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RESEARCH NOTES

Inter-lingual homograph letter detection in mixed language text: Persistent missing-letter effects and the effect of language switching*

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Heretofore, we learned that bilinguals better detected letters in inter-lingual homographs when the context language ascribed a content role to the homograph as compared to a function role. In previous work the target homographs appeared in passages that were of a single language. The present work investigated whether this letter detection pattern would hold if both languages were activated by intermixing languages in a passage. Results suggested that despite intermixing of languages that would excite competing function and content meanings, local sentence context was sufficient to engender a content over function word advantage for inter-lingual homographs that was reminiscent of that obtained with homogenous text.

In deciphering text, readers are sometimes faced with the task of disambiguating lexical units or pathways (Rayner and Pollatsek, 1989). When encountering ambiguous letter strings such as "lead" (in English) several interpretations are possible; however, the local context in which the word appears can rescue the more appropriate meaning and/or role (Koriat, Greenberg and Goldshmid, 1991; Moravcsik and Healy, 1995; Saint-Aubin and Poirier, 1997; Saint-Aubin, Klein and Roy-Charland, 2003). Homographic ambiguity occurs not only within a language, but across languages sharing the same alphabet. Thus, a word such as "pour" is usually a verb in English and a preposition meaning "for" in French. A phenomenon that rests in good part on the role of letter string in text is the missing-letter effect (MLE). This widely studied effect has repeatedly demonstrated that the ability to detect a letter in a word placed in connected text will be affected, in large part, by the role played by that word in the text, and this effect has been demonstrated for intra-lingual homographs across a wide variety of languages and alphabets including Hebrew (Koriat and Greenberg, 1991), French (Saint-Aubin et al., 2003), and German (Muesseler, Koriat and Nisslein, 2000). Hence, the word "on" acting as an adjective in the context "on switch" produces significantly less detection errors for its letter "n" than does the same word acting as a preposition, e.g., "on my way".

More recently, this same letter detection pattern has been observed for bilingual readers confronting inter-lingual homographs such as the aforementioned "pour". Thus, in a French passage in which "pour" has a structural role as a preposition, it engenders fewer letter detections of a target letter, i.e., "r" than when "pour" appears in an English passage as a verb. The present investigation extended the earlier work by examining inter-lingual letter detection in various passage environments. Here we considered whether differential letter detection patterns for inter-lingual homographs requires that these targets appear in a homogeneous language environment (non-switching), or whether such patterns arise in response to local language context (sentences), although the larger text environment is heterogeneous in which the competing languages unpredictably switch from sentence to sentence (switching). Specifically, when readers were forced to process inter-lingual homographs in passages of mixed languages, does the MLE hold, or does the alternating activation of languages keep both meanings/roles sufficiently activated long enough to quash the MLE?

According to the Bilingual Interactive Activation (BIA) model (Dijkstra and Van Heuven, 1998, 2002) recognition of a target word is affected not only by the target language's entries, but by the non-target language's entries as well (integrated lexicon hypothesis). Dijkstra, Van Heuven and Grainger (1998) postulated an integrated lexicon in which words from both languages are secured. Presumably, then, activated lexical entries from both languages compete and thus for inter-lingual homographs

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both meaning are activated initially (Dijkstra, Van Heuven and Grainger, 1998). However, this "non-selective" activation of lexical alternatives of a homograph can be mediated by experimental circumstances (Dijkstra, 2005). As noted by Altarriba and Gianico (2003), when task demands or linguistic constraints promoted a single meaning, the bilingual lexicon is capable of rapidly suppressing the inappropriate language. Thus, when an inter-lingual homograph is embedded in a passage, the language of that passage including its syntax and semantic attributes should rapidly suppress any early semantic/syntactic activation supported by the competing language.

