Commentary on "Multilink: a computational model for bilingual word recognition and word translation" by Dijkstra, Wahl, Buytenhuijs, van Halem, Al-jibouri, de Korte, and Rekké (2018)

The need for a universal computational model of bilingual word recognition and word translation

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Dijkstra, Wahl, Buytenhuijs, van Halem, Al-jibouri, de Korte, and Rekké (2018) present in their keynote article a promising computational model of word recognition and word production in monolinguals and bilinguals, called Multilink. We agree with the authors that the model is a "basis for the development of a more general computational model of word retrieval" (Dijkstra et al., 2018). However, it is also important that such model is universal.

To evaluate whether the model's assumptions are universal, we believe that Multilink should also be evaluated with findings from studies involving different-script (e.g., Chinese-English) bilinguals, because simulations presented in the keynote article focus only on studies with stimuli from alphabetic languages (Dutch and English).

Computational models generally use input representations that are based on the language's writing system (e.g., letters in alphabetic languages). However, there are no letter representations in Multilink to avoid issues with slot-based letter coding systems used in many computational models (Grainger & van Heuven, 2003). This feature of the Multilink reduces the complexity of the model. Importantly, the model is still able to activate orthographically related words based on the input because of the use of a lexical activation function that is based on orthographic similarity (Levenshtein distance). If a similar orthographic similarity measure could be adapted for non-alphabetic languages, it would allow the model to simulate word recognition also in non-alphabetic languages.

To improve the universality of Multilink, it is also important to evaluate the model with data from paradigms that have been widely used with word recognition and word production tasks, such as the masked priming paradigm. As Dijkstra et al. (in press) mention in their keynote article, direct lexical links between translations in the Revised Hierarchical Model (RHM, Kroll & Stewart, 1994) have been challenged by empirical findings from, for example, masked translation priming studies. Based on the RHM's assumption of stronger lexical links from the second language (L2) to the first language (L1) than from L1 to L2, stronger masked translation priming effects from L2 to L1 are predicted than vice versa (Brysbaert & Duyck, 2010), which is inconsistent with the findings in the literature that revealed stronger L1 to L2 than L2 to L1 translation priming effects (for a recent meta-analysis, see Wen & van Heuven, 2017). Masked translation priming effects have already been successfully simulated with computational models (Wen & van Heuven, 2018; Zhao & Li, 2013). Thus, to capture the masked translation priming asymmetry is a crucial test of the model.

Masked priming data (e.g., translation, orthographic) might be especially challenging for Multilink because there is no lateral inhibition between word representations. For example, it is difficult to see how shared neigborhood effects (van Heuven, Dijkstra, Grainger, Schriefers, 2001) can be explained without lateral inhibition. Furthermore, Multilink has no bottom-up inhibitory connections. Thus, a prime word that has orthographic, phonological, or semantic overlap with a target word will received further bottom-up support when the target word is presented to the model, and therefore the prime remains highly active and potentially reaches the recognition threshold before the target word. Thus, inhibitory connections need to be considered in a future version of Multilink.

An important advantage of computational modelling is the ability to compare model variants (e.g., with or without crucial connections or by varying parameters, see for example, Wen & van Heuven, 2018) in order to understand the mechanisms that allow the model to account for empirical findings. The model-to-model comparisons in Dijkstra et al. (in press) are limited to comparing Multilink to other models. We believe it is important to contrast also different variants of Multilink.

In summary, we believe that Multilink is an important step towards the development of a complete computational model of bilingual word recognition and word translation. However, the model should be further developed in order to make it universal. We believe that a universal model needs to be able to account for findings with same-script and different-script bilinguals. Importantly, the model should be further evaluated with data from masked priming studies and inhibitory connections need to be considered in a future version of Multilink.

References

Dijkstra, T., Wahl, A., Buytenhuijs, F., van Halem, N., Al-jibouri, Z., de Korte, M., & Rekké, S. (in press). Multilink: a computational model for bilingual word recognition and word translation. *Bilingualism: Language and Cognition.*

Brysbaert, M., & Duyck, W. (2010). Is it time to leave behind the Revised Hierarchical Model of bilingual language processing after fifteen years of service? *Bilingualism: Language and Cognition, 13*(3), 359-371.

Grainger, J., & van Heuven, W. J. B. (2003). Modeling letter position coding in printed word perception. In P. Bonin (Ed.), *Mental lexicon: "Some words to talk about words"* (pp. 1-24). Hauppauge, NY, US: Nova Science Publishers.

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*(2), 149-174.

van Heuven, W. J. B., Dijkstra, T., Grainger, J., & Schriefers, H. (2001). Shared neighborhood effects in masked orthographic priming. *Psychonomic Bulletin & Review, 8*(1), 96-101.

Wen, Y., & van Heuven, W. J. B. (2017). Non-cognate translation priming in masked priming lexical decision experiments: A meta-analysis. *Psychonomic Bulletin & Review, 24*(3), 879-886.

Wen, Y., & van Heuven, W. J. B. (2018). Limited automatic translation in masked priming: Behavioural evidence from Chinese-English bilinguals. *Journal of Memory and Language, 101*, 84-96.

Zhao, X., & Li, P. (2013). Simulating cross-language priming with a dynamic computational model of the lexicon. *Bilingualism: Language and Cognition, 16*(2), 288-303.