Visual Word Recognition of Code-Switched Words: Possible Evidence for Selective Lexical Access

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Introduction

When bilinguals read a newspaper article in one of their languages, do they completely turn off the other language? Do bilinguals have an on/off switch for each of the languages in their brains? If not, how does the unused language interfere or facilitate processing during reading? When bilinguals read an email with a mixture of their two languages, what happens? Are both languages activated at the same time? Does the bilingual person suffer a terrible headache after reading these emails?

In the past 20 years, many researchers have worked to find answers to these types of questions. And most importantly, these researchers have sought to find an answer to one central question: In bilingual word recognition, is lexical access a language selective or language nonselective process?

Various lexical decision tasks and naming tasks have been used to show that bilinguals experience a simultaneous activation of the lexicons of both of their languages when reading. Even when processing the words in a monolingual text, bilinguals experience a parallel activation of their two lexicons (Dijkstra, 2005). The experimental designs for these studies have taken advantage of similarities in orthography, phonology, and other properties among words in alphabetic European languages. And in particular, these experiments have revealed a cognate facilitation effect. When a bilingual's two languages share a cognate with enough similarity of orthography, meaning, and phonology, the word is recognized more quickly than control words, and is recognized by bilinguals more quickly than monolinguals (Schwartz & Van Hell, 2012). The cognate facilitation effect provides strong evidence in favor of a nonselective lexical access model for bilingual visual word

recognition, and it has been shown to facilitate word recognition in various contexts, even among languages that use different scripts (Kim & Davis, 2003; Hoshino & Kroll, 2008).

Thus far, a significant amount of research supports a language nonselective lexical access model for bilingual word recognition. Indeed, the prevailing model for bilingual visual word recognition, the Bilingual Interactive Activation + model (BIA+) (Dijkstra & Van Heuven, 2002), is heavily based on nonselective lexical access. Essentially, this model says that the lexicons of bilinguals are integrated and always activated together, always activated before any other selectivity occurs, and activated regardless of the task or cues that may differ in the reading environment.

But are there no linguistic cues that can cause or facilitate a selective access to one lexicon and not the other? Several experiments have tested various linguistic cues as possible avenues to a selective lexical access, but thus far, only one linguistic condition has been shown to inhibit access to the non-target lexicon (Gullifer et al, 2013): a strong semantic constraint, one that helps a reader to predict the target word, can decrease the cognate facilitation effect or cause reaction times that differ little from controls (e.g., Schwartz & Kroll, 2006). Thus far, no other conditions seems to alter a bilingual's brain from an integrated and always co-activated lexicons.

However, few research projects have tested natural code-switching conditions, and too many research projects have studied only the same few alphabetic European languages. Do current findings in bilingual visual word recognition apply to the reading of sentences with mixed languages? Will new experiments find the same results when comparing two languages with completely different scripts?

If both lexicons are simultaneously activated in bilingual visual word recognition, why do numerous experiments find a code-switching cost (e.g., Thomas & Allport, 2000)? After all, when "both languages are active regardless of the requirements of the task, then forcing the activation of the language not in use by mixing two languages or switching from one language to the other should have little consequence" (Gullifer et al., 2013, p. 2). And if code-switching has costs, why do bilinguals engage in code-switching so often? Possibly, a study of a more natural code-switching condition would reveal the benefits of a language selective lexical access, or diminish the costs of code-switching in other ways.

The study in this paper attempts to create a more natural, intra-sentential code-switching environment for the purpose of answering this question: When reading at mixed-language text, can a parafoveal awareness of an impending code-switched word lead to a more selective lexical access for bilinguals?

Researchers have shown that orthography plays an important role in parafoveal processing benefits in reading (Schotter, Angele, & Rayner, 2012). And though, for alphabetic languages, semantic information of parafoveal words has not been shown to be processed while the words are in the parafoveal regions, Chinese and Japanese characters may transmit some semantic information during parafoveal processing of parafoveal characters (Yan et al., 2009). Also, numerous studies have shown that phonological information in parafoveal previews helps to guide the processing of the word as it moves into foveal view (e.g., Ashby & Rayner, 2004). These results show that the processing of code-switched words may be quite different when the words are read in a natural intra-sentential mixed-language sentence.