Given that the MLE responded to the context-determined role of an ambiguous letter sequence, it was assumed that the lexical activation of the target word is largely determined post-lexically and presumably later rather than earlier in word identification. In the present case that involved language switching within a passage, what would happen to the MLE? The predictions we made were based on the assumptions of integrated lexicon and a letter detection process that is largely, although not exclusively, post-lexical (see Greenberg, Healy, Koriat and Kreiner, 2004 for evidence supporting this contention). Assuming that post-lexical processing affects letter detection, it was predicted that even in a mixed language context the more appropriate meaning for the embedded local context should eventually emerge preserving the MLE. However, if it is assumed that language switching raised the activation levels of all lexical entries, both appropriate and inappropriate (see Meuter, 2005), then with both languages relatively active, the MLE would vanish. Moreover, the impact of the alternative language's presence should be particularly encouraged if both languages were used equally often and in a non-predictable manner in a mixed language passage (Chan, Chau and Hoosain, 1983). Thus, the present experiments examined several words, in mixed language passages, that have a function role in one language and a content role in a second language. Bilingual participating readers were familiar with both languages in which these target words appeared. The critical issue was whether the letter detection disadvantage for function words is observed under conditions in which language switching occurs within a text.

Much of that research on inter-lingual homograph processing has studied these items in isolation, i.e., not in the context of connected discourse (see Meuter, 2005). The value of assessing their processing as it relates to MLE is that it advances our understanding of non-specific activation and subsequent suppression of the inappropriate alternative in the more natural setting of connected discourse. Letter detection work while somewhat different from normal reading, since it requires performance of a secondary task, nevertheless requires much of the same processes as normal reading. Healy (1994) has argued why the letter detection task should adequately capture ongoing reading processes, and more recently Greenberg, Inhoff and Weger (2006) as well as Roy-Charland, Saint-Aubin, Klein and Lawrence (2007), comparing eye movement patterns for text processing with and without letter detection, supported Healy's assessment. Greenberg et al. (2006) found that whereas letter detection added time to gazes and reduced word skipping, it did so in an additive fashion. Of particular relevance to the present work, was the finding that the differences in eye movement measures between function and content words, including gaze times, skipping and regressions, during reading remained relatively constant when letter detection was added to reading. This finding suggested that while reading may be slowed by detection, differential analysis of the content and structural elements of text is unaltered, consistent with the notion that letter detection did not alter the processing patterns essential to comprehension.

Greenberg and Saint-Aubin's (2004) work, upon which the present study was based, focussed on the response of bilingual readers to inter-lingual homographs in different homogeneous language passages, either French or English. In the first experiment, target inter-lingual homographs "pour" and "or" generated more errors in the language context in which they were function words supporting text structure than when they had content roles ("or" can mean "gold" in French). English monolinguals showed no such switching pattern with "or", consistently generating higher error rates for "or" than "pour" regardless of language. Clearly, for monolinguals the language of the text (understood or not) was less relevant. The monolingual response indicated that the different letter detection patterns found for bilinguals across different language texts was not an artefact of the passage manipulation. In addition, the first experiment demonstrated that language fluency has an impact on letter detection in inter-lingual homographs. English-dominant bilinguals made more errors on "or" in English text than did French-dominant bilinguals. This latter result was consistent with a non-selective model of bilingual representation, since the relative activations of the two meanings in response to readers' fluency was consistent with the notion that although both languages are potentially activated the resting levels for the respective languages is determined by fluency (see Dijkstra and Van Heuven, 1998).

In a second experiment in that study, the new outcome was that the scrambling of a formerly coherent French text vastly reduced the function word disadvantage of "pour" for French dominant bilinguals relative to its disadvantage in a normal text. This finding reinforced the notion that the MLE for inter- as well as intra-lingual homographs is in large measure routed in syntactic/semantic role of the word in text. The final experiment further supported that understanding by systematically holding frequency constant across sets of target words and still showed that detection patterns depended upon word role, although

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certain comparisons also revealed a contribution of frequency to the MLE.

