JSEB

Journal of Social and Ecological Boundaries

Journal of Social and Ecological Boundaries
Summer/Fall, 2006(2.1) 38-67.

ISSN 1551-9880

Asymmetry in Impact of Phonological Overlap on Native and Non-Native Word Recognition

Olga Boukrina
Communications Sciences and Disorders
Northwestern University

Viorica Marian
Communications Sciences and Disorders
Northwestern University

Modern accounts of bilingual representation and processing suggest that the two lexicons of a bilingual are integrated. Parallel activation of first and second languages is supported by empirical data from both the auditory (e.g., Blumenfeld & Marian, 2005; Marian & Spivey, 2003a; Marian & Spivey, 2003b; Spivey & Marian, 1999; Sculpen, Dijkstra, Schriefers & Hasper, 2003; Van Wijnendaele & Brysbaert, 2002) and the visual modalities (e.g., Costa, Miozzo, & Caramazza, 1999), as well as from simulations of cross-language competition with computational models (e.g., Dijkstra, van Heuven, & Grainger, 1998). Generally speaking, whenever characteristics of a non-target language are found to impact target language activation, such as by yielding facilitatory or inhibitory effects in word recognition, this is taken to support an integrated account of bilingual language processing and organization. The degree of activation of the non-target lexicon may vary as a function of language dominance as well as other factors (e.g., modality of presentation, similarity of sensory input in the target language to phonology or orthography of the non-target language, etc.).

In the visual modality, both non-target language phonology and non-target language orthography have been found to impact target language processing. For phonology, masked phonological priming revealed interlingual homophone priming effects from both the native language to the non-native language, and from the non-native language to the native language (e.g., Brysbaert, Van Dyck, & Van de Poel, 1999; Van Wijnendaele & Brysbaert, 2002). The magnitude of interlingual priming was comparable to the magnitude of priming within a single language. For orthography, interference effects were found to be influenced by cross-linguistic word frequency and interlingual orthographic density (the number of words with similar orthography that differed by a single grapheme). In a lexical decision task, Bijeljac-Babic, Biardeau, and Grainger (1997) found that orthographically-related high-frequency primes in the non-target language inhibited processing in the target language and the effect was greater for bilinguals who were highly proficient in the non-native language. Similarly, Van Heuven, Dijkstra, and Grainger (1998) found that words with more orthographic neighbors in the native language slowed responses to target words in the non-native language. In addition to language recognition, orthographic input from the non-target language was also found to impact bilingual language *production*. Hermans, Bongaerts, De Bot, and Schreuder (1998) used a picture-word interference task and found that bilinguals could not suppress native-language lexical information when naming pictures in a non-native language.

In the auditory modality, spoken word recognition was also found to be influenced by phonological and orthographic overlap, as demonstrated by priming effects (e.g., Slowiaczek, Soltano, Wieting, & Bishop, 2003). However, parallel activation occurs more reliably with high-proficiency non-target languages than with low-proficiency non-target languages (Jared & Kroll, 2001; Silverberg & Samuel, 2004; Van Hell & Dijkstra, 2002; Weber & Cutler, 2004). For example, while findings of parallel first-language (L1) activation during second-language (L2) processing have been consistent (Blumenfeld & Marian, 2005, Marian & Spivey, 2003a; Marian & Spivey, 2003b; Weber & Cutler, 2004; Weber & Paris, 2004), findings of parallel L2 activation during L1 processing have been mixed (Ju & Luce, 2004; Marian & Spivey, 2003b; Weber & Cutler, 2004). Marian and Spivey (2003a) tested a group of Russian-English bilinguals when Russian was the non-target language and when English was the non-target language. They found co-activation of the non-target language, both when it was the L1 and when it was the L2. In contrast, Weber and Cutler (2004) tested a group of Dutch-English bilinguals when Dutch was the target language and when English was the target language, and found co-activation of the non-target language when it was the L1, but not when it was the L2. One explanation for this discrepancy lies in the different levels of second-language proficiency and experience across the two participant groups, with higher L2 proficiency levels in the Russian-English bilinguals than in the Dutch-English bilinguals. The language experience of Russian-English bilinguals living in a country where their L2 was the common language differed from the language experience of Dutch-English bilinguals living in a country where their L1 was the common language. It is possible that the Russian-English bilinguals engaged in code-switching more often than the Dutch-English bilinguals (see Grosjean, 1997). As a result, the relative level of activation for both languages could have been greater for Russian-English bilinguals than for Dutch-English bilinguals. Another possible explanation for the differences in L2 activation across studies lies in the degree to which L2 phonemic characteristics match those of the L1. For instance, in a study with Spanish-English bilinguals, Ju and Luce (2004) demonstrated that participants fixated interlingual distractors more frequently than control distractors when voice onset time in Spanish auditory stimuli matched the voice onset times appropriate for English. Thus, co-activation of L2 may be amplified by matching L1 and L2 phonemic characteristics. This suggests that, although a lower-proficiency language may not be co-activated consistently, it can be boosted to show activation. In sum, across studies, bilinguals appear more likely to co-activate a non-target language when this language is more proficient. In contrast, low non-target language proficiency may result in lower activation levels, and reduce the likelihood of its co-activation, when performing a task in a more proficient language.

Different patterns of co-activation observed for auditory processing in L1 and L2 suggest that cross-talk between languages is influenced by native language status. This may be the case because proficiency is usually greater in the first language than in the second language, or as a result of differences in age of acquisition (e.g., Jared & Kroll, 2001; Gerard & Scarborough, 1989). The asymmetry between the first and second languages can be observed not only in auditory word recognition, but also in visual word recognition. For example, Silverberg and Samuel (2004) showed that highly proficient late bilinguals exhibited negative effects of form priming (priming with phonologically and orthographically similar words) from L1 into L2, while late bilinguals with lower levels of L2 proficiency showed no effect of form priming. Similarly, Van Hell and Dijkstra (2002) found that Dutch-English-French trilinguals responded faster in a L1 lexical decision task when the stimuli were cognates with their more proficient L2, but not when the stimuli were cognates with their less proficient L3. Together, these results suggest that as the level of proficiency changes, so does the pattern of first and second language interaction.

This dynamic nature of bilingualism is captured particularly well in Kroll and Stewart's Revised Hierarchical Model (1994). According to the Revised Hierarchical Model, bilinguals' proficiency and manner of acquisition influence first and second language processing and underlying representational mechanisms. During initial stages of second language acquisition, L2 words are connected to L1 words via lexical links, and L1 words are in turn connected to semantic information. It is presupposed that at early stages of second language learning, L2 words are not linked directly to conceptual representations. However, as bilinguals continue to learn the second language and their proficiency level increases, L2 words begin to form direct links to conceptual representations. At later stages of acquisition, L2 words have established connections with conceptual information, but the links between L2 and L1 at the lexical level are preserved and may still be relied upon when processing in a highly-proficient second language. The Revised Hierarchical Model proposes that the strength of various connections is not the same, with conceptual representations linked stronger to L1 lexical representations than to L2 lexical representations. At the lexical level, the path from L2 to L1 is stronger than the path from L1 to L2. Kroll and Stewart's model provided the means for explaining phenomena observed with bilingual participants, such as the asymmetry in translation speed from L2 to L1 and from L1 to L2. For example, the Revised Hierarchical Model would suggest slower forward translation from L1 to L2, due to concept activation, and faster backward translation from L2 to L1 due to form-to-form mapping. Empirical studies involving bilingual translation report precisely these patterns (e.g., Jiang & Forster, 2001; Fox, 1996; Sholl, Sankaranarayan, & Kroll, 1995; Kroll & Stewart, 1994) across multiple methodological paradigms such as picture naming, word naming, word translation and category naming (e.g., Chen, Cheung, & Lau, 1997). Although some studies did not find the asymmetries predicted by the Revised Hierarchical Model (e.g., De Groot & Nas, 1991; Sanchez-Casas, Davis, & Garcia-Albea, 1992), these inconsistencies are likely due to methodological variations across experiments (such as selection of stimuli and consistency of letter-to-sound mappings) testing different types of representation and processing and targeting different populations (for a discussion of the effect of methodological variability on study results, see Francis, 1999; Grosjean, 1997; Marian, in press).

