On keeping cool: The role of inhibition in bilingual word processing

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One of the cool aspects of the original implementation of the BIA model (van Heuven, Dijkstra, & Grainger, 1998) was the discovery that inhibitory connections between language nodes and lexical representations was a necessary feature for the model to be able to simulate the target data set at that time. This demonstrates the importance of computational modeling, a key point of the present target article, since in the conceptual model (Grainger & Dijkstra, 1992), inhibitory connections were postulated to occur only between representations at the same level. Top-down inhibition was subsequently dropped in the BIA+ model (Dijkstra & van Heuven, 2002), and the Multilink model of the present target article (Dijkstra et al., 2018) goes one step further by removing all kinds of inhibitory connections, both between and within levels. Instead, the authors of the model propose that bilingual language processing relies on bidirectional excitatory connections between representations at different levels. This is curious given that even more evidence has accumulated in favor of inhibition since the original implementation of the BIA model, both between neighboring lexical representations (i.e., lateral inhibition) and from language membership representations (e.g., language nodes and tags) down to lexical representations. In this commentary, we focus on whether the exclusion of these two inhibitory processes is warranted, and how the inclusion of these processes might benefit future developments of the model.

Lateral inhibition, which entails inhibitory connections between activated lexical representations, was deactivated in Multilink for the sake of simplicity. However, the literature indicates that lateral inhibition is an important process in the activation and selection of lexical representations both in production (e.g., Sadat, Martin, Costa, & Alario, 2014) and comprehension (e.g., Bijeljac-Babic, Biardeau, & Grainger, 1997; Meade, Grainger, Midgley, Emmorey, & Holcomb, 2018). For example, masked neighbor word primes interfere with processing of the target and slow lexical decision responses relative to orthographically unrelated word primes, and thus provide evidence for lateral inhibition between activated lexical representations. This competition occurs across languages (e.g., Bijeljac-Babic et al., 1997) and is established quite early in second language learners (e.g., Meade, Midgley, Dijkstra, & Holcomb, 2018).

Language membership representations are another important source of inhibition in the literature. In Multilink, language membership representations are connected with both orthographic and phonological lexical representations, but with bidirectional excitatory connections rather than inhibitory ones (cf. Figure 1). However, there is little justification of this choice in the text. Moreover, the lack of inhibitory connections contradicts the empirical evidence for such connections in bilingual language production (e.g., Declerck, Thoma, Koch, & Philipp, 2015) and comprehension (e.g., Declerck & Philipp, 2018). More specifically, these studies observed n-2 language repetition costs, which is typically considered a marker for inhibition coming from language membership representations.

Including one or both of these inhibitory processes might circumvent some of the issues raised by the authors of Multilink. For example, the cognate facilitation effect can be simulated with Multilink, but the effect was exaggerated relative to the size of empirical cognate facilitation effects. The authors addressed this issue by reducing the input activation of the least activated node by a factor of two. However, this ad hoc solution merely allows the model to mimic the empirical data without providing a better understanding of the underlying mechanisms. A more ecologically valid approach to decreasing the cognate facilitation effect might be to include lateral inhibition. Assuming that (non-identical) cognates have separate, language-specific lexical representations, lateral inhibition between these two form representations could substantially reduce their activation. This would lead to diminished activation of the associated semantic and phonological representations and a smaller cognate facilitation effect. Alternatively, inhibition from language membership representations to lexical representations in the non-target language should also reduce the activation of the translation equivalent, and thus have a similar effect.

Based on the evidence in the literature, we would argue that lateral inhibition and inhibition from language membership representations deserve further consideration. We are especially interested in whether implementing one or both of these mechanisms in Multilink would reduce the size of the cognate facilitation effect. Making these changes should be straightforward given the precedent set by previous computational models. Indeed, lateral inhibition is already implemented in Multilink, but was deactivated in the current version. Similarly, connections to and from language membership representations exist in Multilink, but are excitatory rather than inhibitory. It remains to be seen whether these changes will enhance the model’s performance in addition to improving its empirical validity.

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