



# Cognates interfere with language selection but enhance monitoring in connected speech

Chuchu Li<sup>1</sup> · Tamar H. Gollan<sup>1</sup>

Published online: 20 April 2018  
© Psychonomic Society, Inc. 2018

## Abstract

The current study investigated the contribution of phonology to bilingual language control in connected speech. Speech production was elicited by asking Mandarin–English bilinguals to read aloud paragraphs either in Chinese or English, while six words were switched to the other language in each paragraph. The switch words were either cognates or noncognates, and switching difficulty was measured by production of cross-language intrusion errors on the switch words (e.g., mistakenly saying 巧克力 (qiao3-ke4-li4) instead of *chocolate*). All the bilinguals were Mandarin-dominant, but produced more intrusion errors when target words were written in Chinese than when written in English (i.e., they exhibited robust reversed dominance effects). Most critically, bilinguals produced significantly more intrusions on Chinese cognates, but also detected and self-corrected these same errors more quickly than with noncognates. Phonological overlap boosts dual-language activation thus leading to greater competition between languages, and increased response conflict, thereby increasing production of intrusions but also facilitating error detection during speech monitoring.

**Keywords** Cognates · Language control · Speech error · Monitoring · Response conflict

## Introduction

Bilinguals have a remarkable ability to stick to the language they intend to use and rarely produce words in a language they did not intend to speak, although both languages are activated even when they speak in just one language (e.g., Colomé, 2001; Costa, Caramazza, & Sebastian-Galles, 2000; Gollan, Sandoval, & Salmon, 2011; Hermans, Bongaerts, De Bot, & Schreuder, 1998; Hoshino & Kroll, 2008; Kroll, Bobb, Misra, & Guo, 2008; Poulisse & Bongaerts, 1994). An increasing number of studies that investigated how bilinguals control simultaneous activation of their two languages suggest that bilinguals rely on both domain-general executive control processes (e.g., Abutalebi & Green, 2007; Kroll, et al., 2008) and language-specific control mechanisms (e.g., Gollan, et al., 2011; Prior & Gollan, 2013; Weissberger, Wierenga, Bondi, & Gollan, 2012), including semantic (e.g., Schwartz & Kroll,

2006) and grammatical constraints (e.g., Declerck & Philipp, 2015; Gollan & Goldrick, 2016, 2018). The present study investigated if phonological similarity between translation equivalents influences bilinguals' ability to maintain language control in connected speech.

A common way previous studies investigated the role of phonology in planning of bilingual speech production is to compare cognates to noncognates. Cognates are translation equivalents that overlap in phonology (e.g., *lemon-limón*), whereas noncognates differ substantially or entirely in form across languages (e.g., *apple-manzana*). Even when bilinguals intend to speak in just one language, cognates facilitate speech production, for example speeding picture naming latency (see Catalan-Spanish in Costa, et al., 2000; German-English in Poarch & Van Hell, 2012). Such cognate facilitation effects arise even in language pairs that do not overlap in orthography (e.g., in English-Japanese bilinguals; Hoshino & Kroll, 2008). Cognates may also facilitate visual word recognition in single-language tasks (e.g., Caramazza & Brones, 1979; Dijkstra, Grainger, & van Heuven, 1999; Lemhöfer & Dijkstra, 2004; Lemhöfer, Dijkstra, & Michel, 2004; Midgley, Holcomb, & Grainger, 2011; Peeters, Dijkstra, & Grainger, 2013; Van Hell & Dijkstra, 2002), again even in languages that do not overlap in orthography (Gollan, Forster, & Frost,

✉ Chuchu Li  
chl441@ucsd.edu

<sup>1</sup> Department of Psychiatry, University of California, San Diego, 9500 Gilman Drive, La Jolla, CA 92093-0948, USA

1997). In both production and recognition, cognate facilitation effects are commonly assumed to reflect dual-language activation – specifically, extra activation from the non-target language. It is not entirely clear however, how cognates facilitate responses, particularly in production, given the potential for eliciting unintended language switches as a result of boosted activation of the non-target language, and a lack of studies that investigated the possibility of cognate effects on language control errors – i.e., the selection of the right word but in the wrong language, or *intrusion* errors.

Only a small number of studies examined how cognates might influence intended language switching. When bilinguals were cued to switch languages while repeatedly naming pictures with either cognate or noncognate names in separate blocks, switch costs were smaller in cognate than in noncognate blocks (Declerck, Koch, & Philipp, 2012; Li & Gollan, 2018, Experiment 1). However, when cognates and noncognates were inter-mixed in the same block, cognates reduced switch costs only on the first presentation of each picture, and these switch-facilitation effects were eliminated, or even reversed, with repeated presentation (Li & Gollan, 2018, Experiments 2 and 3; see also Christoffels, Firk, & Schiller, 2007; Verhoef, Roelofs, & Chwilla, 2009). Cognates might facilitate language switches via increased dual-language activation, which is largely suppressed on non-switch trials, but robust on switch trials (as bilinguals just produced words in the non-target language and it might take time before that language can be inhibited). With repetition, however, the elimination or reversal of cognate effects might result from feedback from the phonological level to the lexical level, leading to increased competition for selection between languages (Li & Gollan, 2018). Thus, in single-word production, cross-language phonological overlap does appear to influence language control, while the specific effect, whether facilitation or interference, may vary with task demands and context.

The above studies were conducted in out of context speech. However, isolated words are seldom produced in daily life, and it is important to determine if cognate effects might differ when produced in the context of full sentences. For example, cognate facilitation effects in visual word recognition might be reduced when highly proficient Spanish-English bilinguals read sentences with language-specific syntax (though the results were only suggestive), revealing potential syntactic constraints on dual-language activation and lexical access in turn (Gullifer, 2011). Cognate effects may also be modulated by word class, second language (L2) proficiency, and task demands – facilitation effects were smaller with verb than with noun cognates, were smaller in faster readers, and were reduced for readers with a higher L2 proficiency when reading sentences in L2 (Bultena, Dijkstra, & Van Hell, 2014). Cognate facilitation effects were also smaller in highly constraining sentence context than in low constraining context

(Titone, Libben, Mercier, Whitford, & Pivneva, 2011; Schwartz & Kroll, 2006). These results suggest that sentence context (e.g., syntactic and/or semantic information) may sometimes make it easier for bilinguals to reduce dual-language activation perhaps via inhibition of the non-target language (but see Van Assche, Drieghe, Duyck, Welvaert, & Hartsuiker, 2011).

Only a small number of studies considered the influence of cognate status on language switching in connected speech. According to the *triggering hypothesis* (Clyne, 1967, 1980), language switching occurs more often in the neighborhood of (i.e., just before and after) cognates in spontaneous speech. Corpus studies revealed robust triggering effects, including in languages with few (e.g., < 5% in the Dutch-Moroccan Arabic corpus, see Broersma & de Bot, 2006) and with many (> 70% in the Dutch-English corpus, see Broersma, 2009) cognate pairs. Cognates might increase dual-language activation even in connected speech, so that dual-language activation is boosted when planning adjacent words, increasing the chances of a spontaneous language switch. Triggering effects may be especially strong if the other language has already been activated in conversations with frequent code-switching. Several different types of targets appear to induce triggering effects, including proper nouns, cognates that are content words, cognates that are just function words, and even cognates with just moderate form overlap (Broersma, 2009). Furthermore, although the words immediately following a cognate are most likely to be code-switched, targets farther away or even preceding cognates might also be triggered to switch under certain circumstances (e.g., with a high code-switching density), as planning and ultimate ordering of words in overtly produced speech do not necessarily happen in the same order (Broersma & de Bot, 2006; Broersma, 2009). Cognates also appear to increase dual-language activation at the syntactic level, leading to structural priming effects. In one such study, cognates primed Dutch-English bilinguals to switch languages when describing a picture, in the same location as in a sentence they previously repeated (which started in Dutch and ended in English; Kootstra, Van Hell, & Dijkstra, 2012).

Studies of bilingual language comprehension suggest that triggering effects might be conditional. When reading sentences, recognition of switch words was facilitated after cognate nouns, only when switching from the non-dominant to the dominant language (Witteman, 2008). This asymmetry implies that activation of the non-target language is larger when cognates are presented in the non-dominant language (Van Hell & Dijkstra, 2002). While these triggering effects seemed to be modulated by language dominance, no triggering effects were found with verb cognates (Bultena, Dijkstra, & Van Hell, 2015). Bultena et al. speculated that the absence of triggering effects from verb cognates reflected the relatively small degree of phonological overlap for verb versus noun

cognates (a factor that was not controlled across part-of-speech), and a conclusion that is not consistent with findings in corpus studies (Broersma, 2009). Additional work is needed to clarify how cognates influence connected speech, given that evidence to date suggests this may vary across tasks (e.g., language production vs. comprehension), with syntactic category or part of speech (e.g., nouns vs. verbs), and language proficiency or dominance.

One way to investigate connected speech with precise experimental control over the targets of production is to ask bilinguals to read aloud mixed-language passages (Kolers, 1966). Though bilinguals rarely switch languages by mistake in natural settings, similar errors can be produced in the read aloud task. For example, when reading a sentence like: *The curious thing is that very poca people spoke negatively about her*, Spanish-English bilinguals might produce, *The curious thing is that very few people spoke negatively about her* instead (i.e., mistakenly producing the English translation of the word *poca*). Previous work using the read-aloud task revealed language control to be constrained by language dominance; when Spanish-English bilinguals read mixed-language paragraphs, most of the cross-language intrusion errors they produced involved dominant language targets embedded in paragraphs written primarily in the nondominant language (i.e., a reversed dominance effect; Gollan & Goldrick, 2016, 2018; Gollan, Schotter, Gomez, Murillo, & Rayner, 2014; Gollan, Stasenko, Li, & Salmon, 2017). Syntactic factors also influence language control; switches that violated grammatical constraints on code-switched speech elicited more intrusions (Gollan & Goldrick, 2016). Most notably, function words elicited many more intrusions than content words (a result also found in naturally occurring intrusion errors; Poulisse & Bongaerts, 1994), and switches on function words were easier when the switched to language continued after the switch word instead of immediately switching back to the default language (Gollan & Goldrick, 2018). Finally, default language selection exerted a powerful influence on intrusion errors; switches out of the default language elicited the majority of errors while switches back rarely induced errors (Gollan & Goldrick, 2018) even in bilinguals with Alzheimer's disease (see Fig. 1 in Gollan et al., 2017).