While the exact mechanisms underlying the asymmetry between first and second language processing remain unclear, one possible explanation relies on bilinguals' lack of fine-grained distinctions in non-native phonological representations. Research with non-native listeners suggests that auditory word recognition is more difficult in the second language than in the first language (e.g., Bradlow & Bent, 2002). The ease of phonological processing may vary with proficiency, similarly to lexical processing (Kroll & Stewart, 1994). Initially, L1 phonological representations may be organized as tightly constrained categories of sounds and include phonological representations for similar L2 categories. For instance, Best (1995) suggested that some L2 phonemes can be perceptually assimilated to L1 phonetic categories, based on commonalities in the place and manner of articulation and voicing. The assimilation may happen in one of three ways: a non-native phoneme may be included as a categorized exemplar of a native phoneme, an uncategorized exemplar that falls somewhere in between native phonemes, or a *nonassimilable* non-speech sound that bears no resemblance to any native phonemes. In support of this view, empirical evidence shows poor discrimination of L2 phonemes similar to a common L1 category, as compared to L2 phonemes that do not bear resemblance to an L1 category (Best, 1995). However, phonological representations in the second language may become more fine-grained with increased L2 word learning and exposure (e.g., Imai, Walley, & Flege, 2005). In other words, sensitivity to cross-linguistic phonological overlap is asymmetric between first and second language-processing due, at least partially, to differences in phonological representations across the two languages, with lower phonological competence in the second language than in the first language. In addition to phonological competence, other plausible explanations for the asymmetry observed in first and second language processing may rely on differences in lexical organization, age of acquisition, and history of language use (e.g., Zevin & Seidenberg, 2002; Grosjean, 1997). For example, monolingual interlocutors and language settings influence a bilingual's language choice by increasing the use of one language and decreasing its threshold of activation (Jared & Kroll, 2001; Spivey & Marian, 1999; Grosjean, 1997). As a result, the language used more frequently long-term may become dominant and more readily available for processing, and this variability in individual history of language use may contribute to bilinguals' asymmetry in word recognition across languages.

The objective of the present study was to examine the role of cross-linguistic phonological overlap during first and second language processing in the auditory domain. The study was modeled after a visual language processing experiment by Jared and Kroll (2001). Jared and Kroll tested activation of phonological representations in bilinguals' two languages when reading stimuli with overlapping graphemic form and examined the role of proficiency and language context on parallel activation of bilingual lexicons. English-French and French-English bilinguals read out loud English words that had no 'enemies' (i.e. words with the same graphemes), but different phonemic realization, English words that had English enemies, and English words that had French enemies. Stimuli with English enemies were words containing letter clusters for which pronunciation varied from case to case, like *head* and *bead*. Stimuli with French enemies consisted of words that had letter clusters found in both English and French, but pronounced differently in each language (e.g., BAIT and LAIT). The stimuli were presented in three phases: an English-words phase, followed by a French-words phase, and finally another English-words phase. The purpose of the French phase was to activate participants' French spelling-to-sound correspondences and measure the influence of French context on accuracy and response latencies. Results varied depending on whether bilinguals were processing words in their first or their second language. French-English bilinguals activated French spelling-to-sound correspondences while reading in English, as indicated by increased error rates and slower naming latencies for words with French enemies than for words with no enemies. During the first English phase, English-French bilinguals did not activate French spelling-to-sound correspondences, even if they were fluent in French. However, after completing the French phase of the experiment, knowledge of French spelling-to-sound correspondences was activated in the second English phase.

Similar to Jared and Kroll (2001), the present study tested the effect of cross-linguistic overlap on first and second language processing and examined the role of language context on parallel activation of bilingual lexicons. The design of the study followed that of Jared and Kroll and included three language phases. Alternating between languages across the three phases (second language, followed by first language, followed by second language) made it possible to examine the costs of switching language contexts and of varying baselines of activation during word recognition. If there were any costs associated with switching the language of the task to the participant's native language, these costs would be evident in the response pattern during the second non-native phase of the experiment. The differences between the two studies were in (1) the modality of processing, and (2) ways in which input was varied. First, while Jared and Kroll targeted visual word recognition and manipulated orthographic overlap, the present study targeted auditory word recognition and manipulated phonological overlap. Phonological overlap was defined by the presence of phonemes shared across native and non-native languages. In order to manipulate phonological overlap, phonemes in each language were divided into unique and non-unique, or shared. Uniqueness was established by comparing corresponding phonemes in L1 and L2 on their phonological characteristics. Second, while Jared and Kroll (2001) used words with no enemies, words with enemies in the same language, and words with enemies in the other language, the present study used words that did not overlap phonologically, words that overlapped phonologically for one-third of auditory input, words that overlapped phonologically for two-thirds of auditory input, and words that overlapped phonologically completely. Using four levels of overlap made it possible to manipulate phonological overlap in a gradual manner and perform a more fine-grained analysis of the impact of phonology on bilingual spoken word recognition. The direction and consistency of effects across different degrees of overlap were investigated.

To test the extent to which bilinguals activated phonological representations of both languages simultaneously, Russian-English bilinguals were presented with word and non-word stimuli in an auditory lexical decision task. Participants' response times and accuracy rates were measured. It was predicted that if phonology and relevant lexical representations of native and non-native languages were activated and accessed simultaneously whenever one of the languages was activated, then response latencies and accuracy rates for auditory stimuli that overlapped phonologically across languages would show either facilitation or interference effects. Moreover, the role of phonological overlap was predicted to vary across first and second languages. Specifically, overlap with a more proficient language was predicted to influence performance in a less proficient language more than overlap with a less proficient language would influence performance in a more proficient language. Results were interpreted within the context of the Revised Hierarchical Model (Kroll & Stewart, 1994), extended to accommodate phonological representations.

Method

Participants. Twenty-six Russian-English bilinguals, 15 females and 11 males, participated in the study. Their mean age at the time of testing was 22.12 years ($SD = 6.26$). Participants were students at an American university and had lived in the US for an average of 12.65 years ($SD = 9.16$). They had known English for an average of 12.75 years ($SD = 8.90$) and Russian for an average of 20.17 years ($SD = 5.18$), paired samples $t(25) = 4.04$, $p < .001$. Participants reported speaking English on average 7 hours per day (range 0.5-12) and Russian 3.52 hours a day (range 0.3-7), paired samples $t(25) = 3.68$, $p < .001$. Russian was used primarily to speak with family and Russian friends, while English was used primarily in academic and work settings. English was the preferred language for 13 participants, Russian was preferred by 10 participants, while 3 participants reported no language preference. Participants were naïve to the experimental manipulation. The treatment of participants was in accordance with the ethical standards of the APA and all participants were paid for participation.

