ACROSS-LANGUAGE PRIMING IN BILINGUALS: DOES ENGLISH *BET* PRIME FRENCH *BÊTE*?

Rory Turnbull[a,b], Sharon Peperkamp[b]

[a]Department of Linguistics, University of Hawaiʻi at Mānoa, Honolulu, HI, USA

[b]Laboratoire de Sciences Cognitives et Psycholinguistique (ENS, EHESS, CNRS),

Département d'Études Cognitives, École normale supérieure, PSL University, Paris, France

rory.turnbull@hawaii.edu

ABSTRACT

Different languages often share speech sounds, and some degree of phonological similarity or equivalence is commonly assumed between these shared sounds. We investigated phonological representations in late bilinguals through a phonological priming paradigm, where participants heard an English CVC prime followed by a French CVC target. Prime-target pairs either matched (e.g. *bet*, *bête*) or mismatched (e.g. *seed*, *pâte*). If the prime and target share a phonological representation, then responses to the target should be speeded in the matching condition relative to the mismatching condition. In three lexical decision experiments, we tested both French–English and English–French bilinguals. We found no evidence that phonologically matching primes facilitate lexical access. We discuss these results in light of our understanding of phonological representations in bilinguals, language-switching, and priming.

Keywords: phonological priming, auditory priming, interlingual homophones, lexical decision

1. INTRODUCTION

Spoken languages often share similar sounds. For bilingual or multilingual speakers, this raises a question about mental representation: to what extent do these speakers represent the phonemes of different languages with the same abstract units? Consider English *peel* /pil/ and French *pile* 'battery' /pil/. Although these words differ in phonetic detail ([pʰi̞ːᵊɫ] and [pil̥] respectively), many speakers regard these words as having 'the same sounds'. Indeed, $pile_F$ is regarded as more similar to $peel_E$ than it is to, say, $pale_E$ or $teal_E$.[1]

Prior work has claimed that words 'with the same sounds' facilitate lexical access for bilinguals in unambiguous environments. For example, faster picture naming was observed for (near-)matching words (Catalan *gat*, Spanish *gato*) than for non-matching words (Catalan *taula*, Spanish *mesa*) [4, 9]. Similar results have been found in the domain of speech perception [11, 14]: for example, a visual-world study found that German–English and English–German bilinguals were briefly distracted by a competitor image of a *lid* (German *Deckel*) when searching for the target *desk*, even though the experiment was entirely in English [1]. The consensus that emerges from this literature is that cross-linguistic phonological competitors ('interlingual homophones') influence lexical access.

What is unclear, however, is what exactly constitutes a phonological competitor. For the most part, the previous literature has simply assumed that equivalence exists between some pairs (e.g. English /f/ and French /f/) but not between others (e.g. English /k/ and French /œ̃/). These assumptions are largely uncontroversial. However, some phonemes appear to have multiple possible correspondents in the other language, or none at all. Returning to the $pile_F$ example from earlier: we suggested that this word is most similar to $peel_E$, but another plausible mapping is to $pill_E$. It has been proposed that in cases like this, the most phonetically similar mapping is primary while the other is secondary [17]. However, it has been noted that structural issues (such as patterns of allophony, phonotactics, and featural oppositions) are just as, if not more, relevant than plain phonetic similarity [2].

Phonological priming can be used as a diagnostic in determining the similarity of phonemes [8, 16], and could be useful in disentangling these questions. A first step is therefore to determine if the phonological priming paradigm can be used to assess interlingual equivalence in general. This paper reports on three experiments which attempt to answer this question. These all followed the same method: Participants were presented with an English prime, followed by a French target. The task was lexical decision on the target. If an English prime (such as *loop*$_E$ /lup/) leads to facilitation of lexical access to a phonologically similar French target (such as *loupe*$_F$ /lup/ 'magnifying glass'), we can conclude that the phonological representations of the word are similar. If, however, *loop*$_E$ does not facilitate *loupe*$_F$, then their phonological representations must be dissimilar.

2. EXPERIMENT 1

2.1. Participants

Thirty French L1 English L2 bilinguals (23 female) participated in this experiment. Their mean age was 24.3 years (min: 18; max: 33). All participants were native speakers of French and had lived in French-speaking countries their entire lives. They began learning English at a mean age of 10 years (max: 14; min: 6).

2.2. Stimuli

Stimuli consisted of 173 English primes (all real words) and 162 French targets (including both words and nonwords). From these, 389 unique prime–target pairs were constructed. The target either matched the prime in terms of gross phonology (e.g. *bet*$_E$ /bɛt/ preceding *bête*$_F$ /bɛt/), or did not match (e.g. *bet*$_E$ /bɛt/ preceding *loupe*$_F$ /lup/, or *bet*$_E$ preceding */vys/). The majority of stimuli were CVC, with some CCVC and CVCC. Both words and nonwords could be preceded by a phonologically similar prime. This control meant that participants could not simply listen to whether the two words 'sounded similar'; they instead had to perform full lexical access on the target word.

