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Research report

Electrophysiology of cross-language interference and facilitation in picture naming

Ardi Roelofs [a,*], *Vitória Piai* [b], *Gabriela Garrido Rodriguez* [c] *and Dorothee J. Chwilla* [a]

[a] *Radboud University, Nijmegen, The Netherlands*
[b] *Department of Psychology and Helen Wills Neuroscience Institute, University of California, Berkeley, CA, USA*
[c] *Max Planck Institute for Psycholinguistics, Nijmegen, The Netherlands*

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ABSTRACT

Disagreement exists about how bilingual speakers select words, in particular, whether words in another language compete, or competition is restricted to a target language, or no competition occurs. Evidence that competition occurs but is restricted to a target language comes from response time (RT) effects obtained when speakers name pictures in one language while trying to ignore distractor words in another language. Compared to unrelated distractor words, RT is longer when the picture name and distractor are semantically related, but RT is shorter when the distractor is the translation of the name of the picture in the other language. These effects suggest that distractor words from another language do not compete themselves but activate their counterparts in the target language, thereby yielding the semantic interference and translation facilitation effects. Here, we report an event-related brain potential (ERP) study testing the prediction that priming underlies both of these effects. The RTs showed semantic interference and translation facilitation effects. Moreover, the picture-word stimuli yielded an N400 response, whose amplitude was smaller on semantic and translation trials than on unrelated trials, providing evidence that interference and facilitation priming underlie the RT effects. We present the results of computer simulations showing the utility of a within-language competition account of our findings.

1. Introduction

A central issue in bilingual language performance concerns how bilingual speakers manage to select words in a target language while ignoring words in another language. In particular, how are bilingually non-balanced speakers able to select words in a weaker language (e.g., their non-dominant second language) while ignoring words in a stronger language (i.e., their dominant first language)? Bilingual speakers appear to be very good at this. For instance, Poulisse and

* *Corresponding author*. Radboud University, Donders Institute for Brain, Cognition and Behaviour, Centre for Cognition, Spinoza Building, B.02.34, Montessorilaan 3, 6525 HR, Nijmegen, The Netherlands.
E-mail address: A.Roelofs@donders.ru.nl (A. Roelofs).
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Bongaerts (1994) observed that in second-language (English) picture naming, story retelling, and free conversation by Dutch-English bilingual speakers, only .5 percent of all words produced were first-language (Dutch) intrusions (i.e., 771 out of about 140,000 words). In the literature, three main views have been proposed about how bilingual speakers accomplish this feat (see Hall, 2011, for an extensive review). According to the between-language competition view, words in both languages are activated and compete for selection, but speakers select the words in the target language by selectively boosting their activation (De Bot, 2004) or by inhibiting words in the other language (e.g., Green, 1998; Kroll, Bobb, Misra, & Guo, 2008; Kroll, Bobb, & Wodniecka, 2006). According to the within-language competition view, words in both languages are activated but only words in the target language compete for selection (Costa, 2005; Costa & Caramazza, 1999; Roelofs, 1998, 2003, 2010; Roelofs, Dijkstra, & Gerakaki, 2013). Finally, according to the no-competition view, words in both languages are activated, but the activation of words in the target language is boosted and therefore they exceed a selection threshold first and will be selected (Finkbeiner, Gollan, & Caramazza, 2006).

In testing between these theoretical views, a major tool has been the picture-word interference paradigm, in which speakers name pictures while trying to ignore superimposed distractor words. In a bilingual version of this paradigm, pictures have to be named in one language and the distractor words are from the other language. All three views assume that pictures activate words in both languages, but they differ in whether words in another language compete, or competition is restricted to a target language, or no competition occurs. In Sections 1.1 and 1.2, we briefly describe the key behavioral results from monolingual and bilingual picture-word interference studies and we argue that the available response time (RT) evidence is most compatible with the within-language competition view (but see Hall, 2011). Whereas RT studies measure the time elapsing between picture and articulation onset, event-related brain potential (ERP) studies provide electrophysiological information about processing events happening during this time interval. Previous studies have reported characteristic ERP modulations in monolingual picture-word interference, but there is a lack of evidence on bilingual versions of the paradigm. The aim of the research reported in the present article is to fill this gap. In Section 1.3, we briefly describe the ERP evidence on monolingual picture-word interference and outline predictions for bilingual performance. In Sections 2 and 3, we report on a new ERP experiment testing these predictions. In Section 4, we evaluate the three theoretical views on bilingual lexical selection (i.e., between-language competition, within-language competition, and no competition) with respect to their ability to account for our findings, and we present the results of computer simulations showing the utility of a within-language competition account.