Materials. The stimuli were three-phoneme Russian and English words and non-word phoneme-sequences, coded according to the International Phonetic Alphabet (IPA, 1999). All words were unique to Russian and English and no cognates, homophones, or homographs were used. Two-hundred-and-forty stimuli were divided into three sets: Russian set, first English set and second English set. Each set consisted of 40 words and 40 non-words.

In the Russian set, the words were selected so that 10 were comprised of unique Russian phonemes (0-phoneme overlap), another 10 included two unique and one non-unique Russian phonemes (1-phoneme overlap), a third subset of 10 contained one unique and two non-unique phonemes (2-phoneme overlap), and the last 10 consisted of only non-unique Russian phonemes (3-phoneme overlap). The non-word stimuli were constructed in the same manner using unique and non-unique Russian phonemes and are available upon request.

Similarly, the first English set was comprised of 10 words with unique English phonemes (0-phoneme overlap), another 10 with two unique and one non-unique English phonemes (1-phoneme overlap), a third subset of 10 with one unique and two non-unique phonemes (2-phoneme overlap), and the last 10 with non-unique English phonemes only (3-phoneme overlap). The non-words were constructed in the same fashion. The words and non-words in the second English set were selected in the same manner and were different from those in the first English set. A complete list of all word and non-word stimuli used in the Russian and English sets is available upon request.

English vowels and consonants were compared to all corresponding Russian vowels and consonants to determine uniqueness. Pairs of corresponding phonemes were selected based on similarity in sound. For example, the Russian phoneme [a] sounds similar to the English [a:], but not to the English phoneme [u:]. For vowels, phonological characteristics used to evaluate uniqueness were tongue position in the vertical plane (low, mid, and high), lip articulation (rounded or not rounded), and tongue position in the horizontal plane (front, middle, and back). For example, an English phoneme [a:] is a low rise, not rounded, back vowel and a Russian phoneme [a] is a low rise, not rounded, middle vowel. Thus, [a:] and [a] share two phonological characteristics. In this manner, Russian [a] was also compared to corresponding English [æ] and [] Unique phonemes shared 0-2 characteristics; non-unique phonemes shared all three characteristics. English triphthongs were also considered unique, because Russian does not have a counterpart for triphthongs. For consonants, phonological characteristics used to evaluate uniqueness were voice participation (voiced, voiceless or sonorant), palatalization (palatalized or not palatalized), place of articulation (bilabial, labio-dental, front-lingual dental, front-lingual dental-alveolar, palatal, palato-alveolar, back-lingual back-alveolar, velar and glottal) and manner of articulation (plosive, affricative, fricative, nasal, lateral, rolled and semi-vowel) (following Dickushina, 1965). Consonants with two or fewer overlaps across languages were labeled unique.

The phoneme type (consonant or vowel) or the position of the overlapping phoneme within each word were not systematically varied. The overlapping phonemes occurred in the initial position, final position or in the middle of the word. The stimulus pool was limited by the small number of phonologically unique English and Russian phonemes and setting another criterion for stimulus selection would result in fewer available words and compromised generalizability of the findings. Exploring whether overlapping phoneme type or position could influence the results remains a direction for future investigation.

Words were matched for frequency of occurrence within each language. Russian frequency was determined using Sharoff's online frequency dictionary based on a corpus of 16,000,000 words (http://bokrcorpora.narod.ru/frqlist/frqlist-en.html). English frequency was determined using the Kucera and Francis (1967) dictionary, which provides frequency of occurrence for words with a minimum frequency of 0 and a maximum frequency of 69971. All lists had similar mean frequencies. A one-way ANOVA (Phonological Overlap) on four subsets of Russian words revealed no differences in frequencies, F (3, 36) < 1. A 2 x 4 ANOVA (English Set x Phonological Overlap) for English word frequencies showed no main effect of English set [F (1, 68) < 1], no main effect of Phonological Overlap [F (3, 68) = 1.13, p = .34] and no interaction between the two [F (3, 68) < 1]. In addition, words in the Russian phase (M = 50.15, SD = 72.87) did not differ from words in the first English phase (M = 59.18, SD = 78.80), t (77) = .53, p = .60, or second English phase (M = 62.59, SD = 90.05), t (75) = .67, p = .51.

English stimuli were recorded by a native speaker of English in a sound-proof booth. Russian stimuli were recorded in a similar manner by a native speaker of Russian.

Design and Procedure. The experiment followed a 3 x 4 x 2 within-subjects design. The first factor, phase, had three levels: first English phase, Russian phase, and second English phase. Phonological overlap included four levels: 0-phoneme overlap, 1-phoneme overlap, 2-phoneme overlap, and 3-phoneme overlap. The third factor, lexical status, had two levels: word and non-word. The dependent variables measured were latency of response and response accuracy.

The experimenter provided participants with oral instructions in the language appropriate to the experimental phase. At the start of the English phases instructions were presented in English; at the start of the Russian phase instructions were presented in Russian. Upon completion of each phase, participants received a new set of instructions for the next phase. Each phase started immediately after the instructions were provided. Participants heard the stimuli over standard headphones. The first set of English items was played first, followed by the set of Russian items and the second set of English items. The order of the stimuli in each phase was randomized. On each trial, participants performed a lexical decision task about a phoneme sequence by pressing either a "word" or "non-word" key on the response box. There was a 1500 ms inter-trial interval, and a self-paced break was offered after every 20 trials. Reaction times were measured from stimulus offset. At the end of the experiment participants completed a questionnaire about their linguistic background.

Coding and Analyses. Items with accuracy rates less than 70% across participants were excluded from analyses, resulting in elimination of 9.2% of word data and 10.8% of non-word data. In the word data, 3.33% of eliminated words were in the first English phase, 3.33% were in the Russian phase and 2.5% were in the second English phase. In another 0.9% of the word data and 3.75% of the non-word data reaction times were greater than 2500 ms and were substituted[1] with 2500 ms, which was equal to about 2.5 standard deviations above the reaction time mean across participants, and is a conventional cutoff point for lexical decision experiments. Follow-up analyses were conducted for word stimuli only. However, raw accuracy and latency data for non-words were included in Tables 1 and 2 and are available for further inspection.

Table 1. Mean reaction times and standard deviations for each phase and overlap condition, in milliseconds. (All stimuli consisted of three phonemes, coded according to the International Phonetic Alphabet.)