As noted earlier the present study took the examination of inter-lingual homographs in a letter detection task a step further by considering whether the MLE can survive language switching. Research generally suggested that there is some measurable cost to a bilingual when switching from one to another language (Kolers, 1966; Dalyrymple-Alford, 1967, 1985; Macnamara, Krauthammer and Bolgar, 1968; Clyne, 1980). Although, subject to some methodological criticism (see Grossjean, 1997; Meuter, 2005), it is generally acknowledged that reading or conversing with two languages takes more time than doing so with one (Meuter, 2005).

Responding to two languages, however, can be as efficient as handling one when the situational clues allowed readers or listeners to anticipate language change, and under such conditions bilingual responses may not even differ from that of monolinguals. In Macnamara et al., overall bilinguals read intermixed lists more slowly than lists in a single language, but much less so when the intermixing occurred in a predictable rather than random fashion. Chan et al. (1983) found that Chinese–English bilinguals read entire Chinese passages equivalently fast to passages where naturally occurring English words were inserted. However, inserting random English words slowed reading. Amrhein (1999) also showed that even when bilinguals need not use a second language in picture–word translation task, their responses are slower when picture and word stimuli are intermixed than are the responses of monolinguals. Amrhein indicated that the mixing of stimuli (with pictures) apparently created uncertainty that prevented suppression of the alternative symbolic system. Meuter (2005, p. 362) observed that "when in an almost exclusively monolingual setting (strikingly, even when the situation is confined to a block of trials embedded in a bilingual experimental setting), the other language does not appear to affect the selection process. The default value is to set generalized activation for the predominantly required language *for that block only*" [emphasis in the original – SNG&JSA].

In totality, the evidence would appear to suggest that letter detection for inter-lingual homographs embedded in mixed language passages could have been compromised. However, if switching occurs across sentence boundaries, this local context could provide sufficient constraint (given that the sentence is a stand alone semantic/syntactic unit) to suppress the influence of the other language, thereby encouraging a MLE for inter-lingual homographs. Random mixing of sentences in a passage, though, could have delayed inhibition of the second language, particularly when sentence languages alternate. Thus, despite the linguistic integrity of each sentence, generalized activation of a single language ought to be somewhat compromised at a sentence level when the greater context, in this case a passage, keeps refreshing the activity of both languages. The question remains open as to whether suppression of an inter-lingual homograph's language inappropriate meaning will remain sufficiently active in a mixed passage so as to compromise the inter-lingual homograph MLE.

Two experiments were conducted to assess the impact on letter detection for inter-lingual homographs of mixing text in an unpredictable manner within the same passage. The first experiment examined the effect for two inter-lingual homographs, *son* and *on*, for which sentence roles change across language contexts, English and French. A comparison was made between subjects who were familiar with both languages in which the target words appeared, and for those who understood these words in only one context, English. A second experiment evaluated the pattern observed with bilinguals for two additional inter-lingual homographs to determine whether the pattern observed in the first experiment generalized across inter-lingual homographs. Moreover, in the second experiment the inter-lingual (French/English) homograph *pour* was evaluated so it could be compared directly to patterns obtained with *pour* in an earlier study (Greenberg and Saint-Aubin, 2004) in which *pour* was embedded in French-only and English-only passages. The samples used in both the present and the earlier study were drawn from the same participant population so a comparison could be fairly made.

Experiment 1

Method

Participants

Thirty native-English speakers from Union College (24 women and 6 men) composed the monolingual group and 36 native-French speakers from Université de Moncton (23 women and 13 men) composed the bilingual group. Monolingual participants were recruited from a subset of students that had no familiarity (either reading or speaking) with the French language. The bilingual participants indicated in a survey question that they were native-French speakers and that French was used at home. Nevertheless, all bilingual participants scored with a percentile rank of 50 or higher (mean = 85) on the comprehension scale of the Nelson-Denny Reading Test (form G) with norms for ninth graders indicating good English reading skills.

