic manipulations. Specifically, Seo et al. (2018) recruited 23 early Spanish–English bilinguals and had them perform an RITL task in an magnetic resonance imaging scanner. Similar to the current study, the RITL task in Seo et al. (2018) included Prepare Target Language, Select Rule (equivalent to Encode Rule in current version of RITL), Execution, and Response Verification Probe at the end of the trials. They found more distributed activation during the Prepare Target Language phase than during the Encode Rule phase (cf., again in Seo et al., 2018, this phase was called Select Rule). The greater activation during the Prepare Target Language phase was most notably observed in the anterior cingulate cortex, which is largely implicated in performance and conflict monitoring (Abutalebi et al., 2008, 2012; Badgaiyan & Posner, 1998; Barber & Carter, 2005; Botvinick et al., 2004; Carter et al., 1998; Seo et al., 2018). The authors noted that the regions activated during the Prepare Target Language phase were typically associated with bilingual language control. In contrast, during the Encode Rule phases, left-lateralized activation was observed, centered around the inferior frontal gyrus. Because Seo and colleagues did not include a task order manipulation, they were unable to discriminate whether the broadly distributed patterns of activation found during the trial-initial Prepare Target Language phase were due specifically to global language control, trial ramp-up effects, or the general initialization of language use in bilinguals. However, the findings from the current study may lend support for the interpretation that the broadly distributed patterns of activation were more likely due to global language control. Global language control was found to be similarly efficacious across experiments, and the task order manipulation had a minimal impact on measures of language control. Since the current study did not collect the image data using functional magnetic resonance imaging, this finding does not completely rule out the possibility that the broadly distributed activation could still have been elicited due to the order effect. However, the consistent efficacy of global control observed in Experiment 1 and Experiment 2 adds evidence that activation to either asterisks or pound signs in the Prepare Target Language phase may not be solely from the order effect.

Thus, the results obtained from the current experiments in combination with the previous neuroimaging research provide compelling evidence about both the neurocognitive mechanisms deployed during global and local bilingual language control, and the outputs or effects of these mechanisms on the bilingual mind. Taken together, this body of work offers key insights about dissociable global and local bilingual language control mechanisms.

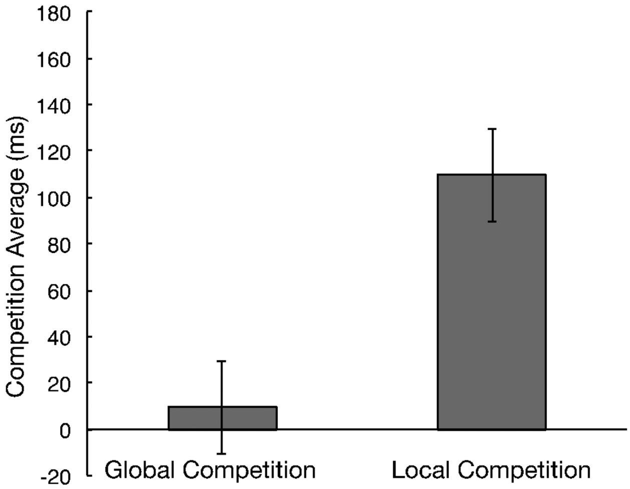
While overall, our task order manipulation had little effect on responses, one critical difference between experiments was the accuracy rates. In Experiment 2, the accuracy rate was not predicted by the target language. One interpretation of this discrepancy is that the presentation of the rule cue first limited the total number of potential responses more so than when the language cue was presented first (i.e., a rule from each language competition vs. many rules within a language competition). However, another related interpretation of these results comes from the conditional routing theory (Stocco et al., 2014). The conditional routing theory explains bilingual language processing as an *If–Then* operation. A target language is operated as a condition providing a linguistic environment specific to the target language at initial stage of language processing. *If* a target language is Spanish then the following executions were run following all Spanish features. This may account for the pattern of results here that the accuracy rate was not predicted by the target language in Experiment 2, but it was in Experiment 1. The hierarchical representation of target language selection being on the first algorithm allows individual language profile (e.g., proficiency, age of acquisition) to influence the rest of the operation. For instance, if one's dominant language is English, the first *if* feature (i.e., *if a target language is Spanish*) sets an English module active for the rest of lower level processing. On the other hand, when a given language task requires local control first (as in Experiment 2) before a language cue, the base condition, the target language is not available being the *if* statement was filled with lower level of language processing instead of target language. Therefore, participants' performance could be less influenced by the language when the lower processing was set as a condition.