The present study investigated the role of cognate status on bilingual language control using the read-aloud task. Specifically, we compared (1) intrusion rates for cognate versus noncognate switch words in paragraph reading, and (2) self-correction rates of these same errors across the two types of switches. Mandarin-English bilinguals read mixed-language paragraphs in which the default language was either Chinese or English while a small number of switch words were written in the other language, either cognates or noncognates. In a post-hoc analysis, Gollan et al. (2014) found that cognates that were also content words (e.g., *moment* and its translation equivalent *momento*) elicited more intrusions

than noncognates in the read aloud task. However, cognate status was not manipulated in that study, and thus cognates and noncognates were not equated for location in sentence context and other properties (e.g., frequency, word length, part of speech). Moreover, the bilinguals tested in Gollan et al. were Spanish-English bilinguals, and thus cognates were similar in both spoken and written form (e.g., *family-familia*). As a result, cognate effects might have been driven by difficulties in reading rather than, or in addition to, arising in speech production. The two languages in the present study have completely distinct writing systems, thus eliminating any possible effects driven by orthographic similarity (see also Hoshino & Kroll, 2008). If cognates effects were driven by reading difficulties in Gollan et al., then no cognate effects would be expected in the present study, because Mandarin and English cognates are not similar in written form (e.g., *chocolate-巧克力* (qiao3-ke4-li4)<sup>1</sup>). Alternatively, if cognates elicit challenges with controlling language selection in speech production, then Mandarin-English bilinguals (like Spanish-English bilinguals in Gollan et al., 2014) should produce more intrusions with cognate than with noncognate targets in the read aloud task. A third possibility was that Mandarin-English bilinguals might even produce fewer intrusions with cognates as dual-language activation facilitates language switching in some contexts (e.g., in the picture-naming tasks in Declerck et al., 2012; Li & Gollan, 2018).

Additionally, we investigated how phonological overlap influences monitoring of speech by comparing self-correction rates of cognate versus noncognate intrusions. One of the most influential accounts of self-monitoring of speech is the perceptual-loop theory, which assumes that the language comprehension system serves the internal inspection of utterances, including both inner planned speech and externally produced speech (Levelt, 1983, 1989; Hartsuiker & Kolk, 2001). The inner loop detects errors by comparing comprehension of the formulated word form planned in inner speech to what was originally intended, while the outer loop detects errors by comparing comprehension of the produced utterance (in overtly produced speech) to what originally intended.<sup>2</sup> In either loop, if the comparison between formulated (or actual) and intended utterances occurs at the phonological level (as suggested by Slevc & Ferreira, 2006), cognates should be missed more often because of phonological similarity, thus making it more difficult to detect planned or produced intrusions on cognates than noncognates. Even if the comparison occurs at the lexical level, if phonological form feeds back up to the lexical level

<sup>1</sup> The pronunciation of the Chinese word *chocolate* is presented in Pinyin here, a Roman alphabetic system that transcribes the pronunciation of Chinese characters. The numbers refer to the tone of each character.

<sup>2</sup> A third conceptual loop involves a check that the preverbal message will match what is expressed in words before any phonological codes are formulated (Levelt, 1989). This loop would not be used in detection of speech errors.

(Costa, Roelstraete, & Hartsuiker, 2006; Cutting & Ferreira, 1999; Dell, 1988; Rapp & Goldrick, 2000), the same outcome would be expected; similarity in form between cognates and noncognates would make it harder to detect differences between intended and planned or produced utterances. As such, the perceptual loop hypothesis likely predicts a lower rate of self-corrections for cognates than noncognates (or possibly no cognate effect in a model without feedback; see Levelt, Roelofs, & Meyer 1999).<sup>3</sup>

Another prominent account is the conflict-monitoring hypothesis (Nozari, Dell, & Schwartz, 2011), in which monitoring of inner speech and competition between response options initiates a signal for error detection – so that greater conflict initiates stronger monitoring. In Declerck, Lemhöfer, and Grainger (2017), French-English bilinguals were cued to switch languages when describing groups of pictures (i.e., inter-sentential switches). Switches elicited higher intrusion rates than non-switch trials ( $M = 0.8\%$  vs.  $0.2\%$ ), but bilinguals were also better at repairing errors produced on switch than on non-switch trials (repair rates  $M = 86.2\%$  vs.  $62.9\%$ ). This result supports the conflict monitoring account, as cross-language interference was stronger on high-conflict (switch) than on low-conflict (non-switch) trials, thus eliciting both higher error rates and better monitoring. With this view, given that cognates increase dual-language activation, cross-language competition should be stronger in cognates leading to both higher intrusion rates and higher self-correction rates. Indeed, even when bilinguals correctly and more easily produced cognates than noncognates, ERP measures revealed greater response conflict for cognates than for noncognates (i.e., a larger error-related negativity (ERN)-like component; Acheson, Ganushchak, Christoffels, & Hagoort, 2012), a finding that further supports the conflict monitoring view. While the conflict-monitoring hypothesis assumes monitoring of the internal speech channel, it does not exclude the contribution of the comprehension system to monitoring of either internal or the external speech. However, the two accounts make different predictions about how cognate status should affect self-correction (perceptual loop predicting no cognate effect or fewer self-corrections for cognates than noncognates, and conflict monitoring predicting more self-corrections of cognate than of noncognate intrusions), thus helping us pinpoint the dominant mechanisms of speech monitoring.

<sup>3</sup> Yet another account, called Forward Modeling, posits that monitoring occurs by comparison of the intended sounds with the somatosensory and/or proprioceptive feedback from the formulated sounds (Lackner, 1974; Hickok, 2012). This account makes the same predictions as the perceptual-loop theory (i.e., fewer self-corrections on cognate than noncognate intrusions) because the movement of tongue in cognate translations will be more similar than that of noncognate translations, leading to larger confusability for cognates.

## Methods

### Participants

Sixty-four unbalanced Mandarin-English bilingual undergraduates at the University of California, San Diego participated for course credit. Table 1 shows self-reported participant characteristics and Multilingual Naming Test scores in both languages (MINT; Gollan et al. 2012). All participants were Mandarin-dominant (i.e., they obtained higher picture-naming scores in Mandarin than in English).

### Materials and procedure

Sixteen mixed-language paragraphs were created. Paragraphs were written mostly in one language with six words in the other language. Each paragraph was modified for rotation across four conditions: (a) English-default (i.e., English as the default language) with cognate switches; (b) English-default with noncognate switches (c) Chinese-default with cognate switches; (d) Chinese-default with noncognate switches. The two conditions of the same default language (i.e., a vs. b, c vs. d) were exactly same except for the switch words, so that any difference found between cognate and noncognate switch words should reflect cognate status rather than surrounding sentence context (e.g., semantic or syntactic constraints).<sup>4</sup> Each paragraph had six controlled language switches out of the default language (i.e., switch-out words), and another six the language switches back into the default language immediately after the switch-out words (i.e., switch-back words). The switch-out words were either cognates (conditions a and c) or noncognates (conditions b and d), and 80.21% of the switch-back targets were noncognate function words (with remaining targets noncognate content words). A total of 48 cognate-noncognate pairs (e.g., *chocolate* and *marshmallow*) were selected (see Appendix Table 3 for the full list of the 48 pairs). The cognates and noncognates were matched in frequency, number of syllables, and familiarity in both Chinese and English ( $ps \geq .15$ ; see Table 2). Ten Chinese-English bilinguals who did not participate in the paragraph reading task rated the phonological similarity of cognate and noncognate translations from 1 (not similar) to 7 (very similar). Cross-language similarity in form was significantly and substantially greater for cognates than for noncognates (see

<sup>4</sup> There were just three exceptions, all in English-default paragraphs, in which minor changes were necessary to fit the syntax of the switch words, including: (1) ...practice the 马拉松 (marathon) vs. practice 赛跑 (running); (2) ...so many 粉丝 (fans) vs. such a big 听众 (audience); and (3) ...弹我的guitar (play my guitar) vs. 拉我的violin (play my violin). Also, for English switch words in Chinese paragraphs, the switch words were always in the singular form if both singular and plural forms fit the Chinese context. In cases where only the plural form fit the context (e.g., 两百 (two hundred) pounds, 一些 (some) hamburgers), we used the plural form of the English targets.

**Table 1** Means and standard deviations of participant characteristics

Characteristic	<i>M</i>	<i>SD</i>
Age	19.75	1.47
Age of acquisition of English	6.16	2.24
Age of acquisition of Mandarin	0.23	0.61
Self-rated spoken English proficiency <sup>a</sup>	4.94	0.81
Self-rated written English proficiency <sup>a</sup>	5.28	0.83
Self-rated spoken Mandarin proficiency <sup>a</sup>	6.95	0.28
Self-rated written Chinese proficiency <sup>a</sup>	6.97	0.18
Current percent of English use	55.20	20.00
Percent of English use during childhood	17.91	15.24
Primary caregiver spoken English proficiency <sup>a</sup>	2.16	1.28
Secondary caregiver spoken English proficiency <sup>a</sup>	2.22	1.37
Primary caregiver spoken Mandarin proficiency <sup>a</sup>	7	0
Secondary caregiver spoken Mandarin proficiency <sup>a</sup>	6.98	0.13
Years lived in Mandarin-speaking country	17.13	2.13
MINT score in English <sup>b</sup>	48.80	5.60
MINT score in Mandarin <sup>b</sup>	61.36	2.62

<sup>a</sup> Proficiency-level self-ratings were obtained using a scale from 1 (almost none) to 7 (like a native speaker)

<sup>b</sup> The maximum possible MINT score is 68

Table 2). An example paragraph in each condition is presented in Appendix 2.