Materials and design

Two prose passages were written. The *on* text comprised 1,450 words and included 40 occurrences of the critical homograph *on*. Twenty occurrences of the homograph *on* were embedded in French sentences and 20 were embedded in English sentences. In English, *on* assumes a function role and has a frequency count of 6,742 occurrences per million (Kučera and Francis, 1967),

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whereas in French, *on* assumes a content role as a third person singular personal pronoun with a frequency count of 5,306 occurrences per million (Baudot, 1992).

In the other prose passage, comprising 1,401 words, 20 occurrences of the homograph *son* were embedded in English sentences and 20 were embedded in French sentences. In English, *son* assumes a content role and has a frequency count of 166 occurrences per million (Kučera and Francis, 1967), whereas in French, *son* can assume either a content role as a noun meaning sound with a frequency count of 71 occurrences per million for this usage or a function role as a possessive adjective with a frequency count of 10,127 occurrences per million (Baudot, 1992). In the text used here, *son* in French was always used as a function word.

For text construction, the following rules were applied to both prose passages. Overall, the prose passage constituted a coherent story. The French and the English sentences alternated in a non-systematic way, but with the constraint that every 12 sentences, there were an equal number of French and English sentences. In addition, in each block of 12 sentences, there were 8 filler sentences with no homograph, and 2 English and 2 French sentences with the homograph. Consequently, for each text, overall there were 60 French and 60 English sentences. In addition, there was never more than one occurrence of the homograph per sentence, the homographs were never at the beginning or the end of a sentence or a line, and they were never adjacent to a punctuation mark. The homographs were also never preceded or followed by a word with the target letter *n*. Finally, there were 120 and 121 occurrences of the target letter *n* in non-critical words in the *on* and the *son* text respectively.

A 2 × 2 mixed-design was used with group based on bilingualism status as the between-participants factor and prose passage was the within-participant factor. Presentation order of the two texts was completely counterbalanced across participants with half the monolingual and half the bilingual participants reading the *on* passage first and the remaining half of each group beginning with the *son* passage.

Bilingual participants were also administered the comprehension scale of the Nelson-Denny reading test (form G) (Brown, Fishco and Hanna, 1993). The comprehension scale consists of seven prose passages and 38 multiple-choice questions. The extended-time administration procedure was used. Accordingly, participants were given 32 minutes to read the passages and answer the questions.

Procedure

Participants took part individually in a private room in one session lasting approximately one hour for bilingual participants and 20 minutes for monolinguals. All participants undertook the letter search task first. For the letter search task, participants received a stapled packet with an instruction sheet on the top. The instructions were printed in French for the bilingual group and in English for the monolingual group. The instructions encouraged the participants to read the text for comprehension at their normal reading speed. As it is usually done in missing-letter effect studies, to promote reading for comprehension, participants were informed that after each text, they would have to answer three multiple-choice comprehension questions about the text. Questions simply test knowledge of simple facts well described in the text and there were three alternative choices for answers. Participants were further instructed that whenever they came across an *n* (either in lower- or uppercase) they were to circle it. They were warned not to slow down their reading speed to detect all the *n*s, and not to backtrack to circle an *n* that they had missed. They were informed that some sentences were in French and others in English. The English monolingual participants were further told that even if they did not know any French, they should attempt to read for meaning. After reading the first text, and answering the comprehension questions about it on the next page, the second text was presented in the stapled packet followed by a page with three comprehension questions about it. Participants read silently the instruction sheet and the experimenter answered all their questions. For the bilingual group, the Nelson-Denny comprehension scale was then administered.

Results

Results are organized in two sections. First, performance on the comprehension questions is presented. Second, the omission data are presented as a function of group based on bilingualism status, sentence language and prose passage (*on* vs. *son* text).