The study in this paper attempts to test the possibility of a parafoveal shortcut to selective lexical access in bilingual visual word recognition. If bilingual readers see that a code-switched word is approaching, will they still activate both lexicons when the word moves into foveal view? For example, if the code-switched word is a cognate in the bilingual's languages, will the bilingual reader process the word with the same reaction time as a non-cognate word of similar frequency? There are two possible outcomes: First, parafoveal awareness of a coming code-switched cognate will not lead to selective lexical access, and the cognate will be recognized more quickly, as predicted by the cognate facilitation effect. Second, parafoveal awareness of a coming code-switched cognate will offer a path to a more selective lexical access, and the cognate will be recognized as slowly as a non-cognate control word. If the former result is found, it will add support to the nonselective view of lexical access in bilingual word recognition, as advanced by the BIA + model. If the latter result is found, a strong semantic constraint will no longer be the only known path to a more selective lexical access.

Participants

In order to ensure a high level of proficiency in the two languages of the experiment, bilingual participants will be chosen from a population of bilinguals who meet the following criteria: he or she is an adult (over the age of 18), bilingual speaker of Japanese and English; he or she is a native speaker of Japanese from birth; he or she began to acquire English during childhood (before the age of 6); he or she has used both Japanese and English continuously since the onset of acquisition of both languages; and he or she has at least 2

years of experience using each language in a monolingual work-place or academic environment. A language history questionnaire will be used to subjectively test for these bilingual proficiencies (see Appendix D).

In addition to the above criteria, candidates will be selected based on the results of objective testing. For candidates who did not fully complete a secondary or tertiary education with graduation from a high school or university in Japan, only those who score in the 98th percentile or higher on the Japanese Language Proficiency Test (JLPT) (日本語能力試験) will be accepted. Similarly, for candidates who did not fully complete a secondary or tertiary education with graduation from a high school or university in an English language environment, only those who score in the 98th percentile or above on the Test of English as a Foreign Language® (TOEFL®) will be selected for participation.

In addition to the above requirements, an Operation-Span task (Turner & Engle, 1989) and possibly a Simon task (Simon & Rudell, 1967) will be used to objectively measure working memory and other cognitive strength differences among successful candidates. These tests follow from research (Bialystok, Craik, Klein, & Viswanathan, 2004; Prior and MacWhinney, 2010) that has shown how bilinguals' abilities can differ in task-switching and use of working memory.

All participants must meet the above subjective and objective criteria. Candidates will be accepted based on the results of either of the above mentioned tests if the tests were taken in the past two years, but they may also take the tests before participation. The cost of the JLPT test or TOEFL® test will be paid in full for those candidates who must take the

tests in order to meet the objective criteria for participation, and all candidates will be paid $50 an hour for their participation in the experiment.

40 participants will be chosen among the population of candidates who meet the above subjective and objective criteria, and they will be divided into four groups of equal number. 2 groups will complete a self-paced reading task with parafoveal awareness of approaching code-switched words, and 2 groups will complete a similar task without a parafoveal awareness of these approaching words. A latin square design will be used to ensure that every participant sees each of the conditions, with each participant tested for one condition for each item.

Materials and Procedure

Japanese/English cognate pairs will be used as target words in pairs of otherwise identical, semantically low-constraint sentences that allow for either word. For example, the following sentence pair is used: A. *When John entered the room, he saw a* ネックレス *and several books on the desk.* (ネックレス = ***necklace***, a cognate in English and Japanese)

B. *When John entered the room, he saw a necklace and several books on the desk.* As much as possible, cognates are chosen from medium to low frequency words of 6 to 8 letters, with Japanese cognates that are limited to 4 or 5 characters (a similar length), and with English cognates that have few orthographic neighbors, based on data and search results from the English Lexicon Project (Balota et al., 2007). Also, all cognates are limited to concrete nouns, they appear in roughly the middle of the sentence, and the cognates have a close

phonological similarity in the two pronunciations. These controls are necessary in order to ensure that the differences in reaction times for lexical decisions are limited to the effect or lack of effect of cognate facilitation in the parafoveal preview and non-parafoveal preview conditions.

2 groups of participants will complete a moving-window, self-paced reading task with contrastive symbols to highlight an impending code-switched word. And the other 2 groups will complete a similar self-paced reading task without contrastive symbols; therefore, the second 2 groups will not know when or if code-switched words are coming in the text (for a complete list of the Japanese/English cognate sentences, please see Appendix A). In Table 1, row A gives an example of the kind of symbolism and sentence that the first 2 groups will see and read, and row B shows the kind of symbolism and sentence that the second 2 groups will see and read:

Table 1	Example symbolism and example sentences for the 2 groups
A	*xxxx xxxx xxxxxxx xxx xxxx xx xxx x* ***XXXXX*** *xxx xxxxxxx xxxxx xx xxx xxxx*
	When John entered the room, he saw a **ネックレス** *and several books on the desk.*
B	xxx xxx xxxxx xxxx xxx xxxxxx xx xxxx xx xxx xxxxxxx xx xxxx xxx xxxx xxx
	The old woman told the couple to look in the **トンネル** to find the lost dog.
ネックレス (*necklace*) **トンネル** (*tunnel*)	