	Words		Non-words	
Degree of phonemic overlap	Reaction time	Standard deviation	Reaction time	Standard deviation
First English phase				
No overlap	560	240	920	353
1-phoneme overlap	494	167	915	398
2-phoneme overlap	531	182	907	394
Complete overlap	476	159	887	395
Russian phase				
No overlap	471	229	702	312
1-phoneme overlap	393	193	773	327
2-phoneme overlap	467	234	835	367
Complete overlap	539	294	689	335
Second English phase				
No overlap	568	261	887	491
1-phoneme overlap	525	175	872	439
2-phoneme overlap	478	165	849	438
Complete overlap	495	155	917	394

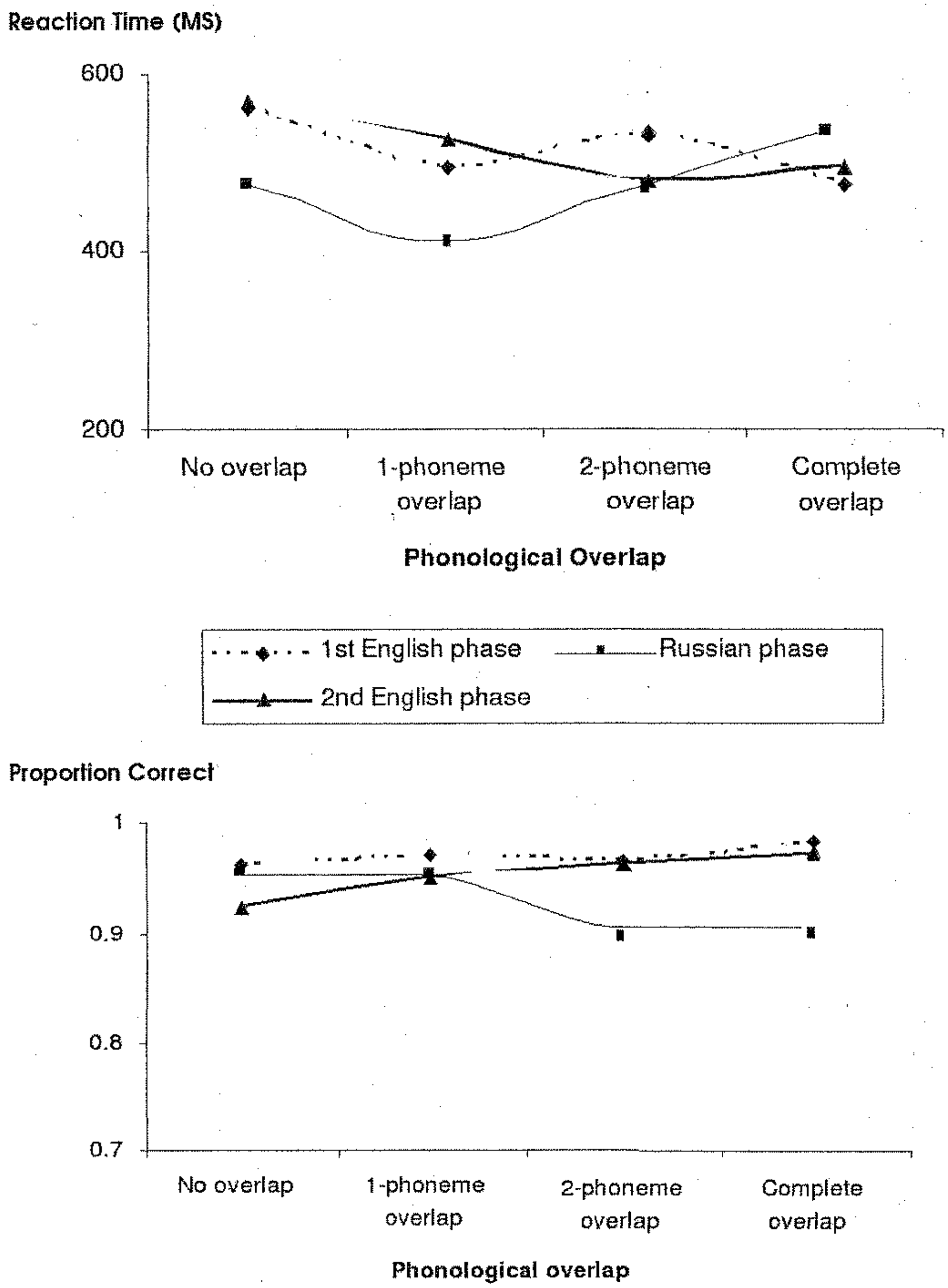
Results

Reaction Time. A 3-way ANOVA with Phase (first English phase, Russian phase, second English phase), Lexical Status (word, non-word) and Phonological Overlap (0-phoneme overlap, 1-phoneme overlap, 2-phoneme overlap, 3-phoneme overlap) was performed[2]. Results revealed a main effect of Phase [F (2, 50) = 4.41, MSE = 147,497.33, $p < .05$] and a main effect of Lexical Status [F (1, 25) = 56.75, MSE = 329,919.11, $p < .001$]. Participants

Table 2. Mean proportions of correct responses and standard deviations for each phase and overlap condition. (All stimuli consisted of three phonemes, coded according to the International Phonetic Alphabet.)

	Words		Non-words	
Degree of phonemic overlap	Mean proportion correct	Standard deviation	Mean proportion correct	Standard deviation
First English phase				
No overlap	.96	.06	.87	.13
1-phoneme overlap	.97	.08	.89	.17
2-phoneme overlap	.97	.06	.91	.12
Complete overlap	.98	.05	.91	.13
Russian phase				
No overlap	.95	.06	.91	.12
1-phoneme overlap	.95	.06	.89	.15
2-phoneme overlap	.89	.14	.96	.06
Complete overlap	.90	.12	.93	.11
Second English phase				
No overlap	.92	.10	.95	.08
1-phoneme overlap	.95	.09	.94	.08
2-phoneme overlap	.96	.06	.91	.10
Complete overlap	.97	.07	.91	.13

Figure 1. Reaction times and accuracy rates for words across phases and conditions of phonological overlap.



responded faster to words ($M = 500$, $SD = 205$) than to non-words ($M = 846$, $SD = 387$) and were faster in the Russian phase ($M = 609$, $SD = 254$) than in the first English phase ($M = 711$, $SD = 246$), $t\ (25) = 2.95$, $p < .01$, or the second English phase ($M = 699$, $SD = 275$), $t\ (25) = 2.05$, $p = .051$. Significant interactions were found between Phase and Phonological Overlap [$F\ (6, 150) = 4.11$, $MSE = 12{,}643.56$, $p < .01$], between Lexical Status and Phonological Overlap [$F\ (3, 75) = 3.42$, $MSE = 15{,}806.49$, $p < .05$], and between Phase, Lexical Status and Phonological Overlap [$F\ (6, 150) = 4.84$, $MSE = 14{,}625.08$, $p < .01$] (for means, see Table 1).

Follow-up analyses showed a main effect of Phonological Overlap in the first English phase [$F\ (3, 75) = 3.18$, $MSE = 10{,}157.67$, $p < .05$], where increased phonological overlap was associated with shorter reaction times (although the relationship was non-linear). Participants responded slower to words with 0-phoneme overlap ($M = 560$, $SD = 240$) than to words with 1-phoneme overlap ($M = 494$, $SD = 167$), $t\ (25) = 2.16$, $p < .05$, or to words with 3-phoneme overlap ($M = 476$, $SD = 159$), $t\ (25) = 2.61$, $p < .05$. Similarly, reaction times to words with 2-phoneme overlap ($M = 531$, $SD = 182$) were slower than to words with 3-phoneme overlap, $t\ (25) = 2.98$, $p < .01$. Reaction times to words with 1-phoneme overlap and to words with 2-phoneme overlap were not significantly different ($p = .06$). In the second English phase no main effect of Phonological Overlap was found. However, planned contrasts showed that reaction times to words with 0-phoneme overlap ($M = 568$, $SD = 261$) were slower than to words with 2-phoneme overlap ($M = 478$, $SD = 165$), $t\ (25) = 2.73$, $p < .05$. No differences in reaction times were found between the first English phase ($M = 515$, $SD = 172$) and the second English phase ($M = 516$, $SD = 371$), either across all stimulus conditions, or at each level of phonological overlap.