Analysis of response accuracy to comprehension questions

In missing-letter effect studies, accuracy data for answered questions are usually not analyzed because their psychometric properties are not documented. However, although the questions were not developed to achieve a fine grain assessment of reading performance, they can provide useful information about the reading comprehension of the two groups based on bilingualism status. In fact, in previous studies with children learning to read, similar questions were successfully used as reading ability indices and results showed that the size of the missing-letter effect varied accordingly (see, e.g., Drewnowski, 1981; Saint-Aubin, Klein and Landry, 2005). As can be seen in Table 1, bilingual participants were more accurate than unilingual participants. In addition, both groups of participants were more accurate on the *on* text than on the *son* text, but the advantage of the bilingual group was of about the same magnitude for both texts. A 2 × 2 mixed-design ANOVA, with group as the between-participants factor, and text

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Table 1. *Means (M) and Standard Deviations (SD) for percentage of correct answers to the three comprehension questions as a function of text and language group.*

	Group			
	Bilinguals		Monolinguals	
Text	M	SD	M	SD
on	98	7.74	72	23.29
son	84	20.29	65	25.49

as the repeated factor, confirmed those trends. In all analyses, the .05 level of significance was adopted. There were significant main effects of group, $F(1,64) = 33.26$, $MSE = 489.92$ and text, $F(1,64) = 11.23$, $MSE = 308.59$, but the interaction did not reach significance, $F = 1.38$.

Omission data

Mean percentages of omission errors for target letter *n* embedded in the homographs *on* and *son* are presented in Table 2 as a function of sentence language, group based on bilingualism status, and target text (*on* vs. *son* text). These percentages were computed for each participant and each condition by dividing the number of omissions by the number of occurrences and then by multiplying the result by 100. Inspection of Table 2 reveals that bilingual participants made more omissions on the function role of *son* (French) than on its content role (English). Although of smaller magnitude, a similar pattern of results was observed for *on* with more omissions for its function role (English) than for its content role (French). For monolinguals, the pattern of results is different: They always made more omissions on the French sentences than on the English sentences. Most importantly, for both English and French sentences, monolinguals always showed the usual missing-letter effect from an English perspective. Specifically, more omissions are made when the target letter is embedded in *on* which is a function word in English than in so*n* which is a content word in English, regardless of local context, i.e., English or French.

Omissions were analysed separately for monolingual and bilingual participants. For bilingual participants, a 2×2 repeated measures ANOVA with text (*on* vs. *son*) and sentence language as factors revealed a significant effect of sentence language, $F(1,35) = 12.43$, $MSE = 64.56$, and of the interaction, $F(1,35) = 23.55$, $MSE = 113.37$, but the main effect of text did not reach significance, $F < 1$. The interaction was further explored with simple main effect tests that revealed significantly more omissions for the target letter *n* when *on* assumed a function (English) than a content (French) role, $F(1,70) = 11.38$, $MSE = 88.97$. The same pattern of role influence was observed for the *son* text with more omissions of the target letter *n* in *son* when it assumed a function (French) rather than a content (English) role, $F(1,70) = 19.12$, $MSE = 88.97$. For the English monolingual participants, the 2×2 repeated measures ANOVA with text (*on* vs. *son*) and sentence language as factors revealed that there were significantly more omissions on the French than the English sentences, $F(1,29) = 22.43$, $MSE = 231.87$, and for *on* than for *son* regardless of context, $F(1,29) = 40.39$, $MSE = 364.97$, but the interaction did not reach significance, $F < 1$. Thus, irrespective of the sentence language, monolingual participants always made more omissions when the target letter was embedded in *on* than in *son*.

Experiment 2

Results of Experiment 1 clearly established that it is possible to observe a MLE inter-lingual homograph effect when language switching occurs randomly across sentences. Given the theoretical importance of this finding, it warranted replication. The need for replication is further emphasised by previous findings in the MLE field revealing that some words such as *the* in English sometimes produced a unique pattern of results that did not generalize in a straightforward manned to other words (e.g., Koriat and Greenberg, 1993). In addition, the MLE has been shown to vary with target letter and its position (e.g., Schneider and Healy, 1993; Saint-Aubin and Poirier, 1997; Assink

Table 2. *Means and Standard Deviations in parentheses for percentage of omission errors as a function of target word, sentence language, language of the preceding sentence, and language group.*

