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# Lexical selection differences between monolingual and bilingual listeners ☆

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ABSTRACT

Three studies are reported investigating how monolinguals and bilinguals resolve within-language competition when listening to isolated words. Participants saw two pictures that were semantically-related, phonologically-related, or unrelated and heard a word naming one of them while event-related potentials were recorded. In Studies 1 and 2, the pictures and auditory cue were presented simultaneously and the related conditions produced interference for both groups. Monolinguals showed reduced N400s to the semantically-related pairs but there was no modulation in this component by bilinguals. Study 3 inserted an interval between picture and word onset. For picture onset, both groups exhibited reduced N400s to semantically-related pictures; for word onset, both groups showed larger N400s to phonologically-related pictures. Overall, bilinguals showed less integration of related items in simultaneous (but not sequential) presentation, presumably because of interference from the activated non-English language. Thus, simple lexical selection for bilinguals includes more conflict than it does for monolinguals.

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## 1. Introduction

In the bilingualism literature, language processing and executive control (EC) are usually investigated separately. For the former, bilinguals typically exhibit lower levels of language proficiency and slower linguistic processing than monolinguals (review in Kroll, Dussias, Bogulski, & Valdes Kroff, 2012); for the latter, bilinguals often demonstrate faster or more efficient processing on non-verbal cognitive control tasks than monolinguals (review in Bialystok & Craik, 2010). Explanations for observed bilingual processing advantages in non-verbal tasks have focused on descriptions of how bilinguals manage their two languages, essentially combining these two areas of investigation. The key point is that both languages of a bilingual are jointly activated, so bilinguals must select between the target and distractor languages and ignore alternatives from the non-target language. This constant need to resolve competition between jointly-activated languages explains both the difficulty in linguistic processing and the enhancement of domain-general control (Bialystok, Craik, Green, & Gollan, 2009). Yet, monolinguals are also subject to selection pressures from within-language alternatives (e.g., cup vs. mug). If this selection process is similar for monolinguals within a language as it is for bilinguals selecting across languages, then such linguistic selection is unlikely to be responsible for the bilingual advantages in domain-general control because speakers in both groups should benefit equally. The present study used event-related potentials (ERPs) to compare these lexical selection processes for monolinguals and bilinguals within a single language. The hypothesis is that cross-language selection adds unique processing demands for bilinguals and results in less within-language integration on related stimuli even within a single language. Failure to integrate related within-language stimuli would reflect greater conflict and the need to recruit more EC. Thus, evidence for different processes underlying lexical selection in a single language will clarify the putative mechanism by which bilingualism leads to enhanced executive control and link the two lines of research into a more coherent explanation.

The notion motivating the present study is that the continual involvement of executive control in language selection makes language processing inherently different for bilinguals than it is for monolinguals. As such, selection between lexical competitors will be carried out differently by the two groups. Support for this claim comes from studies by Marian and colleagues who compared monolingual and bilingual performance on within-language

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phonological competition using both eye-tracking (Blumenfeld & Marian, 2011) and functional MRI (Marian, Chabal, Bartolotti, Bradley, & Hernandez, 2014). In the visual world paradigm, participants search for a target in a display of four pictures (or objects). On competitor trials, one of the pictures shares a phonological onset (e.g., candy) with the target (e.g., candle). Consistent with previous studies, more fixations were observed on phonological competitors than unrelated pictures for both monolinguals and bilinguals (Allopenna, Magnuson, & Tanenhaus, 1998; Desroches, Joanisse, & Robertson, 2006; Marian & Spivey, 2003). Blumenfeld and Marian further postulated that since the phonological distractor was a strong lexical competitor, it should require greater inhibition and produce larger negative priming effects in subsequent responses to that quadrant than would neutral pictures on a probe task. The authors found that the monolingual group, but not the bilingual group, was slower to identify the location of a gray asterisk among black asterisks when it was in the location previously occupied by the phonological distractor than they were for gray asterisks in a control location. Thus, larger negative priming was found for monolinguals than for bilinguals suggesting that bilinguals demonstrated better control by being able to disengage attention following the trial. Consistent with this interpretation, Marian et al. (2014), found that monolinguals showed greater recruitment of executive control regions (e.g., anterior cingulate, superior frontal gyrus) when performing the task, indicating more effortfulness. These studies demonstrate that monolinguals and bilinguals use different selection and inhibitory processes to understand isolated words, supporting the possibility for different engagement of EC resources in lexical processing.