1.1. *Monolingual picture-word interference*

In the widely used monolingual version of the picture-word interference paradigm, speakers name pictures in their native language while trying to ignore spoken or written distractor words in the same language. For example, speakers of English say "horse" to a pictured horse combined with the written word *duck* (i.e., a word from the same semantic category, here animals; the semantic condition), the word *chair* (the unrelated condition), the word *horse* (the identity condition), or a row of Xs (the non-linguistic control condition). RT is typically longer on semantically related than on unrelated trials, called *semantic interference* (e.g., Damian & Martin, 1999; Glaser & Düngelhoff, 1984; Glaser & Glaser, 1989; Rayner & Springer, 1986). Moreover, RTs are longer on unrelated than on control trials, an effect of *lexicality* (e.g., Glaser & Düngelhoff, 1984; Glaser & Glaser, 1989; Roelofs, 2006, 2007). Finally, RTs are shorter on identity than on unrelated trials, an *identity facilitation* effect (e.g., Glaser & Düngelhoff, 1984; Glaser & Glaser, 1989; Roelofs, 2006, 2007).

According to a competition account of lexical selection (e.g., Roelofs, 1992), a semantically related distractor word receives activation from the target picture and is therefore a more potent competitor to the picture name than an unrelated distractor word, which is not activated by the picture. Neumann (1986) and La Heij, Dirkx, and Kramer (1990) referred to this mechanism underlying semantic interference as *reverse priming*. Although a semantically related distractor word will also prime the picture name, this target priming is assumed to be less than the reverse priming of the distractor because of functional distance, as we further explain below. As a consequence, the net effect is semantic interference in RTs. Moreover, when the distractor corresponds to the name of the picture, the target word is primed at all planning levels, yielding the identity facilitation effect. This account of semantic interference and identity facilitation has been computationally implemented in a number of models of word production, including the model of Starreveld and La Heij (1996) and WEAVER++ (Levelt, Roelofs, & Meyer, 1999; Roelofs, 1992, 1993, 1997, 2003, 2006, 2007, 2008a, 2008b, 2008c, 2014).

The WEAVER++ model assumes that information about words is stored in a large declarative associative network. This network is accessed by spreading activation while procedural condition-action rules determine what is done with the activated lexical information depending on the goal (cf. Anderson et al., 2004; Eliasmith, 2013). In picture-word interference experiments, the goal is to name a picture and ignore a superimposed word. A fragment of the lexical network of WEAVER++ is illustrated in Fig. 1 for the words *duck* and *horse*. According to the model, the naming of pictures involves the activation of nodes for lexical concepts, lemmas, morphemes, phonemes, and articulatory programs. For example, naming a pictured horse involves the activation and selection of the representation of the concept HORSE(X), the lemma of *horse* specifying that the word is a noun (for languages such as Dutch, lemmas also specify grammatical gender), the morpheme <horse>, the phonemes /h/, /ɔ:/, and /s/, and the articulatory program [hɔ:s] for British English. The model assumes that perceived pictures have direct access to concepts [e.g., HORSE(X)] and only indirect access to lemmas (e.g., *horse*) and word forms (e.g., <horse> and /h/, /ɔ:/, and /s/), whereas perceived words have direct access to lemmas (e.g., *duck*) and word forms (e.g., <duck> and /d/, /ʌ/, and /k/) and only indirect access to concepts [e.g., DUCK(X)].