	Text			
	on		son	
Group	English [Function role]	French [Content role]	English [Content role]	French [Function role]
Bilinguals	15.14 (13.96)	11.25 (15.23)	7.64 (13.01)	20.97 (22.35)
Monolinguals English	38.33 (24.58)	52.67 (30.31)	17.33 (13.75)	29.33 (20.92)

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and Knuijt, 2000). Consequently, it was important to determine whether the effect would stand up with new homographs and new target letters. Consequently, two new homographs were used (*an* and *pour*), with two new target letters (*a* and *r*) and target letter position within those words varied by being the first for *an* and the last for *pour*.

The second aim of Experiment 2 was to directly investigate the effect of varying the sentence language at random on the size of the MLE inter-lingual homograph effect. The inter-lingual homograph *pour* was introduced to address this issue. The homograph *pour* was selected because it was used previously by Greenberg and Saint-Aubin (2004) for assessing the MLE for inter-lingual homograph in homogeneous language passages. All critical methodological elements of Greenberg and Saint-Aubin's second experiment were the same as those implemented here. Consequently, if there was some cost for switching from one to another language, the size of the MLE should be smaller than what was reported by Greenberg and Saint-Aubin. However, if responding to two languages can be as efficient as handling one, then the size of the MLE should be the same as that observed by Greenberg and Saint-Aubin for the same homograph.

Method

Participants

Thirty native-French speakers from Université de Moncton (23 women and 7 men) volunteered to participate in the experiment. Participants indicated in a survey question that they were native-French speakers and that French was used at home. Nevertheless, all participants scored with a percentile rank of 50 or higher (mean = 82) on the comprehension scale of the Nelson-Denny Reading Test (form G) with norms for ninth graders indicating good English reading skills.

Materials, design and procedure

Two new prose passages were written. The *an* text comprised 1,984 words and included 40 occurrences of the critical homograph *an*. Twenty occurrences of the homograph *an* were embedded in French sentences and 20 were embedded in English sentences. In English, *an* assumes a function role and has a frequency count of 3,747 occurrences per million (Kučera and Francis, 1967), whereas in French, *an* assumes a content role as a noun meaning *year* with a frequency count of 1,171 occurrences per million (Baudot, 1992). There were also 680 occurrences of the target letter *a* in non-critical words. In the other prose passage comprising 1,779 words, 20 occurrences of the homograph *pour* were embedded in English sentences and 20 were embedded in French sentences. In English, *pour* assumes a content role and has a frequency count of 9 occurrences per million (Kučera and Francis, 1967), whereas in French, *pour* assumes function role as a preposition meaning *for* with a frequency count of 7,982 occurrences per million (Baudot, 1992). There were also 442 occurrences of the target letter *r* in non-critical words.

Table 3. *Means (M) and Standard Deviations (SD) for percentage of omission errors as a function of target word and sentence language.*

	Text			
	an		pour	
Role	M	SD	M	SD
Function	18.33	19.17	48.00	24.55
Content	5.17	6.09	19.00	19.04

Presentation order of the two texts was completely counterbalanced across participants with half participants reading the *an* passage first and the remaining half beginning with the *pour* passage. All other aspects of the procedure were the same as those used for the bilingual group in Experiment 1.

Results

Comprehension questions were well answered with an average proportion of correct answer of 87% for both texts. Mean percentages of omission errors for target letter *a* embedded in the homographs *an* and for the target letter *r* embedded in the homograph *pour* are presented in Table 3 as a function of sentence language and target text (*an* vs. *pour* text). Inspection of Table 3 revealed that overall participants made more omissions on the function role of *an* (English) than on its content role (French), and on the function role of *pour* (French) than on its content role (English). A 2 × 2 repeated measures ANOVA with text (*an* vs. *pour*) and sentence language as factors revealed a significant effect of sentence language, $F(1,29) = 15.74$, $MSE = 119.43$, of text, $F(1,29) = 60.07$, $MSE = 236.27$, and as predicted of the interaction, $F(1,29) = 70.85$, $MSE = 188.23$. The interaction was further explored with simple main effect tests that showed significantly more omissions for the target letter *a* when *an* assumed a function (English) than a content (French) role, $F(1,58) = 16.90$, $MSE = 153.83$. The same pattern of role influence was observed for the *pour* text with more omissions of the target letter *r* in *pour* when it assumed a function (French) rather than a content (English) role, $F(1,58) = 82.01$, $MSE = 153.83$.