In the Russian phase, a main effect of Phonological Overlap was also observed [$F\ (3, 75) = 3.17$, $MSE = 16{,}313.23$, $p < .05$]. Contrary to predictions, participants responded slower to words with 0-phoneme overlap ($M = 471$, $SD = 229$) than to words with 1-phoneme overlap ($M = 393$, $SD = 193$), t (25) = 3.58, $p < .01$, whereas they responded faster to words with 1-phoneme overlap than to words with 2-phoneme overlap ($M = 467$, $SD = 234$), t (25) = 3.53, $p < .01$, or with 3-phoneme overlap ($M = 539$, $SD = 294$), t (25) =

4.35, $p < .001$ (see Figure 1).

Accuracy. A 3-way ANOVA with Phase (first English phase, Russian phase, second English phase), Lexical Status (word, non-word), and Phonological Overlap (0-phoneme overlap, 1-phoneme overlap, 2-phoneme overlap or 3-phoneme overlap) revealed a significant two-way interaction between Phase and Lexical Status [F (2, 50) = 12.53, MSE = .006, $p < .001$] and a significant three-way interaction between Phase, Lexical Status and Phonological Overlap [F (6, 150) = 5.12, MSE = .007, $p < .001$] (for means, see Table 2). Follow-up analyses did not reveal any significant differences as a function of Phonological Overlap in the first English phase. In the second English phase participants were more accurate responding to words with 3-phoneme overlap (M = .97, SD = .07) than to words with 0-phoneme overlap (M = .92, SD = .10), t (25) = 2.05, p = .051 (no such effect was observed for non-words). There were no significant differences in accuracy between 1- and 2-phoneme overlap words. No differences in accuracy were found between the first English phase (M = .97, SD = .04) and the second English phase (M = .95, SD = .05), either across all stimulus conditions, or at each level of phonological overlap.

In the Russian phase participants responded more accurately to words with 0-phoneme overlap (M = .95, SD = .06) than to words with 2-phoneme overlap (M = .89, SD = .14), t (25) = 2.60, $p < .05$, or to words with 3-phoneme overlap (M = .90, SD = .12), t (25) = 2.60, $p < .05$. Similarly, they responded more accurately to words with 1-phoneme overlap (M = .95, SD = .06) than to words with 2-phoneme overlap, t (25) = 2.29, $p < .05$, or to words with 3-phoneme overlap, t (25) = 2.62, $p < .05$.

Discussion

The degree of cross-linguistic phonological overlap was found to influence participants' speed and accuracy. However, different patterns were observed for first and second language processing. In the second language (English) greater cross-linguistic phonological overlap was associated with shorter latencies and greater accuracy of response. The opposite pattern was observed for the first language (Russian), where, in general, phonological overlap with the second language was associated with longer latency rates and decreased accuracy. It is important to note that the patterns of results observed in the present study may not hold for bilinguals with a different language-history profile, such as bilinguals who are balanced across both languages, who acquired both languages in parallel, or whose L1/L2 proficiencies differ more drastically[3].

In both English phases of the present study, words that shared phonology with Russian were identified faster and more accurately than words comprised of unique English phonemes. Moreover, as phonological overlap increased, responses were provided faster and with more accuracy. The observed facilitation of the second language as a function of phonological overlap with the first language is consistent with previous research reporting facilitation during masked priming of non-native words with phonologically similar native words (Brysbaert, Van Dyck, & Van de Poel, 1999). Reaction time and accuracy followed the same patterns in both English phases, with no significant differences between the two (as evident from comparisons across all stimulus conditions, as well as at each level of phonological overlap). This suggests that both phonologically-overlapping and phonologically-unique stimuli were processed in a similar manner in the first and second English phases. However, follow-up pair-wise comparisons suggested that the magnitude of the differences was greater in the first English phase than in the second English phase. That is, while in the first English phase reaction times to words with 0- and 1-phoneme overlap, 0- and 3-phoneme overlap and 2- and 3-phoneme overlap were significantly different from each other, in the second English phase, only reaction times to words with 0- and 2-phoneme overlaps and accuracies for words with 0- and 3-phoneme overlap were significantly different from each other. The results of the second English phase suggested that only large differences in degree of overlap significantly affected processing in the second language. It is possible that practice effects and increased familiarity with the task during the course of the experiment reduced sensitivity to fine-grained differences in phonological overlap. As a result, only considerable differences such as between unique phonology and shared phonology affected response latency and accuracy. Alternatively, the discrepancies between the two English phases could be attributed to the change in linguistic context and baseline of activation. In the Jared and Kroll (2001) study, completing a word production task in French led to greater interference for English words with French competitors. Completing a word recognition task in Russian could introduce greater *overall* facilitation for English words and attenuate any differences in reaction times due to phonological overlap. As a result, in the second English phase, the observed effect of phonological overlap was not as robust as in the first English phase.

In the Russian phase, response latency and accuracy were also affected by degree of phonological overlap. Similar to English processing, lexical decision was slower for Russian words with 0-phoneme overlap than for words with 1-phoneme overlap, suggesting that words with shared phonology were easier to process. However, unlike English word recognition, the effect of phonological overlap on Russian word recognition was not unidirectional. Once a threshold was reached, one in which detectable cross-linguistic overlap was present, first language processing appeared to be inhibited by increased phonological overlap with the second language. Participants responded faster to Russian words with 1-phoneme overlap than to Russian words with 2- or 3-phoneme overlap. Furthermore, participants responded with greater accuracy to words with 0-phoneme overlap than to words with 2- or 3-phoneme overlap, and were more accurate responding to words with 1-phoneme overlap than to words with 2- or 3-phoneme overlap. It appears that lexical decision in the first language is subject to interference effects due to increased phonological overlap with the second language. However, there was one unexpected result, namely that lexical decision was slower for Russian words with 0-phoneme overlap than for Russian words with 1-phoneme overlap. Speed-accuracy trade-off is one possible explanation for this finding: While reaction times were slower to stimuli with 0-phoneme overlap than to stimuli with 1-phoneme overlap, accuracy was greater for stimuli with 0-phoneme overlap than for stimuli with 2-phoneme overlap. Alternatively, slower reaction times to words with unique Russian phonemes could be a result of increased activation of English phonology after the completion of the lexical decision task in English. It is possible that the English context of the first phase suppressed access to uniquely Russian phonological information. Reaction time data reflected this suppression, while accuracy data did not, possibly due to reaction time being more sensitive to minor changes in linguistic context. This hypothesis is consistent with previous research on the effects of phonological similarity in bilingual naming, where reaction time measures of processing in a non-native language were more sensitive to phonological neighborhood (Marian & Blumenfeld, 2005). To further test this hypothesis, future research may vary the order of native and non-native language input, so that both are presented with and without prior exposure to the other language.