Paragraphs were selected and adapted from published English–Chinese translations of short stories or news by a native Mandarin–English bilingual (C.L.). Two other native Mandarin–English bilinguals read through the paragraphs and confirmed the intended manipulations (any disagreements were discussed and settled and paragraphs modified accordingly). Paragraphs were constructed by modifying content as needed so that all the critical words (i.e., the switch-out words) fit the story line. In addition, words that are uncommon in either language were replaced. English-default paragraphs ( $M = 128.12$  words,  $SD = 16.17$ ) were longer on average than Chinese-default paragraphs ( $M = 109.69$  words,  $SD = 12.06$ ;  $t(62) = 5.17$ ,  $p < .001$ ). For each default-language condition, ten native Mandarin–English bilinguals who did not participate in the paragraph reading task judged whether the switch words fit the meaning of the sentences from 1 (do not fit) to 7 (fits very well). Each critical sentence that contained a language switch word was presented one at a time. Bilinguals read each sentence three times, once with the cognate target, once with the noncognate, and once with an unrelated word that did not fit the context (these words were selected by a native Mandarin–English bilingual (C.L.) from the same set of 16 paragraphs, and matched the targets in part of speech). All the sentences were presented in a randomized order. These ratings suggested that cognates and noncognates fit the sentence context equally (see Table 2).

Stimuli were presented using the Preview software on an iMac 7 computer with a 20-in. color monitor. On each trial a paragraph appeared on the screen and participants were instructed to read the paragraph aloud as accurately as possible at a comfortable pace. Each bilingual read 16 mixed-language paragraphs, four in each of the four conditions. Paragraphs were presented in one of four different pseudorandom lists, and each bilingual was presented with just one of these lists. The four lists were constructed so that conditions were rotated between subjects and paragraphs in a Latin-square design. In each of the four lists, each paragraph was presented just once. Across lists each paragraph appeared once in each of the four conditions. As such, each list consisted of 16 paragraphs, with four different paragraphs presented in each of the four conditions. The four conditions were evenly distributed throughout the list, and the position of each paragraph was different across the four lists (e.g., paragraph 2 was in condition b and the first trial in list 1, while it was in condition c and last in list 2, in condition d and 12th in list 3, and in condition a and 6th in list 4). In addition, the first paragraph was in different conditions across the four lists (i.e., condition b in list 1, condition d in list 2, condition c in list 3, and condition a in list 4). Each bilingual only saw each cognate or noncognate once, either in the English-default or the Chinese-default condition and thus saw cognate and noncognate targets in just one language (e.g., they would not see *Chocolate* in one paragraph and the Chinese equivalent 巧克力 in another paragraph). For example, paragraph 1 and paragraph 9 shared three cognate–noncognate pairs, so a bilingual would read paragraph 1 in condition a (i.e., English-default, cognate switches; e.g., see 巧克力) but paragraph 9 in condition b (i.e., Chinese-default, noncognates switches; e.g., see *marshmallow*).

Each trial began with a fixation cross that appeared at the location on the screen where the first word in the paragraph would appear and remained on the screen until the participant pressed the space bar, after which the fixation was replaced by the paragraph, which remained on the screen until the participant pressed the space bar again. A two-choice comprehension question followed (in English following English-default, and Chinese following Chinese-default, paragraphs), in which bilinguals were instructed to press one of two keys. For example, participants were required to answer a question such as: *Why did the woman look at the author's hand?* after reading the example paragraph shown in the Appendix 2, and to choose from the following two options: (A) To do fortune telling; (B) To check his talent. Afterwards, participants pressed the space bar again and the question page was then replaced by the fixation point for the following trial. Before beginning, bilinguals completed two practice paragraphs similar in length to the experimental materials: one English-default, and one Chinese-default. The two practice paragraphs had six switches in them as well, three cognates and three noncognates that were not presented in the critical lists.

**Table 2** The characteristics of the cognate and noncognate switch-out targets

	Cognates		Noncognates		Cognates vs. noncognates	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>t-value</i>	<i>p-value</i>
Frequency <sup>a</sup> ( <i>English name</i> )	30.70	73.44	31.91	53.48	< 1	0.85
Frequency <sup>b</sup> ( <i>Chinese name</i> )	39.90	118.64	40.96	153.92	< 1	0.91
Number of syllables ( <i>English Name</i> )	1.92	0.57	2.08	0.94	< 1	0.29
Number of syllables ( <i>Chinese Name</i> )	2.23	0.47	2.25	0.53	< 1	0.74
Familiarity <sup>c</sup> ( <i>English Name</i> )	6.73	0.53	6.76	0.47	< 1	0.77
Familiarity <sup>c</sup> ( <i>Chinese Name</i> )	6.72	0.34	6.78	0.37	1.47	0.15
Cross-language phonological similarity <sup>d</sup>	5.95	0.64	1.30	0.22	28.43	< .001
Appropriateness in the context (English as the default language) <sup>e</sup>	6.56	0.24	6.52	0.24	< 1	0.67
Appropriateness in the context (Chinese as the default language) <sup>e</sup>	6.74	0.08	6.68	0.18	< 1	0.40

<sup>a</sup> The frequency refers to the number per million based on SUBTLEX\_US (Brysbaert & New, 2009)

<sup>b</sup> The frequency refers to the number per million based on SUBTLEX\_CH (Cai & Brysbaert, 2010)

<sup>c</sup> The familiarity was rated by ten Mandarin-English college students (six from Mainland China and four from Taiwan) from 1 (do not know this word) to 7 (very familiar)

<sup>d</sup> Phonological similarity was rated by ten Mandarin-English bilinguals on a scale from 1 (not similar) to 7 (very similar)

<sup>e</sup> For each critical sentence from paragraphs in each default language condition, ten Mandarin-English bilinguals rated whether the 48 cognates, 48 noncognates, and 48 unrelated words (that were selected from the same set of 16 paragraphs) fit the context from 1 (does not fit) to 7 (fits very well). In both conditions, cognates and noncognates were rated as fitting significantly better than the unrelated words ( $M_s < 2$ ,  $p_s < .001$ ); while cognates and noncognates did not differ from each other (as shown in Table 2)

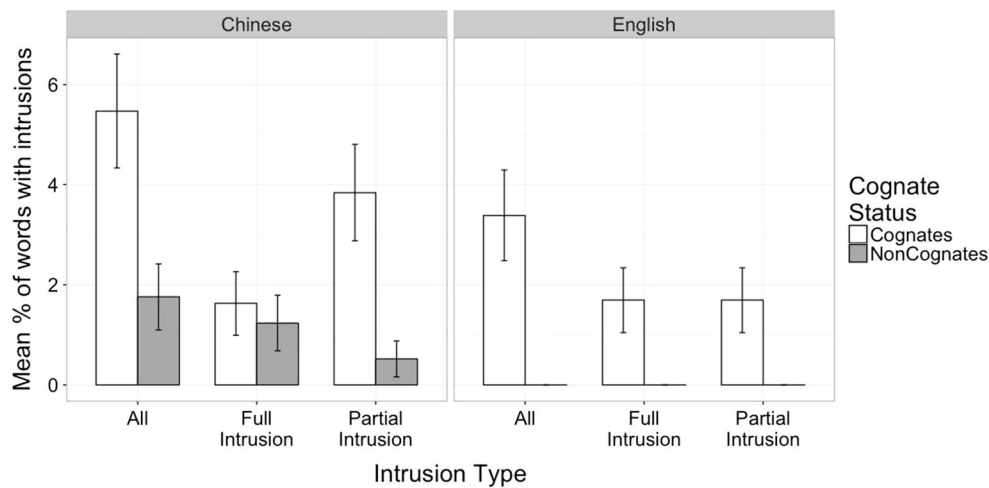
Participants were instructed to read the paragraphs in normal speed, and were not instructed on what to do if they produced error (i.e., self-corrections were entirely spontaneous).

## Results

First, we examined error rates for comprehension questions that followed the paragraphs. Fifty-four participants did not make any errors, eight made just one, and the remaining two bilinguals made just two errors. Thus, error rates in paragraph comprehension questions were very low. Two native Mandarin-English bilingual research assistants transcribed speech errors that bilinguals produced when reading aloud, classifying them as either intrusion or accent errors. On full intrusion errors, participants produced the translation equivalent of the target word (e.g., saying *chocolate* instead of 巧克力 (qiao3-ke4-li4)). Partial intrusion errors were coded when speakers began producing an error but self-corrected before fully producing the error (e.g., saying *cho-克力* when seeing 巧克力). Speakers also produced accent errors in which they produced the correct word but with the accent of the nontarget language, and within language errors (e.g., replacing *here* with *there*). However, we did not report these errors in detail as within-language errors are not affected by language mixing (Gollan & Goldrick, 2016) and accent errors are subjective and would be difficult to code in English given that most participants spoke English with a Mandarin accent even in their spontaneous speech. Both research assistants transcribed all participants' data and

found a total of 163 intrusion errors; 136 of these were produced on cognates, and 27 on noncognates at points that switched languages (out of the default language). We focused our analyses exclusively on cognates and matched noncognates at switch-out of default points. An additional 61 intrusions were produced immediately after switch words (i.e., failures to switch back into the paragraph's default language), and another 31 on proper names targets (which may be like cognates; Gollan, Montoya, & Bonanni, 2005). Agreement between raters was high; classifications matched across raters for 95.3% of words produced. For those the two assistants did not reach an agreement at first,<sup>5</sup> the cases were settled through the discussion among the two research assistants and a third Mandarin-English bilingual. Except for two participants, each bilingual at least produced one intrusion error on switch-out words. We analyzed the intrusion error rates, self-corrections rates, and paragraph reading times using mixed effects regressions (linear for reading times; logistic for error rates; Dixon, 2008). All categorical predictors (i.e., cognate status and language) were contrast coded. Subject and word were entered as two random intercepts with related random slopes. Significance was assessed via model comparisons (Barr, Levy, Scheepers, & Tily, 2013).