An additional analysis was computed to compare the size of the inter-lingual homograph effect observed here with *pour* when language changed at random across

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sentences with the pattern reported by Greenberg and Saint-Aubin (2004) with homogeneous language passages. To this end, data of Greenberg and Saint-Aubin's bilingual group reading the text displayed normally in Experiment 2 was used here for the comparison. Greenberg and Saint-Aubin's bilingual group was composed of 24 students from Université de Moncton and they had a mean percentile rank of 83 on the comprehension scale of the Nelson-Denny Reading Test which was very similar to the mean of the current sample's 82 on the same test. The text used by Greenberg and Saint-Aubin was also very similar to the current one except that they were homogeneous language passages with one passage in English and one in French. There were 8 instances of *pour* in each language. The mean omission rate for the target letter *r* embedded in *pour* was 26.56% for the French normal prose passage and 15.10% for the English normal prose passage. A 2×2 mixed-design ANOVA with text as the between-participants factor (homogeneous prose passages used by Greenberg and Saint-Aubin vs. current text) and language (English vs. French) as the repeated-measure factor was computed. Results revealed a significant main effect of text, $F(1, 52) = 6.17$, $MSE = 692.92$, with more omissions in the current text than in the 2004 prose passages, of language, $F(1,52) = 48.52$, $MSE = 225.90$, with as predicted more omissions for the French function word usage than for the English content word usage, and a significant interaction, $F(1,52) = 9.08$, $MSE = 225.90$. The interaction reflected that the MLE inter-lingual homograph effect in the current study was actually larger than that observed in the 2004 study in which homogeneous language passages were used. Simple main effect tests revealed that the effect of language was indeed significant for both Greenberg and Saint-Aubin's sample, $F(1,52) = 6.97$, $MSE = 225.90$, and the current sample, $F(1,52) = 55.84$, $MSE = 225.90$, however. In addition, there were significantly more omissions in the current sample for the French function usage of *pour* than in Greenberg and Saint-Aubin's sample with respectively 48.00% and 26.56% of omissions, $F(1,104) = 13.34$, $MSE = 459.41$, but there was no difference for the English content word usage of *pour*, $F < 1$.

Discussion

Experiment 2 provided strong support for the generalizability of an inter-lingual homograph MLE in the context of mixed passages. Importantly, a comparison of the present study's *pour* target with the same target in homogeneous passages (Greenberg and Saint-Aubin, 2004) showed that even against a homogeneous baseline, intermixing of languages did not moderate the impact of different lexical roles for this homograph. Thus, at least for this target it was clear that language switching did not make the late selection of the homograph's appropriate interpretation less efficient. In fact, somewhat surprisingly, the pattern with the mixed passage was apparently stronger than with homogeneous passages. Nevertheless, it is important to note that the MLE was still significant in the homogeneous context of the earlier study.