Table 17
Experiment 2: Model Comparison for Accuracy

Models	AIC	BIC	LogLik	Deviance	χ^2	*df*	*p*
Base model versus base model + probe type	−17.13	−7.54	10.56	−21.13	21.13	2	<.001***
Base model + language versus base model + probe type + language	−15.72	−6.13	9.85	−19.72	19.72	2	<.001***

Note. All tested models include random intercepts for subjects. "Base model" includes a fixed effect of "trial" only. AIC = Akaike information criterion; BIC = Bayesian information criterion; LogLik = log-likelihood.
*** $p \leq .001$.

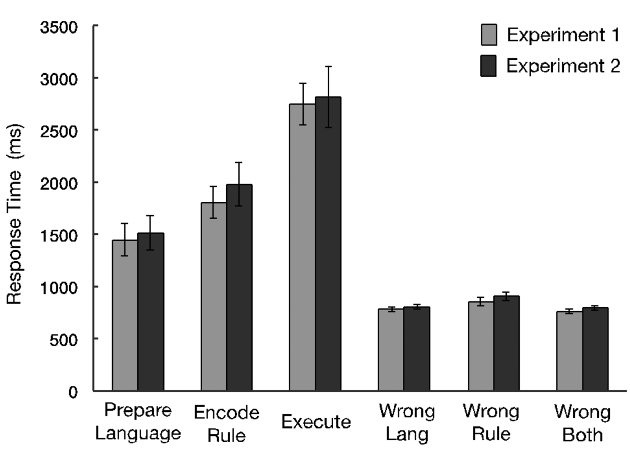
Figure 4
Global Competition Effect (Left) and Local Competition Effect (Right) in Experiment 2



Note. The global competition effect is the difference in reaction times between the *Wrong Language* condition and the *Wrong Both* condition. The local competition effect is the difference in reaction times between the *Wrong Rule* condition and *Wrong Both* condition. The error bars are the standard errors of the means.

Another possible explanation for the pattern of results observed is that irrespective of the task structure provided, the predominance of global control mechanisms displayed by bilinguals in our experiments reflects the similar canonical language environments of this rather homogeneous group of bilinguals. Specifically, it is likely that Spanish–English bilinguals in Seattle spend a considerable amount of time speaking in a single-language (English) environment. To explore this possibility, we computed a post hoc exploratory correlation examining the relative strengths of local and global control mechanisms as a function of participants' responses to the question "I tend to switch language during a conversation" on a scale of 1 (*never*) to 5 (*always*; Tables 2 and 11). Our results

Figure 5
Response Time Comparison Between Experiment 1 and Experiment 2



suggested a modest positive correlation between self-reported switching behaviors and global dominance, $r(46) = .34$, $p = .018$, suggesting that frequent switchers had larger differences in accuracy between *Wrong Language* and *Wrong Rule* probes than did infrequent switchers. That is, bilinguals who switch more frequently may have particularly efficient global control, driving up their accuracy on the wrong language probes, and/or could be especially conflicted when encountering a wrong rule probe given the relative infrequency of such errors. We see this as another interesting avenue for future research.

In summary, results from the current experiment converge with previous research suggesting that global and local bilingual control mechanisms are dissociable in both brain and behavior, adding that global, target language selection mechanisms are deployed during morphosyntactic rule production tasks. The current research adds to a growing body of work demonstrating the utility of RITL tasks in studying linguistic phenomena, as they allow the experimental separation of highly complex and interactive processes that occur during natural language use. As in previous research, however, we acknowledge that in separating these phenomena into artificial tasks, we may be fundamentally changing the way they operate in natural language. Thus, converging work using more naturalistic paradigms is also needed.