<sup>5</sup> Most of the disagreements (nine out of 12) were caused by difficulty determining in which language a cognate was produced, particularly for partial intrusions in which the error word was not produced in full. Sometimes, research assistants needed to listen together to productions of an entire paragraph to come to an agreement based on the participants' accent on words that were not switched.



**Fig. 1** Mean proportion of intrusion errors by error type (i.e., collapsing full and partial intrusions, full intrusions only, and partial intrusions only) in each target language. The error bars show the 95% confidence intervals

### Intrusion error rates

In previous studies (Gollan et al., 2014, 2017; Gollan & Goldrick, 2016, 2018), analyses were focused on full intrusions as they far outnumbered partial intrusions, whereas the present study showed the opposite pattern (i.e., partial intrusions far outnumbered full intrusions; see section on self-corrections). Two factors may have contributed to this difference: first, the present study was the first to examine if bilinguals reading aloud languages that do not share script nevertheless still produce intrusion errors; second, all switches in the present study were on content words, which rarely elicited intrusions in previous studies (Kolers, 1966; Gollan et al., 2014; Gollan & Goldrick, 2016, 2018; the only exception was a study which focused on bilinguals with Alzheimer's disease, Gollan et al., 2017). Partial intrusions rates might have been relatively lower in previous research as function words elicited the majority of intrusion errors, and function words rarely elicited partial intrusion errors, probably because function words are short, leaving relatively little time to halt production in mid-error to make a repair. We assume these two types of intrusions differ mainly in the extent to which the planned errors were (or were not) successfully monitored and not in the process of error generation. As such, we first report an analysis that collapsed together all intrusions (collapsing full and partial intrusions), and subsequently repeated the analyses separately for each error type (full vs. partial).

Figure 1 (the labels all) shows the collapsed intrusion error rates in each language (Chinese vs. English) by condition (cognates vs. noncognates). See Appendix 3 (Table 4) for a summary of the logistic regression model output. Overall, bilinguals produced significantly more intrusion errors with cognates than noncognates ( $M = 4.43\%$  vs.  $0.88\%$ , 136 vs. 27 errors;  $\beta = 10.34$ ,  $SE \beta = 13.60$ ,  $\chi^2(1) = 38.35$ ,  $p < .001$ ), and more intrusions with Chinese than with English targets

(i.e., a reversed dominance effect, bilinguals more often produced translation equivalents of targets written in Chinese in English by mistake, than the reverse  $M = 3.61\%$  vs.  $1.69\%$ , 111 vs. 52 errors;  $\beta = 9.28$ ,  $SE \beta = 13.60$ ,  $\chi^2(1) = 14.07$ ,  $p < .001$ ). Additionally, there was a significant interaction between cognate status and language ( $\beta = -16.75$ ,  $SE \beta = 27.19$ ,  $\chi^2(1) = 5.10$ ,  $p = .024$ ); bilinguals produced more intrusions with cognate than noncognate targets in both Chinese ( $M = 5.47\%$  vs.  $1.75\%$ , 84 vs. 27 errors;  $\beta = 1.90$ ,  $SE \beta = .55$ ,  $\chi^2(1) = 14.70$ ,  $p < .001$ ) and English ( $M = 3.38\%$  vs.  $0\%$ , 52 vs. 0 errors;  $\beta = 19.18$ ,  $SE \beta = 53.28$ ,  $\chi^2(1) = 20.84$ ,  $p < .001$ ), but the cognate effect was stronger in Chinese than in English ( $M = 3.72\%$  vs.  $3.38\%$ , 57 vs. 52 errors difference). Stated differently, bilinguals produced more intrusions in Chinese than in English with both cognates ( $M = 5.47\%$  vs.  $3.38\%$ , 84 vs. 52 errors;  $\beta = .84$ ,  $SE \beta = .42$ ,  $\chi^2(1) = 4.09$ ,  $p = .043$ ) and noncognates ( $M = 1.75\%$  vs.  $0\%$ , 27 vs. 0 errors;  $\beta = 17.59$ ,  $SE \beta = 93.55$ ,  $\chi^2(1) = 5.23$ ,  $p = .022$ ), but the effect of language was larger for cognates than noncognates ( $M \text{ Difference} = 2.09\%$  vs.  $1.75\%$ , 32 vs. 27 errors difference).

We further considered the results of partial versus full intrusions separately, following previous work (Gollan et al., 2014; Gollan & Goldrick, 2016, 2018). With full intrusions as the measure (see Fig. 1, labels Full Intrusion; see also Appendix 3, Table 5), bilinguals also overall produced more errors with cognates than noncognates when collapsing the two languages ( $M = 1.66\%$  vs.  $0.62\%$ , 51 vs. 19 errors;  $\beta = 9.17$ ,  $SE \beta = 18.93$ ,  $\chi^2(1) = 6.73$ ,  $p = .009$ ); they also produced marginally more errors with Chinese than English targets ( $M = 1.43\%$  vs.  $0.85\%$ ; 44 vs. 26 errors;  $\beta = 8.41$ ,  $SE \beta = 18.92$ ,  $\chi^2(1) = 2.97$ ,  $p = .085$ ). However, with Chinese targets alone, full intrusion rates were only numerically higher with cognates than noncognates, ( $M = 1.63\%$  vs.  $1.24\%$ , 25 vs. 19 errors;  $\beta = .94$ ,  $SE \beta = .98$ ,  $\chi^2(1) < 1$ ), whereas with English targets alone, bilinguals produced significantly more full intrusions with

cognates than noncognates ( $M = 1.69\%$  vs.  $0\%$ ; 26 vs. 0 errors;  $\beta = 17.37$ ,  $SE \beta = 59.8$ ,  $\chi^2(1) = 4.91$ ,  $p = .027$ ). However, the interaction between cognate status and language was not significant ( $\beta = -16.50$ ,  $SE \beta = 37.82$ ,  $\chi^2(1) = 2.51$ ,  $p = .113$ ).

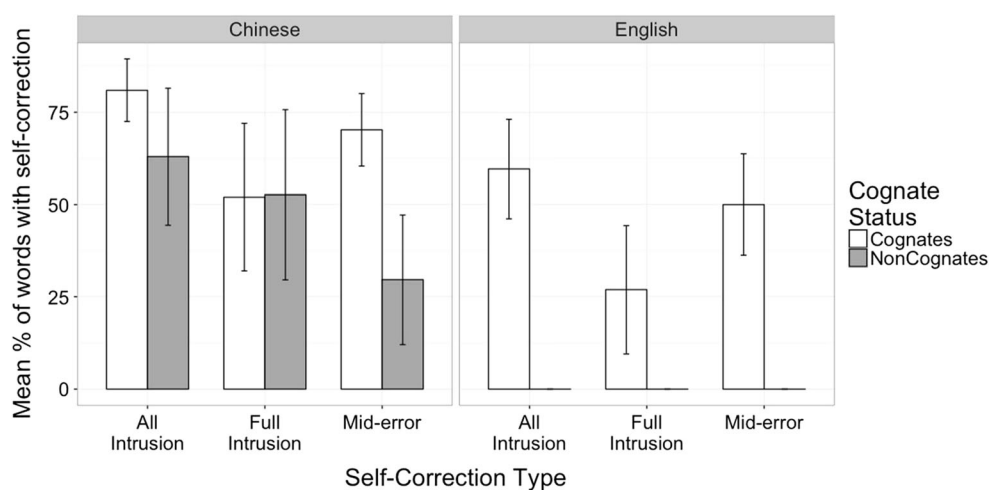
With partial intrusions as the measure (see Fig. 1, labels Partial Intrusion; see also Appendix 3, Table 6), bilinguals overall produced significantly more errors with cognates than noncognates when collapsing the two languages ( $M = 2.77\%$  vs.  $0.26\%$ , 85 vs. 8 errors;  $\beta = 10.89$ ,  $SE \beta = 16.04$ ,  $\chi^2(1) = 38.75$ ,  $p < .001$ ), and produced marginally more errors with Chinese than English targets ( $M = 2.18\%$  vs.  $0.85\%$ ; 67 vs. 26 errors;  $\beta = 8.53$ ,  $SE \beta = 16.01$ ,  $\chi^2(1) = 3.11$ ,  $p = .078$ ). These cognate effects were significant with Chinese targets alone ( $M = 3.84\%$  vs.  $0.52\%$ , 59 vs. 8 errors;  $\beta = 3.25$ ,  $SE \beta = 1.04$ ,  $\chi^2(1) = 23.09$ ,  $p < .001$ ), and with English targets alone ( $M = 1.69\%$  vs.  $0\%$ , 26 vs. 0 errors;  $\beta = 18.93$ ,  $SE \beta = 45.59$ ,  $\chi^2(1) = 17.77$ ,  $p < .001$ ), and there was no significant interaction between cognate status and language ( $\beta = -15.07$ ,  $SE \beta = 32.02$ ,  $\chi^2(1) = 1.02$ ,  $p = .313$ ). Given that bilinguals did not produce any intrusion errors (either partial or full intrusions) with English noncognate targets, any comparisons involving English noncognates must be considered with caution – the lack of power in this condition could influence the reliability of the results. Therefore, for the remaining analyses and discussion, we mainly focus on the comparison between Chinese cognate and noncognate targets.

### Self-correction rates

Only two previous studies on the read-aloud task in bilinguals considered self-correction rates. Gollan and Goldrick (2016) compared how many intrusions younger versus older bilinguals self-corrected in mid-error utterance (i.e., speakers

corrected an error while they were in the middle of producing the error, [partial intrusions/(partial intrusions + full intrusions)]), and found higher self-correction rates in younger bilinguals for both content ( $M = 41.0\%$  vs.  $31.2\%$ ) and function words ( $M = 5.4\%$  vs.  $1.4\%$ ), revealing a monitoring impairment in older bilinguals. Gollan et al. (2017) found no significant difference between Alzheimer's patients and controls in mid-error correction rates ( $M = 18.18\%$  vs.  $15.38\%$ ); however, patients' self-correction rates of fully produced intrusions (i.e., [self-corrected full intrusions/total full intrusions];  $M = 11.11\%$  vs.  $40.91\%$ ), and their overall self-correction rates (i.e., [(partial intrusions+ self-corrected full intrusions)/(partial intrusions + full intrusions)]) were significantly lower than controls ( $M = 22.72\%$  vs.  $46.15\%$ ).