The 1st two groups will sit in front of a computer screen and will read the following instructions: *You will complete a self-paced reading task. In this task, you will see lowercase*

*x's that represent the letters in English words, and you will see upper case, bold **X**'s that represent the characters in a Japanese word. You will press the space bar to proceed from one word to the next word until you reach the end of the sentence. However, you will press the enter key when you see a nonsense word. A nonsense word is a word that does not exist in Japanese or English. Most importantly, you will decide as quickly as possible if each word in the sentence is a real word in either Japanese or English. At the end of each sentence, you will be asked to answer a comprehension question about the sentence. You will complete 5 practice sentences before starting the actual test. When you are ready to begin, please press the space bar.*

For the 2nd two groups, the same instructions will be given, but the first few lines of instruction will read differently as follows: *You will complete a self-paced reading task. In this task, you will see lowercase x's that represent the letters in English words. These lowercase x's may also represent one or two Japanese words.* (The remainder of the instructions are identical after this point) (see Appendix E for the 5 practice sentences).

The experimental stimuli and tasks will be designed and implemented using E-prime 2.0 software (Psychology Software Tools, Pittsburg, PA), and all results will be recorded and automatically stored in secured database files. The software will record the reaction time (RT) for each of the lexical decisions as the participants read the sentences. The reaction time will measure the time from the previous press of the space-bar (or enter key) to the next pressing of the space bar (or enter key). These reaction times are the dependent variable in the experiments. The software will also record the responses to comprehension questions (see Appendix C). The participants will write the answers freely in a text box, and the

answers will be graded manually. When a participant misses a comprehension question for a sentence, the data for the sentence will not be used for analysis.

Participants in both groups will encounter nonsense words in half of their sentences, and these nonsense words will be selected from a list of nonsense words constructed by the English Lexicon Project software (Balota et al., 2007), with characteristics corresponding to the English cognates in the Japanese/English cognate pair sentences. The Japanese nonsense words will be katakana approximations of the English nonsense words in this list, will not form Japanese words, and will have forms that do not have orthographic neighbors among Japanese katakana words. Participants in all groups will encounter at least one nonsense word in half of their sentences, and these sentences will be separate from the Japanese/ English control sentences (See Appendix B for a complete list of the nonsense word sentences).

Each participant in each group will see a random mixture of 12 sentences, with 6 sentences from among the nonsense word sentences and 6 sentences from among the Japanese/English cognate pair sentences. Each participant will see 3 sentences with the English cognate targets, 3 sentences with the Japanese cognate targets, 3 sentences with a Japanese nonsense katakana word, and 3 sentences with an English nonsense word. The four possible sentence types will be balanced among the 12 sentences.

Reaction times for word recognition of Japanese cognates in the parafovial facilitation condition will be compared to reaction times for Japanese cognates in the condition without parafoveal facilitation. Reaction times for the English cognate counterparts will also be compared to these results.

Additional experiments will compare reaction times for recognizing Japanese/English cognates in comparison to reaction times for recognizing katakana loan words that do not come from English, such as コンクール(*konkulu*; contest), ブランコ(*buranko,* slide), シャボン玉(*shabondama,* bubble), アンケート(*anketto,* survey), オルゴール(*orugolu,* music box), ピエロ(*piero,* clown), ランドセル(*randoselu,* satchel), ホチキス (*hochikisu*, stapler), or ズボン(*zubon,* pants) (see the bottom of Appendix A). Do Japanese/English bilinguals recognize these katakana words less quickly than katakana words that are cognates in English, when they appear in the same place in identical sentences, and when they can see that a code-switched word is coming?

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Appendix A

List of Japanese/English cognate pairs in identical sentences
When the man entered the room, he saw a **ネックレス** and several books on the desk.
When the man entered the room, he saw a **necklace** and several books on the desk.
My grandfather's old **カメラ** was still able to take good photos, even though it had a bad **レンズ** .
My grandfather's old **camera** was still able to take good photos, even though it had a bad **レンズ**.
The old woman told the couple to look in the **トンネル** area to find the lost dog.
The old woman told the couple to look in the **tunnel** area to find the lost dog.
I had difficulty getting a **チケット** for the concert, but my **友達** bought one for me.
I had difficulty getting a **ticket** for the concert, but my **友達** bought one for me.
On Saturday, I needed to buy **ガソリン** for the new generator.
On Saturday, I needed to buy **gasoline** for the new generator.
For Christmas, I gave my uncle some **パジャマ** and a bag of dried fruit.
For Christmas, I gave my uncle some **pajamas** and a bag of dried fruit.
Mark found the **ラケット** and the **ボール** in the corner of his office, behind the boxes.
Mark found the **racket** and the **ボール** in the corner of his office, behind the boxes.
At the end of the **映画**, the main character holds the **バイオリン** above her head.
At the end of the **映画**, the main character holds the **violin** above her head.
The family went to the **公園** to watch the **マラソン** and enjoy the good weather.
The family went to the 公園 to watch the **marathon** and enjoy the good weather.
If the girl likes the **レストラン**, her boyfriend should have the **パーティー** there.