Limitations of the Study

We put our best efforts into designing the pseudoword stimuli so that the participants would not be able to discern whether the pseudowords originated from English or Spanish. However, some of the words may sound slightly more English than Spanish or vice versa. This is a limitation of the current study in that this may influence the participants' answers and response times. As mentioned above, the RITL task is rather artificial, so it is unclear how much the RITL task is reflecting natural language processing.

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(*Appendix follows*)

Appendix

Table A1
Pseudo Verb Stimuli

Root word	Probe
GREEER	GREEERED
AVEDER	APADIÓ
LEFER	LEFERING
FOMBSER	FOMBSIENDO
AFESER	AFESIÓ
REATER	RESPERIÓ
NUSER	NUSIÓ
TUICEER	TUITERRED
POBSER	POBSERING
SCOMER	SCOMERED
CHEGSER	CHEGSIENDO
ZAUNCHER	ZAUNCHIENDO
JOLER	JOLERED
SNAINER	SNAINIÓ
YOLLER	YUSEARING
FUMER	FUMERING
DROTER	DROTIÓ
VARTSER	VARTSIENDO
MIPESER	MIPESERING
CALDSER	CALDSIENDO
YISTSER	YISTSIÓ
NANTER	NANTIENDO
QUIDEER	QUIDEERED
TUNGEER	TUNGEERING
BLAGEER	BLAGEIENDO
OPEDER	OBETERED
ELTER	ELTIENDO
FALER	FALERED
LUPER	LUPERED
SPISER	SPISERING
ZANGER	ZEMJERING
CRADER	CRADERED
YAYEDER	YAYEDIENDO
TRAUTER	TRAUTIÓ
FODER	FODIÓ
QUIBSER	QUIBSIÓ
ZORMEDER	ZORMEDERING
SPUNSER	SPUNSIENDO
SELDSER	SELDSERING
GOAKSER	GOAKSIENDO
MISHER	MISHIENDO
LORCHER	LORCHERING
LOTEER	LOTEERED
BEALER	BEALERING
VUMSER	VIBRIÓ
FREGSER	FREGSIENDO
HEZER	HEZIÓ
PROTER	PROTIENDO
HONDSER	HEMDSIENDO
TOMPERER	TOMPERIÓ
DWEER	DWEERED
GUCKSER	GUCKSIENDO
JARNEDER	JARNEDERING
SUSTER	SUSTERING
VANKER	VANKERED
VEWTER	VEWTIÓ
HESKER	HESKERED
PIBER	PIBIENDO
BINTER	BINTERING
NASSER	NASSIÓ
YANER	YANIÓ
SOLTER	SOLTIÓ
MEPER	MITIENDO
FLARER	FLARERED
VAWEDER	VAWEDERING
ERMER	ERMERED
BIXER	BIXERED
NESKER	NESKIENDO
ROLSER	ROLSERING
SCOPESER	SPOCESING
SMONEER	SMONEERED
VOOSEER	VOOSEERING
CILDER	CILDERING
VITER	VITIENDO
ZILLER	ZELGIENDO
POVEER	POVEERED
ZORMSER	ZORMSIENDO
NURER	NURERING
SWENTSER	SWENTSIÓ
TANEER	TANEIÓ
PARFER	PARFIÓ
ZUDER	ZUDIENDO
PIVEDER	PIVEDIÓ
GUDER	GUDIENDO
HIFFSER	HIFFSIENDO
BRALSER	BRALSIÓ
TABBEDER	TABBEDERING
RIRER	RIRIENDO
MILTSER	MAKESERING
BARNEDER	BARNEDERED
MUNER	MUNERED
GIRER	GIRIÓ
ARPER	ARPERING
LORBER	LORBERED
JOMPER	JOMPIÓ
JORSEER	JORSEERED

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