A potential caveat that may explain the non-linear result patterns in the two English phases and the conflicting result in the Russian phase is related to stimulus selection. In each stimulus group, phonological overlap was manipulated by varying the number of phonologically-unique sounds used to construct word stimuli. Because of design constraints (i.e. all stimuli had to be three phonemes long and have a particular phonemic make-up), it was not possible to select words of similar frequency. Instead, words in all stimulus groups were matched for frequency, so that each group contained both high- and low-frequency words. The wide frequency range of the stimuli could have contributed to the variability in the data. This caveat was addressed, in part, by excluding the reaction time and accuracy outliers from the analyzed data. For example, words with very low frequency, such as 'troth' and 'drudge' produced accuracy rates lower than 70% across participants and were excluded from analyses. Another caveat to stimulus selection was that the type of overlapping phoneme and its position were not systematically varied. It is possible that the type of overlapping phoneme could have contributed to the observed reaction time patterns, at least in some of the cases. For example, in the 1-phoneme overlap condition reaction times were slower when the overlapping phoneme was a vowel ($M = 606$, $SD = 63$) than when it was a consonant ($M = 455$, $SD = 111$), ($t\ (26) = 2.64$, $p < .05$). Similarly, reaction times were slower when the overlapping phoneme was in the middle of the word, always a vowel, ($M = 606$, $SD = 63$), than when it was in the beginning ($M = 436$, $SD = 118$), ($t\ (13) = 2.71$, $p < .05$), or the end of the word ($M = 470$, $SD = 106$), ($t\ (15) = 2.38$, $p < .05$). No such differences were observed in the 2-phoneme overlap condition. Note that the proportion of overlapping consonants and vowels did not differ systematically across conditions. The number of overlapping consonants was higher than the number of overlapping vowels in each group. Since overlapping vowels yielded slower reaction times than overlapping consonants, reaction times should have been slowest for the 3-phoneme overlap condition, where the number of overlapping vowels was the greatest. This pattern was observed in the Russian phase, but not in the first, or the second English phase. In contrast, in both English phases, reaction times for 3-phoneme overlap words were faster than in other conditions. It is likely, therefore, that the phoneme type and position had a minimal influence on the pattern of results observed in the study.

Overall, the facilitation and interference effects observed in the present study provide evidence for an integrated account of bilingual lexical organization. Cross-linguistically overlapping phonological input activated both languages, regardless of the task-relevant language. The results of the present study also suggest that cross-linguistic overlap may influence native and non-native word recognition differently. Whereas word recognition in a non-native language appears to be *facilitated* by phonological overlap with the native language, word recognition in a native language appears to be *inhibited* by phonological overlap with the non-native language, but only beyond a certain threshold. In the non-native language, activation of the native language phonology aided processing, perhaps due to faster phoneme recognition in the first language as a result of extensive previous use. Alternatively, this facilitation effect from the first language into the second language may be explained in terms of order of acquisition, with the first language mediating subsequent language learning. Cross-lingustic phonological overlap with the second language delayed or compromised lexical decision in the first language, possibly due to competition between viable word-form representations as a result of simultaneous activation of second language phonology. This competition between viable phonemic representations may be associated with high levels of L2 activation as a result of recency of exposure, given that the second language (English) was used more frequently by participants around the time of the study (due to being at an American university).

In some ways, the results of the present study are similar to those of Jared and Kroll (2001), who also observed interference from the second language during first language processing. When English-French bilinguals named English words, French letter-to-sound mappings were activated after participants had completed the

French phase of the study (i.e., in the third phase, but not in the first phase). However, unlike our study, Jared and Kroll also observed interference from the first language. French-English bilinguals showed interference for French enemies in the English phases. The different patterns of findings in Jared and Kroll's study compared to the results reported here may be due to the different modalities tested (visual versus auditory) and the fact that the present study did not manipulate letter-to-sound mappings and focused instead exclusively on degree of phonological overlap.

The results of the present study carry implications for both applied bilingual settings and for theoretical models of bilingual language organization. Practically speaking, finding cross-linguistic influences on language processing impacts educational and clinical services. For instance, knowing that overlap with the first language facilitates second language processing suggests that L2 learners may benefit from linguistic input that shares phonology with their native language, at least in early stages of language learning. In addition, placing special emphasis on acquisition of difficult non-overlapping phonemes may further improve performance. Modifying language learning strategies to allow late learners to profit from the phonological overlap with their L1 and to pay particular attention to the non-overlapping phonology of their L2 may be particularly beneficial to immigrant populations. (For immigrants, the pressures to communicate clearly in the second language and to fit into the new linguistic and cultural environments are greater than for native speakers who are learning a second language in academic settings for enrichment purposes.) Similarly, knowing that overlap with the second language inhibits first language processing suggests that language learners may benefit from unique input when processing in a native language. It may also help explain mechanisms of first language attrition (e.g., Gurel, 2004; Francis, 2005; Seliger & Vago, 1991), where repeated use of L2 in a predominantly monolingual second-language setting may systematically inhibit native language phonology and contribute to its deterioration. Moreover, treatment of bilingual populations with language disorders, such as bilingual aphasia and Specific Language Impairment in bilingual children, may be able to incorporate the findings of cross-linguistic L1 facilitation and L2 inhibition to 'bootstrap' treatment in the two languages. For instance, efficiency of treatment for bilingual aphasia with impairments primarily in the second language may be maximized when the starting point for remediation uses second-language words that share greater phonological overlap with the native language.

Theoretically speaking, the results of the present study can be interpreted within the context of Kroll and Stewart's (1994) Revised Hierarchal Model of bilingual organization. According to the model, in unbalanced bilinguals, lexical representations of second-language words are associated with lexical representations of first-language words. We suggest that the same dynamics may apply not only to lexical processing, but also to phonological processing. In unbalanced bilinguals, phonological representations in the second language may be associated with phonological representations in the first language. Single native categories may initially include phonological representations for similar non-native categories. In later stages of acquisition, separate representations are established for L2 phonology; however, traces of early associations with L1 phonology may remain. A second language phoneme with similar characteristics across languages may then activate relevant L1 and L2 phonological information. In this case, activation of L1 phonology would be beneficial since it includes early variants of L2 representations. Multiple activations of relevant phonological information in the auditory input would lead to greater accuracy and faster response times. This pattern of results was observed for English stimuli with phonemes that shared characteristics across languages. Unique English phonemes, on the other hand, do not have such 'privileged' associations with L1 phonology due to failure to match them with any native phonological category during acquisition. Thus, words with unique English phonemes are processed slower and less accurately than words with non-unique phonemes.

Concluding that second language phonemes are represented within the phonemic categories of the first language, and may lack fine-grained distinctions is consistent with findings that L2 phonemes similar to a common L1 category are discriminated with more difficulty than L2 phonemes that do not bear resemblance to an L1 category (e.g., Best, 1995) and with research showing that auditory word recognition in the second language is more difficult than in the first language and may be linked to less-defined phonetic representations (e.g., Bradlow & Bent, 2002). It has been suggested that in late learners, L2 phonological representations are affected by L1 phonology and differ from the representations of native speakers (Flege, 1995). Imai, Walley, and Flege (2005) investigated the mismatch between auditory input and phonological representations in late learners of English. When English words with many phonologically-similar neighbors were pronounced with a Spanish accent, Spanish speakers recognized them with greater speed and accuracy than native English speakers. However, when English words were pronounced with an English accent, Spanish speakers with low English proficiency responded slower and less accurately compared to native English controls and Spanish speakers with high English proficiency. These findings suggest that late learners of English assimilated phonological representations of English phonemes to phonological representations in their native language.

The Revised Hierarchal Model suggests an asymmetry in the representation of lexical information, where L2 words have stronger associations with L1 words, while L1 words have weaker associations with L2 words. In the same way, while L2 phonemes similar to L1 phonemes may be linked to L1 phonological representations, L1 phonemes similar to L2 phonemes are less likely to be connected to L2 representations. Thus, L1 phonemes with characteristics similar to L2 phonemes do not benefit from activation of L2 phonological information. In fact, such activation may hinder lexical decision in L1 due to competition from similar word-form representations. This phonological interference may drive the pattern of findings observed in the present study and yield increased latency and decreased accuracy of word recognition for input that shares phonemic characteristics with the non-native language.