Following these two studies, we examined self-correction rates in all three ways (i.e., all correction rates, full-intrusion correction rates, and mid-error correction rates; see Fig. 2, and see also Appendix 3, Table 7). Collapsing all the corrections, the correction rates tended to be higher with cognates than with noncognates, but this difference was not significant ( $M = 85.7\%$  vs.  $66.7\%$ , i.e., 72 corrections out of 84 errors vs. 18 corrections out of 27 errors;  $\beta = 1.44$ ,  $SE \beta = .88$ ,  $\chi^2(1) = 2.68$ ,  $p = .102$ ). Looking at full intrusions alone, there also was no difference between cognates and noncognates in self-correction rates ( $M = 52.0\%$  vs.  $52.6\%$ , i.e., 13 corrections out of 25 errors vs. 10 corrections out of 19 errors;  $\beta = -.03$ ,  $SE \beta = .62$ ,  $\chi^2(1) < 1$ ). However, the analyses of mid-error corrections revealed significantly higher correction rates on cognates than noncognates ( $M = 70.2\%$  vs.  $29.6\%$ , i.e., 59 corrections out of 84 errors vs. 8 corrections out of 27 errors;  $\beta = 46.20$ ,  $SE \beta = 8.36$ ,  $\chi^2(1) = 33.70$ ,  $p < .001$ ). Because very few full intrusion errors were produced in the present study, below we focus our conclusions on the mid-error correction



**Fig. 2** Three types of self-correction rates by condition in each target language. For each self-correction type, all intrusion refers to the collapsed self-correction rates (i.e., [(partial intrusions+ self-corrected full intrusions)/(partial intrusions + full intrusions)]), full intrusion refers to the self-correction rates for fully produced intrusion errors (i.e., [self-

corrected full intrusions/total full intrusions]), and mid-error refers to partial intrusion rates out of all intrusions (i.e., [partial intrusions/(partial intrusions + full intrusions)]). The error bars show the 95% confidence intervals. Note that bilinguals produced no intrusions on English noncognate switch-out targets, thus no self-corrections were possible



rates (while acknowledging that a different pattern may be found in a study that elicits more full intrusion errors).

### Reading times

To consider if cognate effects on intrusion errors might have reflected a tendency to read more quickly (i.e., possibly a speed-accuracy trade-off), we examined paragraph reading times. Cognate status of switch words and default language were contrast coded. Subject and paragraph were entered as two random intercepts with related random slopes. We log-transformed the reading times to improve normality (see also Appendix 3, Table 8). Overall, bilinguals read English-default paragraphs (which had six Chinese switch words) significantly slower than Chinese-default paragraphs (which had six English switch words) ( $M = 54.26$  s vs.  $45.92$  s;  $\beta = .16$ ,  $SE \beta = .009$ ,  $\chi^2(1) = 112.81$ ,  $p < .001$ ). This could reflect the bilinguals' Chinese-dominance, but no doubt also reflected the fact that English-default paragraphs were longer on average than Chinese-default paragraphs. Of greater interest, reading times were not significantly different with cognate versus noncognate switch words ( $M = 50.25$  s vs.  $49.94$  s;  $\beta = .005$ ,  $SE \beta = .005$ ,  $\chi^2(1) = 1.25$ ,  $p = .263$ ; note that in this comparison, paragraph length is equated), but there was a marginally significant tendency for paragraphs that elicited the most errors to also be read more slowly, i.e., an interaction between cognate status and default language ( $\beta = .015$ ,  $SE \beta = .008$ ,  $\chi^2(1) = 3.08$ ,  $p = .079$ ). Bilinguals read English-default paragraphs with Chinese switch-out targets significantly more slowly with cognate than with noncognate switch words ( $M = 54.64$  s vs.  $53.88$  s;  $\beta = .013$ ,  $SE \beta = .005$ ,  $\chi^2(1) = 5.04$ ,  $p = .025$ ). By contrast, bilinguals read Chinese-default paragraphs with English switch words, which seldom elicited intrusion errors, at about the same speed in the cognate versus noncognate conditions ( $M = 45.85$  s vs.  $45.99$  s;  $\beta = -.002$ ,  $SE \beta = .008$ ,  $\chi^2(1) < 1$ ). Thus, the condition that produced the most intrusion errors (English-default paragraphs) also produced a cognate effect in the same direction in reading times, while at the same time Chinese-default paragraphs exhibited no evidence of significant effects of cognate status on reading times, suggesting that there is no clear sign of a speed-accuracy trade-off.

### Discussion

The present study investigated how cross-language overlap between translation equivalents at the phonological level influences bilingual language control in connected speech. Mandarin-English bilinguals read paragraphs written primarily in English or Chinese, in each of which six words were switch-out words written in the other language. Replicating prior work (Gollan et al., 2014, 2017; Gollan & Goldrick, 2016, 2018; Kolers, 1966), bilinguals exhibited reversed dominance effects, producing more intrusion errors when attempting to produce

dominant-language switch-out words in paragraphs written primarily in the nondominant language. Of greatest interest, bilinguals produced significantly more intrusion errors with Chinese cognates than noncognates, even though Chinese and English cognates do not overlap in written form. Bilinguals produced very few intrusions with English targets, but the few English words that did induce intrusion errors were all cognates. Additionally, though cognates induced more errors, bilinguals were also better at rapidly detecting and self-correcting intrusions in mid-error with cognates than with noncognates. Paragraph reading times revealed some significant effects in the same direction; bilinguals read English-default paragraphs with Chinese cognate switch words significantly more slowly than English-default paragraphs with Chinese noncognate switch words (while no cognate effects were found on reading times of Chinese-default paragraphs).

### Cognates elicit intrusions in connected speech

Our finding of intrusion errors and significant cognate effects, despite the salient difference in orthography between Chinese and English translation equivalents, pinpoints cognate effects to planning and production of speech much more than was possible in previous work with this paradigm with Spanish-English bilinguals, in which cognates could just as easily have been mis-read as mis-produced (Gollan et al., 2014). Indeed, the production of *any* intrusion errors in the read-aloud task with Chinese-English bilinguals might not be expected if such errors arise exclusively in visual perception or comprehension of the written words. These considerations are consistent with previous suggestions that intrusion errors in the read-aloud task primarily reflect mechanisms of speech production (even though reading aloud obviously also requires visual word recognition; Gollan & Goldrick, 2016, 2018). Because cognate effects in the present study could not possibly have involved reading errors, we focus the remaining discussion on how cognates might influence the ability to control language switches in speech production, including why cognates interfered with selection of the intended targets when a switch was required and induced more intrusion errors, and on the other hand, why cognates instead facilitated self-correction rates.

The higher rate of intrusions with cognate targets in the present study suggested that it is more difficult for bilinguals to switch out of the default language when producing cognates (i.e., a cognate interference effect on code-switching). In contrast, in spontaneous conversation between bilinguals, code-switches are more likely to occur in the vicinity of cognates, i.e., evidence for the triggering hypothesis and a kind of cognate facilitation effect on code-switching, as it is easier for bilinguals to switch out of the default language just after or even before producing cognates (Broersma & de Bot, 2006; Broersma, 2009). A critical difference between these two sources of data was that while we examined attempted

switches on cognate words, triggering effects measure the probability of switching spontaneously on noncognates in the vicinity of cognates. When attempting to switch on cognate targets themselves, activation of phonology may – in some circumstances – including, apparently, planning of connected speech during reading aloud, increase the extent to which translation equivalents are active at the lexical level (i.e., lexical competition), thus making it more (not less) difficult to switch out of the default language. By contrast, words adjacent to cognates will be switched more often because cognates will activate the non-default language at a global whole-language level (but noncognates will not) – thereby facilitating a switch. Thus, cognates can either facilitate or interfere with processing, depending on the processing level, task goals, or both, while the core mechanism underlying differences between cognates and noncognates is always increased dual-language activation.

It might also seem that cognate interference effects on intrusion errors is inconsistent with cognate facilitation effects found in picture naming (Costa et al., 2000; Gollan & Acenas, 2004; Hoshino & Kroll, 2008; Poarch & Van Hell, 2012), and with cognate switch-facilitation effects (i.e., cognates facilitate cued language switching; Declerck et al., 2012; Li & Gollan, 2018, Experiment 2). Importantly, though, Li and Gollan (2018) found that cognates facilitated switches on the first presentation of each picture, after repetition these facilitation effects switched to interference (i.e., cognates were named progressively more slowly with repetition, especially on switch trials without preparation time between cue and target; see also Christoffels et al., 2007). To explain these findings, Li and Gollan (2018) suggested that cognate-switch facilitation effects might arise at the phonological level (Costa et al., 2000), while interference effects might reflect selection difficulties arising at the lexical level. In repeated picture naming, selection difficulties might become more likely on switch trials if repetition can strengthen or speed feedback from phonology to the lexical level. Accordingly, the higher rate of intrusions on cognates in the present study might reflect interference at the lexical (not the phonological) level. In the read-aloud task bilinguals can only produce intrusion errors when translation equivalents are readily accessible; though cognates might facilitate access to both the targets and their possibly intruding replacements, the greater competition for selection generated by the latter might far outweigh any facilitatory effects.<sup>6</sup>

<sup>6</sup> Cognates might become accessible at the lexical level in both languages more rapidly in reading aloud than in picture naming for two reasons. First, written words, even Chinese characters (though they do not have transparent grapheme-to-phoneme correspondence), are named more quickly and automatically than pictures (e.g., Biederman & Tsao, 1979; Potter, So, Von Eckardt, & Feldman, 1984). Second, in reading aloud the eyes are often ahead of the mouth which allows look ahead and planning of upcoming speech (Buswell, 1922; Inhoff, Solomon, Radach, & Seymour, 2011) – which could provide more time for translation equivalents to become active at the lexical level where competition for selection makes switching more difficult (Li & Gollan, 2018).