A further distinction was made among the primes according to whether they could be plausibly interpreted as an English pronunciation of a French word. For example, *loop*$_E$ /lup/ could be considered to be an English-accented production of *loupe*$_F$. On the other hand, *bed*$_E$ cannot be interpreted in this way because /bɛd/ is not a French word. A possible task-specific strategy that participants could adopt is to attend to the English prime *as if it were French*, perform French lexical decision on the prime, and immediately respond with their decision if the target is phonetically similar to the prime. While the inclusion of non-French-sounding primes does not entirely invalidate this strategy, it allows for it to be tested and controlled at the analysis stage. That is, if this strategy is being used then we expect to observe faster responses to French nonwords following non-French-like primes and French lexical words following French-like primes, relative to all other conditions.

Table 1: Overview of trial types, varying in lexicality of target word, the French-like-ness of the prime word, and the phonological match or mismatch between prime and target. W: Word trial; NW: Non-word trial; FP: French-like prime; NFP: Non-French-like prime.

			FP	NFP
Match	W	Prime	*loop* /lup/	N/A
		Target	*loupe* /lup/	N/A
	NW	Prime	N/A	*bed* /bɛd/
		Target	N/A	*/bɛd/
Mismatch	W	Prime	*bet* /bɛt/	*trade* /tɹeɪd/
		Target	*loupe* /lup/	*loupe* /lup/
	NW	Prime	*bet* /bɛt/	*good* /gʊd/
		Target	*/vys/	*/piʃ/

All words (primes and targets) were preceded by a grammatically appropriate particle, such as *the*$_E$ or *le*$_F$. This step was taken to maximize intelligibility of the short stimuli by L2 listeners, and because many bare nouns in French are ungrammatical without a particle. While most research on phonological priming has used bare words (e.g. [6, 13]), short phrases have been shown to lead to equivalent priming effects [16].

The different trial types are summarized in Table 1. Four counterbalanced lists were constructed, each consisting of 56 words and 56 nonwords with French-sounding primes, and 22 words and 22 nonwords with non-French-sounding primes. Of the word trials, 28 were matching and 50 non-matching; and of the nonword trials, 11 were matching and 68 non-matching. No participant was presented more than once with a given prime or a given target.[2] The prime phrases were recorded by a male native speaker of English, and the target phrases by a female native speaker of French.

2.3. Procedure

Participants were randomly assigned to one of the counterbalanced lists. The procedure followed that of [16]: The prime phrase was presented on screen. The recording of the prime was presented over headphones 500 ms later. At the offset of the audio, the visual display was replaced by a fixation cross. After another 500 ms delay, the target was presented over headphones. Participants responded "word" or "nonword" to the last word of the target phrase. The next trial began 750 ms after a response was registered. Every 7 trials, participants were prompted by question on the screen where they were asked if they had encountered a particular prime before. This secondary task was intended to ensure that participants were paying attention to the primes; they received visual feedback on their accuracy.

2.4. Analysis

A mixed-effects linear regression model was constructed to predict (log-transformed) reaction time to correctly answered target trials. Fixed effects were match condition (matching vs not matching), prime type (French-like prime vs non-French-like prime), target word frequency (z-transformed), and prime word frequency (z-transformed). Random intercepts of prime word, target word, and participant were included along with a random slope for match condition by prime word, target words, and participant. This was the largest random slope structure that led to reliable convergence.

An additional analysis was undertaken in order to check for the use of the task-specific strategy of performing lexical decision on the English prime as if it were French, and then accepting or rejecting the target if there was an approximate phonological match between the words. For each participant, a t-test was performed to compare the reaction times of trials which were eligible for this strategy to the reaction times of other trials.[3]

2.5. Results

Mean reaction times are reported in Table 2. All participants scored above chance on the lexical decision task, and so none were excluded. Thirty-eight items were removed for having accuracy rates below chance. This left 1499 correct responses to target items that could be analyzed. No significant effects in the mixed-effects model were observed (all $p > .3$). Thus, there was no systematic difference between the conditions, even when accounting for the ability of the prime to be interpreted as a French word. The t-tests revealed no evidence for strategic bias in the results. (Three participants actually responded significantly more *slowly* to trials with the hypothetically beneficial conditions.)

2.6. Discussion

This experiment revealed no evidence of priming from English into French for French–English late bilinguals. It is plausible that the lack of an effect could be attributed to the fact that English is the L2 of these participants, and we expect greater influence of L1 on L2 processing than vice versa (i.e. language transfer [7]). That is, to observe true interlingual priming we may need to use the L1 to prime the L2. This possibility motivated Experiment 2, where we tested English–French bilinguals.

Table 2: Mean of by-subject mean reaction times for Experiment 1, split by condition. Standard deviations in parentheses.

Prime type	Similarity	RT (ms)
French-like	Match	760 (172)
French-like	Mismatch	771 (160)
Non-French-like	Mismatch	763 (164)

3. EXPERIMENT 2

3.1. Participants

Eleven English L1 French L2 bilinguals (9 female) participated in this experiment. Their mean age was 24.5 years (min: 21; max: 28). The participants were working or studying in Paris at the time of the experiment, and began learning French at a mean age of 12.5 (min: 5; max: 22). Each participant had been resident in France for between 1 and 6 years at the time of the experiment.