Similar arguments can be applied to the way in which monolinguals and bilinguals process semantic competition. In the monolingual literature, semantic competition has been demonstrated by means of more fixations to semantic competitors in a visual world paradigm (e.g., Huettig & Altmann, 2005) and slower picture naming latencies following a semantic prime (e.g., Schriefers, Meyer, & Levelt, 1990). Yet little is known about how bilinguals resolve semantic competition. For bilinguals, several models assume a shared but language-independent semantic/conceptual store (e.g., Revised Hierarchical Model, Kroll & Stewart, 1994; Bilingual Interactive Activation model, Dijkstra & van Heuven, 2002; Distributed Lexical/Conceptual Feature Model, De Groot, 1992; see Francis, 2005 for a review). As such, the strength and nature of lexical links from each language to semantic knowledge may differ depending on specific linguistic knowledge, but simple semantic processing (e.g., is the object in this picture natural or man-made?) is likely to be comparable for monolinguals and bilinguals (Gollan, Montoya, Fennema-Notestine, & Morris, 2005). Nonetheless, selecting a concept for language production is not akin to simple semantic processing, since speakers must select between close yet competing alternatives and attach this concept to a word in one language.

Understanding how resolution of phonological and semantic competitors may differ for bilingual and monolingual listeners is important because it will provide insight into explaining the enhancement of EC found for bilinguals. Examining how conflict resolution unfolds in real time is best determined with event-related potentials (ERPs), a measure that is sensitive to online processing. Consequently, we utilized a speech perception task to examine processes that are used during language production, namely identifying pictures and assigning them labels. In the Picture Selection Task, each target picture (e.g., monkey) was paired with an alternative that was related semantically (e.g., gorilla), phonologically (e.g., money), or unrelated (e.g., belt). An auditory word was simultaneously presented and participants were required to select the named picture by means of a key press. Based on previous eye-tracking studies, related stimuli were expected to induce response competition (e.g., Allopenna et al., 1998; Blumenfeld & Marian, 2011). For semantic competition, both pictures must be recognized so the distinctive features for the target word can be identified and associated with an appropriate lexical label. For phonological competition, the target word must be interpreted in the correct language, but bilinguals need to attend to the phonological information relevant only for that language and possibly ignore the translation equivalents activated by the pictures. Thus, the nature of the competition from these two sources is expected to be substantially different from each other.

Given the novelty of the task, it is difficult to fully predict the electrophysiological outcomes, but extrapolation from previous ERP studies leads to several hypotheses. For semantically-related pairs, the most relevant ERP component is the N400. This component is sensitive to semantic and lexical mismatches between the stimulus and expectations such that mismatches are associated with larger negative amplitudes than matches (Kutas & Federmeier, 2011). In paradigms in which two semantically related pictures are presented either sequentially (Holcomb & McPherson, 1994; McPherson & Holcomb, 1999) or simultaneously (Zani et al., 2015), relatedness has resulted in less N400 negativity than found on unrelated pairs. This attenuation of the N400 for related primes has been interpreted as semantic integration (Holcomb & McPherson, 1994; Kutas & Federmeier, 2011). Presenting phonologically-related stimuli simultaneously has also been found to produce less negative waveforms than unrelated pairs (e.g., Dumay et al., 2001; Praamstra, Meyer, & Levelt, 1994). For example, Dell'Acqua et al. (2010) reported that electrophysiological responses to pictures with phonologically-related superimposed words (i.e., the picture name and word shared two or three initial phonemes) produced less negative waveforms from 250 to 450 ms than unrelated pairs.

The demands of the Picture Selection Task differ from priming tasks and relatedness judgments used in previous research where recognizing the relationship between stimuli aids responses. Consequently, phonological and semantic competition in the present case is expected to result in longer response times than will be found for unrelated stimuli. In the ERP data, it would be reasonable to hypothesize that greater negativity in the N400 would be observed in the presence of conflict. However, a study by Blackford, Holcomb, Grainger, and Kuperberg (2012) found a different pattern: when a semantically-related auditory prime preceded a picture, there was a reduced N400 but longer picture naming time than there was for an unrelated prime. The N400 indexed the perceived relationship between the prime and the target, but the recognition of the relationship interfered with their ability to make a verbal response. In the present paradigm, participants must also select between two related alternatives. Thus, it was hypothesized that for monolinguals, related pairs would produce both N400 attenuation and behavioral interference expressed as longer RTs.

A study by Kotz (1997) provides insight into potential group differences between monolinguals and bilinguals in their electrophysiological responses to related stimuli. Participants performed a visual lexical decision task that included a semantic priming manipulation, with primes presented at three SOAs. Monolinguals exhibited N400 attenuation for related prime-target pairs at all three SOAs but bilinguals exhibited a reduction in the N400 at SOAs of 200 ms and 800 ms but not at 0 ms when the target and prime were presented simultaneously. Kotz offered several possible explanations for this difference including less automatic spreading activation in bilinguals and insufficient time to access the meaning of both words in the L2. However, unlike longer SOAs, an SOA of 0 ms presents a problem of concurrent selection, a situation that may differentially impact bilinguals and monolinguals because it is similar to the bilingual experience in which

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