Consistent with this view, in monolinguals, production is more difficult for targets in denser phonological neighborhood effects (cognates can be considered phonological neighbors). However, while inhibitory effects tend to dominate in normal production, when lexical access is disrupted, as in aphasia, facilitation emerges (e.g., Goldrick, Folk, & Rapp, 2010; Sadat, Martin, Costa, & Alario, 2014), which resembles cognate effects on self-corrections.

### Cognates facilitate speech monitoring

Though cross-language overlap in phonology elicited more speech errors, it also made monitoring of speech errors easier. Self-correction rates tended to be higher with cognate than with noncognate intrusions ( $M = 85.7\%$  vs.  $66.7\%$ ), an effect that was significant in mid-error correction rates ( $M = 70.2\%$  vs.  $29.6\%$ ). In fact, most intrusions with cognate targets were self-corrected before the word was fully produced, thus leading to a low rate of full intrusions. Since this was the first study of reading aloud of mixed-language paragraphs written in languages with distinct orthographies, it might seem as if the salient visual cues (the difference between Chinese and English) caused the low rate of full intrusions. However, the difference in orthography was just as salient for noncognates, which elicited full intrusions frequently ( $70.4\%$  out of all noncognate intrusions with Chinese targets, while only  $29.8\%$  of all Chinese cognate intrusions were full intrusions). Therefore, differences in orthography cannot explain why bilinguals seldom produced full intrusion errors with cognate switch targets. Consistent with this conclusion, another recently completed study with Chinese-English bilinguals reading aloud mixed-language paragraphs, but with many switches on function words targets, elicited many full intrusion errors (about  $90\%$  of all intrusions; Schotter, Li, & Gollan, submitted; function word switches are more intrusion prone in the read aloud task but were not included in the present study because no function words are Chinese-English cognates; Gollan et al., 2014; Gollan & Goldrick, 2016, 2018). Thus, the high rate of mid-error corrections in the present study should likely be attributed to cognate status (not to differences in orthography).

Mid-error corrections reflect an explicit monitoring behavior. Given their very rapid occurrence (usually right after the first or second phoneme of the error word), repairs of speech errors that are halted and corrected as they were being produced were likely planned during monitoring of an internal channel of planned speech (not an external channel, see Nooteboom, 2005; internal vs. overt monitoring stages may be distinguished by a delay of about 500 ms; Nooteboom & Quené, 2017). As explained in the Introduction, the greater rate of self-corrections for cognates than noncognates is the opposite

of what the perceptual-loop theory predicts (Levelt, 1983, 1989; Hartsuiker & Kolk, 2001), but given the greater potential for confusability between languages is predicted by a conflict-monitoring account. On this view, increased dual-language activation for cognates both elicited more intrusion errors and signaled a need for greater monitoring, and higher self-correction rates (Nozari et al., 2011; Hanley, Cortis, Budd, & Nozari, 2016; Nozari & Novick, 2017).

A further implication is that monitoring must take place at a processing level that is sensitive to word form, which could be either at the phonological level or at the lexical level (or both) in a model that assumes feedback. At the lexical level, feedback would increase confusability as to which target was intended, and at the phonological level cross-language similarity in phonological forms would create greater confusability as to whether the activated phonemes do or do not match the phonemes intended for production. Finally, though we argued that our results are more consistent with conflict monitoring, the two accounts are not entirely mutually exclusive (Hartsuiker, Bastiaanse, Postma, & Wijnen, 2005). The perceptual-loop theory may dominate the monitoring in the external channel of speech, which could be more related to self-correction of fully produced intrusions. Interestingly, full intrusions with cognate and noncognate targets were self-corrected at similar rates ( $M = 52.0\%$  vs.  $52.6\%$ ), a result the perceptual-loop theory predicts – in a model without feedback (Levelt et al., 1999).

### The language dominance effect

Lastly, our results replicated previously reported *reversed dominance* effects on intrusion errors, such that Mandarin-dominant bilinguals produced more intrusions with Chinese than with English target words. In previous read-aloud studies with Spanish-English bilinguals (Gollan et al., 2014, 2017; Gollan & Goldrick, 2016, 2018), English-dominant bilinguals also produced more intrusions with English than with Spanish targets. Reversed dominance effects in the read-aloud task are consistent with the Inhibitory Control Model (Green, 1986, 1998; see also Christoffels, et al., 2007; Costa & Santesteban, 2004; Costa, Santesteban, & Ivanova, 2006; Declerck, Stephan, Koch, & Philipp, 2015; Fu, et al., 2017; Gollan & Ferreira, 2009; Gollan, Kleinman, & Wierenga, 2014; Kleinman & Gollan, 2016; Peeters & Dijkstra, 2017; Verhoef, et al., 2009, 2010); bilinguals inhibit the dominant language, particularly when reading aloud paragraphs written primarily in the non-dominant language, and must release this inhibition to produce dominant-language switch words. The present results build on these findings by demonstrating generalizability

to bilinguals immersed in either their dominant or their nondominant language given that both Mandarin-dominant bilinguals (in the present study) and English-dominant bilinguals (in previous work) were immersed in English (at UCSD). They also generalize to bilinguals who acquired their nondominant language later (as in the present study) or earlier (in previous work) than the dominant language. Thus, the more-inhibited language appears to be determined most by language dominance rather than by language immersion, or the order of language acquisition. Language dominance appeared to modulate cognate effects in the present study as well, i.e., cognate interference effects were stronger with Chinese than English targets, though we could not draw this conclusion with certainty, as English noncognates elicited very few intrusions.

### Conclusion

The results of the present study provide further demonstration of how cognates can – depending on the task – both facilitate and interfere with bilingual language control (see also Goldrick, Runnqvist, & Costa, 2014; Li & Gollan, 2018), and localize production of intrusion errors in the read-aloud task to speech production instead of visual perception processes by involving two languages that share very different writing systems. When reading aloud full paragraphs, Chinese-English bilinguals had more difficulty planning switches out of the default-language with cognates – presumably because phonological overlap between translation equivalents increases dual-language activation at a stage of processing in which translation equivalents compete for selection. At the same time, the very same intrusion errors with cognate targets were identified and rapidly corrected more easily than noncognates – revealing a distinction between the effects of dual-language activation on different task goals (i.e., planning a switch out of the default language versus identifying and correcting a failure to switch). Further work is needed to reveal more precisely how phonological overlap between target and error words might initially derail but subsequently facilitate repair in monitoring the match between intended versus planned (or produced) speech in bilinguals and monolinguals alike.

**Acknowledgements** The authors thank Tiffany Ho and Zhujun Shao for composition of the paragraphs and assistance with data collection, and Yang Lu and Zhujun Shao for error coding. This research was supported by grants from the National Science Foundation (BCS1457519) and the National Institute of Health (DC011492; HD051030). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the NSF or NIH.

## Appendix 1

**Table 3** Chinese-English target words used in the present study

Cognates		Noncognates	
汉堡	hamburger	饺子	dumpling
沙发	sofa	椅子	chair
巧克力	chocolate	棉花	marshmallow
派对	party	野餐	picnic
豆腐	tofu	豆子	beans
台风	typhoon	飓风	hurricane
磅	pound	公斤	kilogram
吉他	guitar	小提琴	violin
伏特加	vodka	龙舌兰	tequila
威士忌	whisky	鸡尾酒	cocktail
高尔夫	golf	橄榄球	football
咖啡	coffee	茶	tea
保龄	bowling	网球	tennis
卡通	cartoon	动画	animation
布丁	pudding	蛋糕	cake
沙拉	salad	水果	fruit
三明治	sandwich	面条	noodle
吐司	toast	面包	bread
培根	bacon	牛排	steak
比基尼	bikini	游泳衣	swimsuit
雪茄	cigar	香烟	cigarette
妈妈	mom	叔叔	uncle
蕾丝	lace	丝绸	silk
扑克	poker	骰子	dice
模特	model	演员	actress
夹克	jacket	大衣	coat
香槟	champagne	果汁	juice
芒果	mango	苹果	apple
咖喱	curry	烧烤	barbeque
印度	India	中国	China
爵士	jazz	古典	classic
麦克风	microphone	耳机	earphone
风			
雷达	radar	探测器	detector
粉丝	fans	听众	audience
基因	gene	心脏	heart
沙龙	salon	研讨会	seminar
幽默的	humorous	好笑的	funny
维他命	vitamin	营养	nutrition
俱乐部	club	协会	association
马拉松	marathon	赛跑	running
迷你	mini	小	small
嘻哈	hip-hop	电子	electronic
柠檬	lemon	葡萄	grape
乒乓	ping-pong	羽毛球	badminton
球		球	
拿铁	latte	牛奶	milk
芭蕾	ballet	歌剧	opera
坦克	tank	火箭	rocket
瑜伽	yoga	体操	gymnastics

## Appendix 2

An example paragraph and its variants presented between subjects across different conditions.

### (a) English Word Order, cognate switches

I followed her into a house and saw a number of people from astrology 俱乐部 who were practicing fortune telling. I sat down in front of a table. The woman behind the table made an unknown hand gesture over a cup of hot 咖啡 and began to play 扑克 on a board. The board had many sections, each with a strange picture on it. In the pictures, there were knights drinking 威士忌 on horses, red baseball bats fighting with golden 吉他 and silver flutes, and crying women looking at a map of 印度 in the garden. Then she took my hand and looked at my palm, closed it, and closed her eyes.

### (b) English Word Order, noncognate switches

I followed her into a house and saw a number of people from astrology 协会 who were practicing fortune telling. I sat down in front of a table. The woman behind the table made an unknown hand gesture over a cup of hot 茶 and began to play with 骰子 on a board. The board had many sections, each with a strange picture on it. In the pictures, there were knights drinking 鸡尾酒 on horses, red baseball bats fighting with golden 小提琴 and silver flutes, crying women looking at a map of 中国 in the garden. Then she took my hand and looked at my palm, closed it, and closed her eyes.