In sum, the Russian-English bilinguals tested in the present study were faster to recognize words in their first language compared to their second language. Results of the lexical decision task showed that words in the second language were processed faster and with greater accuracy when auditory input overlapped in phonological qualities with the first language. Native-language words that shared phonology with the second language were processed slower and with less accuracy than words with unique native phonology. However, first-language words that were completely unique in phonological characteristics were also recognized slower, suggesting a possible threshold effect in, or a linguistic-context influence on first language processing. These differences in the direction and magnitude of the effect were uncovered only because degree of phonological overlap was systematically manipulated across four levels. Had the study grouped stimuli into Overlap and No-overlap conditions only, the fine-grained distinctions of the present findings would not have been possible. Such graded manipulation of phonological overlap emerged as a valuable tool for exploring processing in the bilingual language system. Studies of language interaction in bilinguals typically use cognates, homophones, or homographs, which are usually the exception to bilingual linguistic input rather than the rule. Non-cognate, non-homophonic/non-homographic stimuli that are comprised of either overlapping or non-overlapping phonology, such as the words used in the present study, provide a window into the more general system of bilingual organization.

To conclude, both the facilitation and the interference effects observed in the present study support parallel accounts of bilingual language processing and integrated accounts of bilingual lexical organization. However, they also suggest an asymmetry in first and second language phonological processing in unbalanced bilinguals. This asymmetry is similar to that observed in studies of lexical organization in unbalanced bilinguals, as accounted for in the Revised Hierarchical Model. We propose that the same dynamics and developmental trajectory may also apply to phonological representations and extend the Revised Hierarchical Model to phonological processing.

Notes

1. Reaction times above 2500 ms were substituted (rather than deleted) in order to limit the amount of data excluded and to preserve the extreme scores while scaling down the effect.
2. Reaction time and accuracy were also analyzed by-items (F2) using three-way ANOVAs with Phase (first English phase, Russian phase, second English phase), Lexical Status (word, non-word) and Phonological Overlap (0-phoneme overlap, 1-phoneme overlap, 2-phoneme overlap, 3-phoneme overlap) as independent variables.

   For reaction time, results revealed a main effect of Phase ($F2$ $(2, 216) = 27.89$, $MSE = 16{,}172.78$, $p < .001$) and a main effect of Lexical Status ($F2$ $(1, 216) = 420.88$, $MSE = 16{,}172.78$, $p < .001$).

Two-way interactions were found between Lexical Status and Phonological Overlap ($F2$ (3, 216) = 2.64, MSE = 16,172.78, p = .05) and between Phase and Lexical Status ($F2$ (2, 216) = 6.23, MSE = 16,172.78, $p < .01$); and a three-way interaction between Phase, Lexical Status, and Phonological Overlap approached significance ($F2$ (6, 216) = 1.99, MSE = 16,172.78, p = .07). Follow-up analyses showed no effect of Phonological Overlap in the first or the second English phases, and a significant effect of Phonological Overlap in the Russian phase ($F2$ (3, 72) = 3.17, MSE = 16,313.23, $p < .05$). In general, by-items and by-subjects analyses yielded similar results, however there were some inconsistencies. Namely, the interaction between Phase and Phonological overlap and the main effect of Phonological Overlap in the first English phase were significant by-subjects, but not by-items, and the interaction between Phase and Lexical Status was significant by-items, but not by-subjects.

For accuracy, results revealed a main effect of Lexical Status ($F2$ (2, 216) = 10.35, MSE = .004, $p < .001$), and a significant two-way interaction between Phase and Lexical Status ($F2$ (2, 216) = 4.08, MSE = .004, $p < .05$). A two-way interaction between Phase and Phonological overlap and a three-way interaction between Phase, Lexical Status, and Phonological overlap were significant by-subjects, but not by-items, and a main effect of Lexical Status was significant by-items, but not by subjects. The inconsistencies between by-subjects and by-items analyses could be attributed to the large frequency range of the word stimuli, since low frequency words may be affected differently by phonological overlap than high frequency words. Due to multiple constraints on stimuli selection, it was not possible to keep frequency constant. Instead, words in each group were matched for frequency, so that overall mean frequency was similar across groups and each group had a similar number of high and low frequency words.

3. In our sample of bilinguals, proficiency in L2 could have contributed to the overall pattern of performance. To explore this hypothesis, ANCOVA analyses were performed on both accuracy and RT (with Phase, Lexical Status and Phonological Overlap as factors), where the covariate consisted of the number of years participants had known English as an approximate index of L2 proficiency. ANCOVA analyses on RT yielded a main effect of Phase (F (2, 48) = 9.60, MSE = 127,362.60, $p < .001$) and Lexical Status (F (1, 24) = 23.07, MSE = 336,486.45, $p < .001$). ANCOVA analyses on accuracy yielded an interaction between Phase and Lexical Status (F (2, 48) = 4.78, MSE = .006, $p < .05$). These findings were consistent with those of

the ANOVAs reported in the Results section. However, though the direction of the effects was preserved, some interactions did not reach significance (in the RT analyses, Lexical Status by Phonological Overlap and Phase by Phonological Overlap; in both analyses, Phase by Lexical Status by Phonological Overlap). This suggests that some of the variability in the data was due to differences in participants' L2 use. Note that most of this variability (as well as the large standard deviations in participants' statistics in general) is likely due to one older participant (age = 51 years) who had been speaking English for a longer period of time.

Acknowledgments

We thank the editor and two anonymous reviewers for helpful comments on this work. Data for this study were collected as part of the first author's honors thesis under the direction of Dr. Cynthia Connine and were supported by an Undergraduate Research Grant to the first author and by grant R01DC02134 to Cynthia Connine. Data analyses and writing of this paper were supported by Grants NICHD 1R03HD046952 and NSF BCS-0418495 to the second author. We thank Dr. Ken Kurtz, Dr. Richard Pastore, Margarita Kaushanskaya, Henrike Blumenfeld, Nadia Cone, Avital Rabin, Jay Mittal and Alison Moy for their contributions to this work.

References

Best, C. T. (1995). A direct realist view of cross-language speech perception. In W. Strange (Ed.), *Speech Perception and Linguistic Experience: Theoretical and Methodological Issues in Cross-Language Speech Research* (pp. 171-204). Timonium, MD: York Press.

Bijeljac-Babic, R., Biardeau, A., & Grainger, J. (1997). Masked orthographic priming in bilingual word recognition. *Memory and Cognition*, 25, 447-457.

Blumenfeld, H.K., & Marian, V. (2005). Covert bilingual language activation through cognate word processing: An eye-tracking study. *Proceedings of the Twenty-Seventh Annual Meeting of the Cognitive Science Society* (pp. 286-291). Mahwah, NJ: Lawrence Erlbaum.

Bradlow, A. R., & Bent, T. (2002). The clear-speech effect for non-native listeners. *Journal of the Acoustic Society of America*, 112, 272-284.

Brysbaert, M., Van Dyck, G., & Van de Poel, M. (1999). Visual word recognition in bilinguals: evidence from masked phonological priming. *Journal of Experimental Psychology: Human Perception and Performance*, 25, 137-148.

Chen, H. C., Cheung, H., & Lau, S. (1997). Examining and reexamining the structure of Chinese-English bilingual memory. *Psychological Research*, 60, 270-283.

Costa, A., Miozzo, M., & Caramazza, A. (1999). Lexical selection in bilinguals: Do words in the bilingual's two lexicons compete for selection? *Journal of Memory and Language*, 41, 365-397.