3.2. Stimuli, procedure, analysis

The stimuli and procedure were identical to those of Experiment 1, with one exception: the prime was only auditory, not visual. This was done because it was thought that the participants, being English natives, would not need visual assistance in comprehending the prime. Analysis followed that of Experiment 1. Due to convergence issues no random slopes were included.

3.3. Results

Mean reaction times are reported in Table 3. No participants were excluded: 478 data points from correctly-answered target word trials were thus available for analysis. More frequent words had faster reaction times than less frequent words ($\beta = -0.078$, $t = -2.549$, $p = .014$). No other significant effects were observed (all $p > .4$). The t-tests revealed no evidence for strategic bias in the responses.

3.4. Discussion

A comparison of overall mean accuracy rates suggests that these English–French bilinguals (mean: 70.1%) were less adept at the lexical decision task

Table 3: Mean of by-subject mean reaction times for Experiment 2, split by condition. Standard deviations in parentheses.

Prime type	Similarity	RT (ms)
French-like	Match	839 (180)
French-like	Mismatch	870 (164)
Non-French-like	Mismatch	846 (218)

than the French–English participants of Experiment 1 (mean: 79.5%). Nevertheless, the lack of any indication of a priming effect is surprising. A possible confound is the high cognitive load of the experiment—the stimulus phrases varied in syntactic class, and different word classes are known to be processed differently [10, 3]. Experiment 3 therefore restricted the stimuli to nouns only.

4. EXPERIMENT 3

4.1. Participants

Nine English L1 French L2 bilinguals (seven female) participated in the experiment. Their mean age was 26.7 years (min: 20; max: 32). The participants were working or studying in Paris at the time of the experiment, and began learning French at a mean age of 15.1 (min: 7; max: 27). Each participant had been resident in France for between 1 and 6 years at the time of the experiment.

4.2. Stimuli, procedure, analysis

A subset of the stimuli from Experiment 1 were chosen. Only nouns were selected, and organized into three lists of 106 prime–target pairs each, with the same proportions of words–nonwords and French-sounding and non-French-sounding primes as in Experiments 1 and 2. Leading particles were omitted from both prime and target, since all stimuli were nouns. The procedure followed that of Experiment 2. Analysis followed that of Experiment 2. Due to convergence issues the random intercept of prime word was not included.

4.3. Results

Mean reaction times are reported in Table 4. Two participants had accuracy at chance level and were not included in the analysis. As a result, 235 correct responses to target words were available for analysis. No significant effects in the mixed-effects model were observed (all $p > .2$). The t-tests revealed no evidence for strategic bias in the results.

Table 4: Mean of by-subject mean reaction times for Experiment 3, split by condition. Standard deviations in parentheses.

Prime type	Similarity	RT (ms)
French-like	Match	788 (323)
French-like	Mismatch	708 (337)
Non-French-like	Mismatch	675 (217)

5. DISCUSSION AND CONCLUSIONS

Three experiments did not reveal evidence of cross-language phonological priming, from either L2 to L1 (Experiment 1) or L1 to L2 (Experiments 2 and 3). This result is surprising, as previous studies have observed competition and interference effects between L1 and L2 [1, 4, 9, 11, 14], as well as monolingual phonological priming in similar contexts to the current study [16].

Despite their relatively low number of participants, Experiments 2 and 3 had sufficient power to observe effects of equivalent magnitude to identity priming in monolingual contexts [16]. Indeed, examination of the condition means in Tables 3 and 4 suggest that there was not even a hint of a pattern towards priming. Repeating our modeling on pooled data from both of these experiments revealed the same pattern of non-significant results.

An alternative explanation for these null results might relate to the cost of language switching. Specifically, each trial involved such a switch, as the prime had to be processed in English and the target in French. Language switching is cognitively costly [12], and a prior study has reported a mean switch cost of over 100 ms in picture-naming tasks [15]. This delay is larger than the usual size of phonological priming effects [5, 13, 16], so it is possible that the language switching simply 'overwhelmed' any phonological priming effect. If this is the case, then the phonological priming paradigm is ultimately inappropriate for answering questions of phonological similarity between languages.

Future work could use a visual world paradigm, following [1], where the non-target language is implicitly rather than explicitly primed. Such an approach would avoid the possible issues of language switching. However, it is not clear whether the visual world paradigm is sensitive enough to detect the differences in magnitude of priming between, say, $peel_E$ and $pile_F$ versus $pill_E$ and $pile_F$. Further research towards achieving this long-term objective is clearly warranted.

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[1] Subscript E and F denotes English and French words respectively.

[2] The complete set of all stimuli, and the four counterbalanced lists, is available at https://github.com/roryturnbull/BilingualPhonologicalPrimingICPhS19.

[3] A reviewer asks why we did not simply include this factor as a fixed effect in our models. A fixed effect would only assess whether there was a strategic bias *in aggregate* across all participants in a given experiment. Since we did not expect a strategic bias, if present, to exist for all participants, we instead looked for the presence of bias in each participant individually.