### (c) Chinese Word Order, cognate switches

跟着她进了一栋房子,看见了很多占星术club的人在练习占卜。我在一张桌子前坐了下來,桌子后的女人在一杯热coffee上方做了一个不知道是什么的手势,然后开始在一张板上摆弄起poker来。那块板子由很多部分组成,每一部分上面都有奇怪的画。上面有在马上喝whisky的骑士,正在跟金色guitar和银色长笛打架的红色球棒,以及在花园里面边看India地图边哭的女人。接着她拿起我的手掌看了看,合上它,然后闭上了她的眼睛。

### (d) Chinese Word Order, noncognate switches

跟着她进了一栋房子,看见了很多占星术association的人在练习占卜。我在一张桌子前坐了下來,桌子后的女人在一杯热tea上方做了一个不知道是什么的手势,然后开始在一张板上摆弄起dice来。那块板子由很多部分组成,每一部分上面都有奇怪的画。上面有在马上喝cocktail的骑士,正在跟金色violin和银色长笛打架的红色球棒,以及在花园里面边看China地图边哭的女人。接着她拿起我的手掌看了看,合上它,然后闭上了她的眼睛。

## Appendix 3

Summary tables of the logistic and linear regression models in the present study.

**Table 4** Logistic regression models on intrusion rates with full and partial intrusions collapsed

Fixed effects	Estimate	Std.Error	$\chi^2$	p
Intercept	-9.37	6.80		
Cognate status (noncognate/cognate)	10.34	13.60	38.35	< 0.001
Language (English/Chinese)	9.28	13.60	14.07	< 0.001
Cognate status*language	-16.75	27.19	5.10	0.024
Post-hoc analyses:				
Cognate status for Chinese	1.90	0.55	14.70	< 0.001
Cognate status for English	19.18	53.28	20.84	< 0.001
Random effects	Variance			
Word intercept	2.46			
Subject intercept	0.29			
Cognate Status Subject slope	0.66			
Language Subject slope	0.32			
Cognate status*Language Subject slope	0.04			

**Table 5** Logistic regression models of intrusion rates with full intrusions only

Fixed effects	Estimate	Std.Error	$\chi^2$	p
Intercept	-11.52	9.49		
Cognate Status (noncognate/cognate)	9.17	18.93	6.73	0.009
Language (English/Chinese)	8.41	18.92	2.97	0.085
Cognate Status*Language	-16.50	37.82	2.51	0.113
Post-hoc analyses:				
Cognate Status for Chinese	0.94	0.98	0.96	0.327
Cognate Status for English	17.37	59.80	4.91	0.027
Random effects	Variance			
Word Intercept	8.04			
Subject Intercept	0.18			
Cognate Status Subject slope	0.95			
Language Subject slope	1.59			
Cognate Status*Language Subject slope	5.75			

**Table 6** Logistic regression models of intrusion rates with partial intrusions only

Fixed effects	Estimate	Std.Error	$\chi^2$	p
Intercept	-9.86	8.02		
Cognate status (noncognate/cognate)	10.89	16.04	38.75	< 0.001
Language (english/chinese)	8.53	16.01	3.11	0.078
Cognate status*language	-15.07	32.02	1.02	0.313
Post-hoc analyses:				
Cognate Status for Chinese	3.25	1.04	23.09	< 0.001
Cognate Status for English	18.93	45.59	17.77	< 0.001
Random effects	Variance			
Word intercept	1.54			
Subject intercept	0.44			
Cognate status Subject slope	1.78			
Language Subject slope	1.03			
Cognate status*Language Subject slope	2.04			

**Table 7** Logistic regression models of self-correction rates

All corrections	Fixed effects	Estimate	Std.Error	$\chi^2$	p
	Intercept	1.46	0.46		
	Cognate status (noncognate/cognate)	1.44	0.88	2.68	0.102
	Random effects	Variance			
	Word intercept	< .0001			
	Subject intercept	0.45			
	Cognate Status Subject slope	0.45			
Full-intrusion corrections	Fixed effects	Estimate	Std.Error	$\chi^2$	p
	Intercept	0.10	0.33		
	Cognate status (noncognate/cognate)	-0.03	0.62	0.003	0.957
	Random effects	Variance			
	Word intercept	< .0001			
	Subject intercept	0.06			
	Cognate status Subject slope	< .0001			
Mid-error corrections	Fixed effects	Estimate	Std.Error	$\chi^2$	p
	Intercept	11.83	3.26		
	Cognate status (noncognate/cognate)	46.20	8.36	33.70	< .001
	Random effects	Variance			
	Word intercept	1776.5			
	Subject intercept	890.7			
	Cognate status Subject slope	3293.8			

**Table 8** Linear mixed effects models of Reading Times (log-transformed)

Fixed effects	Estimate	Std.Error	$\chi^2$	p
Intercept	3.89	0.03		
Cognate Status (noncognate/cognate)	0.005	0.005	1.25	0.263
Language (English/Chinese)	0.16	0.009	112.81	<0.001
Cognate Status*Language	0.015	0.008	3.08	0.079
Post-hoc analyses:				
Cognate Status for Chinese Switch Words	0.013	0.005	5.04	0.025
Cognate Status for English Switch Words	-0.002	0.008	0.068	0.795
Random effects	Variance			
Subject Intercept	1.16E-02			
Cognate Status Subject slope	2.76E-05			
Language Subject slope	4.34E-03			
Cognate Status*Language Subject slope	1.49E-04			
Paragraph Intercept	1.48E-02			
Cognate Status Paragraph slope	4.70E-04			
Language Paragraph slope	3.91E-03			
Cognate Status*Language Paragraph slope	3.98E-04			
Residual	3.54E-03			

## References

- Abutalebi, J., & Green, D. (2007). Bilingual language production: The neurocognition of language representation and control. *Journal of Neurolinguistics*, 20, 242–275.
- Acheson, D. J., Ganushchak, L. Y., Christoffels, I. K., & Hagoort, P. (2012). Conflict monitoring in speech production: Physiological evidence from bilingual picture naming. *Brain and language*, 123(2), 131–136.
- Barr D. J., Levy R., Scheepers C., Tily H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language*, 68, 255–278.
- Biederman I., & Tsao Y.-C. (1979). On processing Chinese ideographs and English words: Some implications from Stroop-test results. *Cognitive Psychology*, 11, 125–132.
- Broersma, M. (2009). Triggered codeswitching between cognate languages. *Bilingualism: Language and Cognition*, 12, 447–462.
- Broersma, M., & de Bot, K. (2006). Triggered codeswitching: A corpus-based evaluation of the original triggering hypothesis and a new alternative. *Bilingualism: Language and Cognition*, 9, 1–13.
- Brysbaert, M., & New, B. (2009). Moving beyond Kučera and Francis: A critical evaluation of current word frequency norms and the introduction of a new and improved word frequency measure for American English. *Behavior research methods*, 41(4), 977–990.
- Bultena, S., Dijkstra, T., & Van Hell, J. G. (2014). Cognate effects in sentence context depend on word class, L2 proficiency, and task. *The Quarterly Journal of Experimental Psychology*, 67(6), 1214–1241.
- Bultena, S., Dijkstra, T., & Van Hell, J. G. (2015). Language switch costs in sentence comprehension depend on language dominance: Evidence from self-paced reading. *Bilingualism: Language and Cognition*, 18(3), 453–469.
- Buswell, G. T. (1922). *Fundamental reading habits: A study of their development*. Chicago, IL: University of Chicago Press.
- Cai, Q., & Brysbaert, M. (2010). SUBTLEX-CH: Chinese word and character frequencies based on film subtitles. *PLoS one*, 5(6), e10729.
- Caramazza, A., & Brones, I. (1979). Lexical access in bilinguals. *Bulletin of the Psychonomic Society*, 13(4), 212–214.
- Christoffels, I. K., Firk, C., & Schiller, N. O. (2007). Bilingual language control: An event-related brain potential study. *Brain Research*, 1147, 192–208.
- Clyne, M. (1967). *Transference and triggering: Observations on the language assimilation of postwar German-speaking migrants in Australia*. Den Haag: Martinus Nijhoff.
- Clyne, M. (1980). Triggering and language processing. *Canadian Journal of Psychology*, 34, 400–406.
- Colomé, À. (2001). Lexical activation in bilinguals' speech production: Language-specific or language-independent? *Journal of Memory and Language*, 45(4), 721–736.
- Costa, A., Caramazza, A., & Sebastián-Gallés, N. (2000). The cognate facilitation effect: Implications for models of lexical access. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 26(5), 1283–1296.
- Costa, A., & Santesteban, M. (2004). Lexical access in bilingual speech production: Evidence from language switching in highly proficient bilinguals and L2 learners. *Journal of Memory and Language*, 50, 491–511.
- Costa, A., Santesteban, M., & Ivanova, I. (2006). How do highly proficient bilinguals control their lexicalization process? Inhibitory and language-specific selection mechanisms are both functional. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 32(5), 1057–1074.
- Cutting, J. C., & Ferreira, V. S. (1999). Semantic and phonological information flow in the production lexicon. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 25(2), 318–344.
- Declerck, M., Koch, I., & Philipp, A. M. (2012). Digits vs. pictures: The influence of stimulus type on language switching. *Bilingualism: Language and Cognition*, 15(04), 896–904.