De Groot, A. M. B., & Nas, G. L. J. (1991). Lexical representation of cognates and noncognates in compound bilinguals. *Journal of Memory and Language*, 30, 90-123.

Dijkstra, T., Grainger, J., & van Heuven, W. J. B. (1999). Recognition of cognates and interlingual homographs: The neglected role of phonology. *Journal of Memory and Language*, 41, 496-518.

Dijkstra, T., van Heuven, W. J. B., & Grainger, J. (1998). Simulating cross-language competition with the bilingual interactive activation model. *Psychologica Belgica*, 38, 177-196.

Dickushina, O. J. (1965). *English Phonetics*. Moscow: Prosvesh'enie.

Flege, J. E. (1995). Second language speech learning: Theory, findings and problems. In W. Strange (Edl), *Speech Perception and Linguistic Experience*, 233-272. Timonium, MD: York Press.

Fox, E. (1996). Cross-language priming from ignored words: Evidence for a common representations system in bilinguals. *Journal of Memory and Language*, 35, 353-370.

Francis, N. (2005). Research findings on early first language attrition: Implications for the discussion on critical periods in language acquisition. *Language Learning*, 55, 491-531.

Francis, W. S. (1999). Cognitive integration of language and memory in bilinguals: Semantic representation. *Psychological Bulletin*, 125, 193-222.

Gerard, L. D., & Scarborough, D. L. (1989). Language-specific access of homographs by bilinguals. *Journal of Experimental Psychology: Learning, Memory and Cognition*, 15, 305-315.

Grosjean, F. (1997). Processing mixed languages: Issues, findings, and models. In A. M. B. de Groot and J. F. Kroll (Eds.), *Tutorials in Bilingualism: Psycholinguistic perspectives* (pp. 225-254). Mahwah, N. J.: Lawrence Erlbaum.

Gurel, A. (2004). Selectivity in L2-induced L1 attrition: A psycholinguistic account. *Journal of Neurolinguistics*, 17, 53-78.

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,* 213-229.

Imai, S., Walley, A. C., & Flege, J. E. (2005). Lexical frequency and neighborhood density effects on the recognition of native and Spanish-accented words by native English and Spanish listeners. *Journal of the Acoustic Society of America*, 117, 896-907.

International Phonetic Association. (1999). *Handbook of the International Phonetic Association: A Guide to the Use of the International Phonetic Alphabet*. Cambridge: Cambridge University Press.

Jared, D., & Kroll, J. F. (2001). Do bilinguals activate phonological representations in one or both of their languages when naming word? *Journal of Memory and Language*, 44, 2-31.

Jiang, N., & Forster, K. I. (2001). Cross-language priming asymmetries in lexical decision and episodic recognition. *Journal of Memory and Language*, 44, 32-51.

Ju, M., & Luce, P. A. (2004). Falling on sensitive ears. *Psychological Science,* 15(5), 314-318.

Kedrova, G.E., Potapov, V.V., & Omelyanova, E.B. Russian Phonetics. Retrieved November 16, 2003, from http://www.philol.msu.ru/rus/galya-1/index1.htm

Kroll, J. F., & Stewart, E. (1994). Category interference in translation and picture naming: Evidence for asymmetric connections between bilingual memory representations. *Journal of Memory and Language*, 33, 149-174.

Kucera, H., & Francis, W. N. (1967). Computational analysis of present-day American English. Providence, RI: Brown University Press. Retrieved November 16, 2003, from http://www.psy.uwa.edu.au/mrc-database/uwa_mrc.htm

Marian, V. (in press). Bilingual research methods. In J. Altarriba & R. R. Heredia (Eds.), *An Introduction to Bilingualism: Principles and Processses*. Mahawah, NJ: Lawrence Erlbaum.

Marian, V., & Blumenfeld, H. K. (in press). Phonological neighborhood density guides lexical access in native and non-native language production. *Journal of Social and Ecological Boundaries: Special Issue on Bilingualism.*

Marian, V., & Spivey, M. (2003a). Bilingual and monolingual processing of competing lexical items. *Applied Psycholinguistics*, 24, 173-193.

Marian, V., & Spivey, M. (2003b). Competing activation in bilingual language processing: Within- and between-language competition. *Bilingualism: Language and Cognition*, 6, 97-115.

Sanchez-Casas, R., Davis, C. W., & Garcia-Albea, J. E. (1992). Bilingual lexical processing: exploring the cognate, non-cognate distinction. *European Journal of Cognitive Psychology*, 4, 293-310.

Sculpen, B., Dijkstra, T., Schriefers, H. J., & Hasper, M. (2003). Recognition of interlingual homophones in bilingual auditory word recognition. *Journal of Experimental Psychology: Human Perception and Performance*, 26, 1155-1178.

Seliger, H. W., & Vago, R. M. (1991). The study of first language attrition. In H. W. Seliger & R. M. Vago (Eds.), *First Language Attrition* (pp. 3-15). New York: Cambridge University Press.

Seymour, G. (1969). *Practical English Phonetics*. London: Leonard Hill Books.

Sharoff, S. (2003). The frequency dictionary for Russian. [Computer software]. Retrieved November 16, 2003, from http://bokrcorpora.narod.ru/frqlist/frqlist-en.html

Sholl A., Sankaranarayanan, A., & Kroll J. F. (1995). Transfer between picture naming and translation: A test of asymmetries in bilingual memory. *Psychological Science*, 6, 45-49.

Silverberg, S., & Samuel, A. G. (2004). The effect of age of second language acquisition on the representation and processing of second language words. *Journal of Memory and Language*, 51, 381-398.

Slowiaczek, L. M., Soltano, E. G., Wieting, S. J., & Bishop, K. L. (2003) An investigation of phonology and orthography in spoken-word recognition. *The Quarterly Journal of Experimental Psychology*, 56A, 233-262.

Spivey, M. J., & Marian, V. (1999). Cross talk between native and second languages: Partial activation of an irrelevant lexicon. *Psychological Science*, 10, 281-284.

Van Hell, J. G., & Dijkstra, T. (2002). Foreign language knowledge can influence native language performance in exclusively native contexts. *Psychonomic Bulletin & Review*, 9, 780-789.

Van Heuven, W. J. B., Dijkstra, T., & Grainger, J. (1998). Orthographic neighborhood effects in bilingual word recognition. *Journal of Memory and Language*, 39, 458-483.

Van Wijnendaele, I. & Brysbaert, M. (2002). Visual word recognition in bilinguals: Phonological priming from the second to the first language. *Journal of Experimental Psychology: Human Perception and Performance*, 28, 616-627.

Weber, A., & Cutler, A. (2004). Lexical competition in non-native spoken-word recognition. *Journal of Memory and Language*, 50, 1-25.

Weber, A., & Paris, G. (2004). The origin of the linguistic gender effect in spoken-word recognition: Evidence from non-native listening. *Proceedings of the Twenty-Sixth Annual Meeting of the Cognitive*

Science Society (pp. 1446-1451). Mahwah, NJ: Lawrence Erlbaum.

Wilson, M. (1997). MRC psycholinguistic database: Machine usable dictionary, version 2.00. Retrieved November 16, 2003, from www.psy.uwa.edu.au/mrcdatabase/uwa_mrc.htm

Wise, C. M. (1958). *Introduction to Phonetics*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Zevin, J. D., & Seidenberg, M. S. (2002). Age of acquisition effect in word reading and other tasks. *Journal of Memory and Language*, 47, 1-29.