The somewhat stronger effect in the intermixed context might have captured a more active attempt on the part of readers to suppress the alternative inappropriate meaning. Assuming, as we have, based on a variety of patterns observed in the earlier work (see Greenberg and Saint-Aubin, 2004), that letter detection reflects a relatively late post-lexical selection process, this more pronounced difference may not be that surprising. Specifically, routine switching within a passage may not only have raised activation levels of both languages more so than in homogeneous text, but also served as cue to actively suppress the inappropriate language's lexical entry. In homogeneous passages, readers may have been less conscious of the alternative activated meaning of the inter-lingual homograph, and thus no conscious effort was made to inhibit that meaning (although unconsciously this was clearly the case), and thus processing proceeded until a relatively late point when the heretofore activated alternative entry fell below threshold (e.g., Dijkstra, 2005). We speculated that with mixed passages the repeated cueing of competing languages engaged readers in a somewhat more strategic attempt at suppression. Together with the less conscious inhibition, the strategic process led to a cumulative and more efficient suppression of the alternative meaning than had been observed with *pour* in homogeneous passages. Indeed, lexical activation effects appeared more robust in lexical decision tasks that allow for conscious expectations to help guide strategic processing (Neely, 1977). Again, according to this hypothesis, it is assumed that the alternating use of languages either reminded the reader of the competition, or perhaps informed the lexicon (maybe unconsciously) that competitive meanings were possible.

Conclusions

The present findings elaborated on the results of Greenberg and Saint-Aubin (2004). Again it was observed that suppression of a competing language's inappropriate meaning occurs rapidly, although post-lexically, in a letter detection task performed while reading. The inter-lingual MLE obtained for bilinguals was not found for monolingual subjects in Experiment 1, indicating that the bilingual response pattern was not a result of the peculiarities of target word placement, but rather issued from the bilingual's dual familiarity with inter-lingual representations of these target homographs. Recent work by Greenberg, Inhoff and Weger (2006) demonstrated that although letter detection slows reading, it does not alter the normal pattern of processing differences between function words supporting text structure and content words filling out meaning (see also Roy-Charland et al.,

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2007; Saint-Aubin and Klein, 2001). Experiment 2 produced a nearly identical set of data for different letters, words and target positions. Presumably, then, the patterns that emerged here capture the changes in processing of inter-lingual homographs as a function of their changing roles across different languages when reading. Taken together, it appeared that the inter-lingual MLE is robust in the context of mixed passages suggesting that local context arouses late selection of an appropriate target in the face of competing language activation.

Importantly, single sentences were sufficient to move the suppression process along efficiently enough to produce an appropriate interpretation. The task as explained in our earlier work is most likely tapping into relative late post-lexical activation (Greenberg and Saint-Aubin, 2004) and thus the present findings furthered the notion of a non-selective processing of language by bilinguals (Dijkstra and Van Heuven, 1998, 2002).

The pattern of letter detection in a homogeneous passage suggested that both meanings were initially available, but also that the inappropriate alternative is efficiently eliminated (Greenberg and Saint-Aubin, 2004). Current results revealed that this process survived the language intermixing manipulation and was even stronger than what was found with homogeneous texts. Whereas, the impact of mixing languages has been widely demonstrated in reaction time studies involving naming of concepts (e.g., Meuter and Allport, 1999), those studies that involved reading sentences (e.g., Clyne, 1980) failed to capture the impact of switching on the processing of individual words (Meuter, 2005). Here, though, we had the opportunity to test whether frequent language switching, at sentence junctures, affected the process of sorting out the correct meaning and role. Apparently, switching languages by itself did not significantly compromise late suppression, since the MLE in a broad sense survived the mixed language presentations.

In Meuter and Allport's work, it was found that responses in the same language sped up with successive responses with that language, and while a switch cost emerged immediately following a language switch, it did not persist past initial words. Perhaps, had the target words here not been embedded in the middle of sentences, but instead appeared at the beginning of the sentences, the MLE might have dissolved. However, in this study participants processed conceptually connected sentences instead of random word sequences (see Meuter and Allport, 1999), and the connected text with distinct meaning units might modify the impact that the language switch point has on the words that immediately follow the switch. Finally, it is worth recalling that as suggested by some earlier studies, the impact of language switching could be dampened when language switching is more systematic and hence predictable (Macnamara et al., 1968; Chan et al., 1983), but here language order was unpredictable.

In sum, the inter-lingual homograph MLE can survive language switching within a cohesive passage. Moreover, comparison with earlier work indicated that there might be some strategic control of the late suppression process that also underlies the inter-lingual MLE.

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