- Declerck, M., Lemhöfer, K., & Grainger, J. (2017). Bilingual language interference initiates error detection: Evidence from language intrusions. *Bilingualism: Language and Cognition*, 20(5), 1010–1016.
- Declerck, M., & Philipp, A. M. (2015). A sentence to remember: Instructed language switching in sentence production. *Cognition*, 137, 166–173. <https://doi.org/10.1016/j.cognition.2015.01.006>
- Declerck, M., Stephan, D. N., Koch, I., & Philipp, A. M. (2015). The other modality: Auditory stimuli in language switching. *Journal of Cognitive Psychology*, 27(6), 685–691.
- Dell, G. S. (1988). The retrieval of phonological forms in production: Tests of predictions from a connectionist model. *Journal of Memory and Language*, 27(2), 124–142.
- Dijkstra, T., Grainger, J., & Van Heuven, W. J. (1999). Recognition of cognates and interlingual homographs: The neglected role of phonology. *Journal of Memory and Language*, 41(4), 496–518.
- Dixon, P. (2008). Models of accuracy in repeated-measures designs. *Journal of Memory and Language*, 59, 447–456.
- Fu, Y., Lu, D., Kang, C., Wu, J., Ma, F., Ding, G., & Guo, T. (2017). Neural correlates for naming disadvantage of the dominant language in bilingual word production. *Brain and Language*, 175, 123–129.
- Goldrick, M., Folk, J. R., & Rapp, B. (2010). Mrs. Malaprop's neighborhood: Using word errors to reveal neighborhood structure. *Journal of Memory and Language*, 62(2), 113–134.
- Goldrick, M., Runnqvist, E., & Costa, A. (2014). Language switching makes pronunciation less nativelike. *Psychological Science*, 25(4), 1031–1036.
- 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, & Cognition*, 35, 640–665.
- Gollan, T. H., Forster, K. I., & Frost, R. (1997). Translation priming with different scripts: Masked priming with cognates and noncognates in Hebrew-English bilinguals. *Journal of Experimental Psychology: Learning Memory and Cognition*, 23(5), 1122–1139.
- Gollan, T.H., & Goldrick, M. (2016). Grammatical constraints on language switching: Language control is not just executive control. *Journal of Memory and Language*, 90, 177–199.
- 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(1), 143–156.
- Gollan, T. H., Montoya, R. I., & Bonanni, M. P. (2005). Proper names get stuck on bilingual and monolingual speakers' tip of the tongue equally often. *Neuropsychology*, 19(3), 278.
- 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.
- Gollan, T.H., Weissberger, G., Runnqvist, E., Montoya, R.I., & Cera, C.M. (2012). Self-ratings of spoken language dominance: A multilingual naming test (MINT) and preliminary norms for young and aging Spanish-English bilinguals. *Bilingualism: Language and Cognition*, 15, 594–615.
- Gollan, T. H., Kleinman, D., & Wierenga, C. E. (2014). What's easier: Doing what you want, or being told what to do? Cued versus voluntary language and task switching. *Journal of Experimental Psychology: General*, 143(6), 2167–2195.
- 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.
- Gollan, T. H., Stasenko, A., Li, C., & Salmon, D. P. (2017). Bilingual language intrusions and other speech errors in Alzheimer's disease. *Brain and Cognition*, 118, 27–44.
- Green, D. W. (1986). Control, activation and resource: A framework and a model for the control of speech in bilinguals. *Brain & Language*, 27, 210–223.
- Green, D. W. (1998). Mental control of the bilingual lexicosemantic system. *Bilingualism: Language and Cognition*, 1, 67–81.
- Gullifer, J. W. (2011). The effect of syntactic constraints on parallel activation of words in the bilingual's two languages (Master's Thesis, The Pennsylvania State University).
- Hanley, J. R., Cortis, C., Budd, M. J., & Nozari, N. (2016). Did I say dog or cat? A study of semantic error detection and correction in children. *Journal of experimental child psychology*, 142, 36–47.
- Hermans, D., Bongaerts, T., De Bot, K., & Schreuder, R. (1998). Producing words in a foreign language: Can speakers prevent interference from their first language?. *Bilingualism: language and cognition*, 1(3), 213–229.
- Hartsuiker, R. J., Bastiaanse, R., Postma, A., & Wijnen, F. (Eds.). (2005). *Phonological encoding and monitoring in normal and pathological speech*. London: Psychology Press.
- Hartsuiker, R. J., & Kolk, H. H. (2001). Error monitoring in speech production: A computational test of the perceptual loop theory. *Cognitive psychology*, 42(2), 113–157.
- Hickok, G. (2012). Computational neuroanatomy of speech production. *Nature Reviews Neuroscience*, 13, 135–145.
- Hoshino, N., & Kroll, J. F. (2008). Cognate effects in picture naming: Does cross-language activation survive a change of script? *Cognition*, 106, 501–511.
- Inhoff, A. W., Solomon, M., Radach, R., & Seymour, B. A. (2011). Temporal dynamics of the eye-voice span and eye movement control during oral reading. *Journal of Cognitive Psychology*, 23(5), 543–558.
- 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(5), 700–714.
- Kolers, P. A. (1966). Reading and talking bilingually. *The American Journal of Psychology*, 79(3), 357–376.
- 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(4), 797–819.
- Kroll, J. F., Bobb, S. C., Misra, M., & Guo, T. (2008). Language selection in bilingual speech: Evidence for inhibitory processes. *Acta psychologica*, 128(3), 416–430.
- Lackner, J. R. (1974). Speech production: Evidence for corollary discharge stabilization of perceptual mechanisms. *Perceptual and Motor Skills*, 39, 899–902.
- Lemhöfer, K., & Dijkstra, T. (2004). Recognizing cognates and interlingual homographs: Effects of code similarity in language-specific and generalized lexical decision. *Memory & Cognition*, 32(4), 533–550.
- Lemhöfer, K., Dijkstra, T., & Michel, M. (2004). Three languages, one ECHO: Cognate effects in trilingual word recognition. *Language and cognitive processes*, 19(5), 585–611.
- Levelt, W. J. M. (1983). Monitoring and self-repair in speech. *Cognition*, 33, 41–103.
- Levelt, W. J. M. (1989). *Speaking: From Intention to Articulation*. Cambridge, MA: MIT Press.
- Levelt, W. J. M., Roelofs, A., & Meyer, A. S. (1999). A theory of lexical access in speech production. *Behavioral and Brain Sciences*, 22, 1–38.
- Li, C., & Gollan, T. H. (2018). Cognates facilitate switches and then confusion: contrasting effects of cascade versus feedback on language selection. *Journal of Experimental Psychology: Learning, Memory, and Cognition*. <https://doi.org/10.1037/xlm0000497>.



- Midgley, K. J., Holcomb, P. J., & Grainger, J. (2011). Effects of cognate status on word comprehension in second language learners: An ERP investigation. *Journal of Cognitive Neuroscience*, 23(7), 1634–1647.
- Nootboom, S. G. (2005). Lexical bias revisited: Detecting, rejecting and repairing speech errors in inner speech. *Speech Communication*, 47, 43–58.
- Nootboom, S. G., & Quené, H. (2017). Self-monitoring for speech errors: Two-stage detection and repair with and without auditory feedback. *Journal of Memory and Language*, 95, 19–35.
- Nozari, N., & Novick, J. (2017). Monitoring and control in language production. *Current Directions in Psychological Science*, 26(5), 403–410.
- Nozari, N., Dell, G. S., & Schwartz, M. F. (2011). Is comprehension necessary for error detection? A conflict-based account of monitoring in speech production. *Cognitive psychology*, 63(1), 1–33.
- Peeters, D., Dijkstra, T., & Grainger, J. (2013). The representation and processing of identical cognates by late bilinguals: RT and ERP effects. *Journal of Memory and Language*, 68(4), 315–332.
- Peeters, D., & Dijkstra, T. (2017). Sustained inhibition of the native language in bilingual language production: A virtual reality approach. *Bilingualism: Language and Cognition* (in press).
- Potter M.C., So K.-F., Von Eckardt B., & Feldman L.B. (1984) Lexical and conceptual representation in beginning and proficient bilinguals. *Journal of Verbal Learning and Verbal Behavior*, 23, 23–38
- Poulisse, N., & Bongaerts, T. (1994). First language use in second language production. *Applied linguistics*, 15(1), 36–57.
- Poarch, G. J., & Van Hell, J. G. (2012). Cross-language activation in children's speech production: Evidence from second language learners, bilinguals, and trilinguals. *Journal of Experimental Child Psychology*, 111(3), 419–438.
- Prior, A., & Gollan, T. H. (2013). The elusive link between language control and executive control: A case of limited transfer. *Journal of Cognitive Psychology*, 25(5), 622–645.
- Rapp, B., & Goldrick, M. (2000). Discreteness and interactivity in spoken word production. *Psychological review*, 107(3), 460–499.
- Sadat, J., Martin, C. D., Costa, A., & Alario, F. X. (2014). Reconciling phonological neighborhood effects in speech production through single trial analysis. *Cognitive psychology*, 68, 33–58.
- Schwartz, A. I., & Kroll, J. F. (2006). Bilingual lexical activation in sentence context. *Journal of Memory and Language*, 55(2), 197–212.
- Slevc, L. R., & Ferreira, V. S. (2006). Halting in single word production: A test of the perceptual-loop theory of speech monitoring. *Journal of Memory and Language*, 54, 515–540.
- Titone, D., Libben, M., Mercier, J., Whitford, V., & Pivneva, I. (2011). Bilingual lexical access during L1 sentence reading: The effects of L2 knowledge, semantic constraint, and L1–L2 intermixing. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 37(6), 1412.
- Van Assche, E., Drieghe, D., Duyck, W., Welvaert, M., & Hartsuiker, R. J. (2011). The influence of semantic constraints on bilingual word recognition during sentence reading. *Journal of Memory and Language*, 64(1), 88–107.
- Van Hell, J. G., & Dijkstra, T. (2002). Foreign language knowledge can influence native language performance in exclusively native contexts. *Psychonomic bulletin & review*, 9(4), 780–789.
- Verhoef, K. M. W., Roelofs, A., & Chwilla, D. J. (2009). Role of inhibition in language switching: Evidence from event-related brain potentials in overt picture naming. *Cognition*, 110, 84–99.
- Verhoef, K. M., Roelofs, A., & Chwilla, D. J. (2010). Electrophysiological evidence for endogenous control of attention in switching between languages in overt picture naming. *Journal of Cognitive Neuroscience*, 22(8), 1832–1843.
- Weissberger, G. H., Wierenga, C. E., Bondi, M. W., & Gollan, T. H. (2012). Partially overlapping mechanisms of language and task control in young and older bilinguals. *Psychology and Aging*, 27(4), 959.
- Witteman, M. J. (2008). Lexical and contextual factors in codeswitching: A behavioral and electrophysiological study. M.Sc. dissertation, Radboud University Nijmegen.