If the girl likes the **restaurant**, her boyfriend should have the **パーティー** there.
After dinner, the woman asked for **ティッシュ** and some medicine.
After dinner, the woman asked for **tissue** and some medicine.
In the upstairs bedroom, there are many old **アルバム** that you can take home.
In the upstairs bedroom, there are many old **album** that you can take home.
Everyone will need to bring **シャンプー** and other toiletries when we stay in Europe.
Everyone will need to bring **shampoo** and other toiletries when we stay in Europe.
As a result of the fire, most of the **カーペット** and curtains were burned.
As a result of the fire, most of the carpet and curtains were burned.
The boy didn't see the **タクシー** as he ran into the road.
The boy didn't see the **taxi** as he ran into the road.
There are three **ポケット** on the girl's new bluejeans, and two on her **T シャツ**.
There are three pockets on the girl's new bluejeans, and two on her **T シャツ**.
Example sentences with Japanese cognates that are not cognates in English
There are three **シャボン玉** on the girl's new bluejeans, and two on her T シャツ.
In the upstairs bedroom, there are many old **オルゴール** that you can take home.
The boy didn't see the **ピエロ** as he ran into the road.
Mark found the **アンケート** and the **ボール** in the corner of his office, behind the boxes.
As a result of the fire, most of the **ランドセル** and curtains were burned.
The family went to the **公園** to watch the **コンクール** and enjoy the good weather.
When the man entered the room, he saw a **ホチキス** and several books on the desk.
The old woman told the couple to look in the **ブランコ** area to find the lost dog.

Appendix B

List of sentences with nonsense words in Japanese katakana and English.
The dog was drinking water behind the slandma and the cat was running away.
After the party, two グラリアス and a picture of the Eiffel tower were found.
During the big storm, a lonbust fell from a high building and landed on a car.
If the mayor decides to make バグテイン , he will not be reelected.
The tall woman saw a slooper on her chair and yelled for a policeman.
The fog was heavy in the morning, and I couldn't see the スミンクリ across the river.
When my friend gave me drudents, I said thank you, but secretly, I didn't want them.
When my dad went down to the basement, he found クルアレジ and some pipes.
While traveling in Europe, I lost my glandard and needed to call for help.
Inside a large room, a フラチュア and two paintings were gathering dust.
When the sun came out, the people went to the longlam to fix the problem.
After the dance, the janitor found ポビクリー in the trash can in the corner.

Appendix C

Comprehension questions for the sentences with the Japanese/English cognate pairs.
What did the man find on the desk?
Who was the previous owner of the camera?
Who was old woman speaking with?
Who bought a ticket for the person who wanted to go to the concert?
When did the person need gasoline?
What did the uncle get for Christmas?
Where was the ball?
During what part of the movie does the main character hold the violin above her head?
Why did the family go to the park?
Who might organize a party at a restaurant?
What did the woman ask for?
Where are the old albums?
What kind of things are the people taking to Europe?
What happened to the curtains?
Where was the boy running?
How many pockets, in total, are on the girl's clothing?

Appendix D

Language History Questionnaire	
How old are you?	
When did you begin to learn the Japanese language?	
When did you begin to learn the English language?	
Have you used both Japanese and English continuously since childhood?	
Do you have experience using both Japanese and English in a workplace environment or academic environment? For how long?	
Where did you attend and graduate high school?	
Where did you attend and graduate college?	
At present, how would you rate your English language abilities?	1 – 2 – 3 – 4 – 5 – 6 – 7 1 = I don't speak English well. 7 = My English and Japanese abilities are about the same.

Appendix E

The 5 Practice Sentences
The cat jumped on the ソファー when the dog ran through the room.
After carrying the heavy grallops up the stairs, my back was hurting.
The group walked to the ammotate and each member brought strusts for everyone.
If the プリリト is stronger than yesterday, let's stay at home.
Mark gave his wife a new ドレス for her birthday.