Critical review of three models on how bilingual lexicon is organised

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Resumen
The present article critically reviews the two most influential hierarchical models that have been proposed to account for the organisation of the bilingual lexicon. That is, the word association and concept mediation models (Potter et al., 1984) and the Revised Hierarchical Model (RHM) proposed by Kroll and Stewart (1994). Finally, it will also examine recent research on how bilinguals organise the vocabulary of different languages and it will offer a conclusion.
Palabras clave: bilingual lexicon, bilingual brain, bilingualism, word association concept mediation model, Revised Hierarchical Model.

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Abstract
The present article critically reviews the two most influential hierarchical models that have been proposed to account for the organisation of the bilingual lexicon. That is, the word association and concept mediation models (Potter et al., 1984) and the Revised Hierarchical Model (RHM) proposed by Kroll and Stewart (1994). Finally, it will also examine recent research on how bilinguals organise the vocabulary of different languages and it will offer a conclusion.
Keywords: bilingual lexicon, bilingual brain, bilingualism, word association concept mediation model, Revised Hierarchical Model.

During the last decades, many scholars have tried to discern the unique mechanisms that bilinguals use to represent two languages in the brain and avoid interference when speaking in the target language. Hence, this critical review will be centred on analysing how and at what level the languages of a bilingual are interconnected in the brain. Therefore, first I will provide a brief and simplified description of these three studies which are central for the discussion on how the lexicon of a bilingual is organised. Moreover, I will examined the different models that these authors have proposed over time which are relevant to understand the mechanisms of the bilingual mind, especially I will concentrate on the hierarchical models of word association and concept mediation models (Potter et al., 1984) and the Revised Hierarchical Model (RHM) proposed by Kroll and Stewart (1994) and has exercised a pervasive influence on bilingualism research. Secondly, I will critically evaluate the methodology used and the results obtained by these experiments. Thirdly, I will examine the implications of these studies for the study of bilingualism. In addition, I will address recent and pertinent research to support my claims.

GENERAL OVERVIEW OF THE STUDIES AND THE MODELS ACCOUNTING FOR THE BILINGUAL MIND

Potter et al. (1984) aimed to test the hypotheses concerning the level of representation at which translation equivalents in the two languages of a bilingual might be associated. On the one hand, the word association model assumes that the bilingual accesses new second language (L2) words by the lexical link connecting the concepts with first language (L1) words. Thus, unbalanced bilinguals whose L2 is weaker than their L1 need to retrieve words in L1 before producing or understanding second language. On the other hand, the concept mediation model which appears to be adopted by more balanced bilinguals, claims that bilinguals do not resort to L1 words to speak or comprehend in their second language, since L2 words can access directly to concepts which are shared with L1 words. Therefore, Potter et al. (1984) engaged proficient Chinese-English bilinguals and the so called *relative novice* English-French bilinguals in a naming, translation and picture naming tasks in order to test the different hypotheses posed by the models. The word association model predicts that bilinguals will be slower in picture naming in L2 than in forward translation (i.e. from L1 to L2), since to accomplish the former, the bilingual needs to retrieve the concept and then the lexical representation of the word in L1 to produce the

name of the picture in L2, while in forward translation the speaker has already been provided with the concept and word in L1 and thus, the retrieval of the L2 word is hypothesised to be faster. On the contrary, since the concept mediation model states that L1 and L2 words can access concepts directly, and thus, there is no L1 mediation, forward translation and picture naming in L2 is predicted to follow similar processes. The authors reported similar times for forward translation and picture naming in L2 for both proficient bilinguals and surprisingly, for unbalanced bilinguals. Potter et al. (1984) interpreted these results as supporting the concept mediation model. They argued that regardless of proficiency level, bilinguals can access concepts directly, and there is no need of L1 concept mediation. Therefore, they failed to find evidence consistent with the developmental model which claimed that non-proficient bilinguals may assume a word association model during their first stages of second language learning and then as they become more proficient in their L2, they will change to a concept mediation model.

In addition, Kroll and Stewart (1994) challenged the concept mediation results for both proficient and unbalanced bilinguals obtained by Potter et al. (1984) by involving native English and Dutch-English fluent bilinguals in picture naming and translation tasks which were presented in semantic related or unrelated lists. They reported interference, when participants named pictures that were semantically categorised, but this inhibitory effect disappeared when it was alternated with word naming. Consistently with their claim that picture naming involves similar processes as translation, they found that the semantic category interference persisted in forward translation, which was interpreted as conceptually mediated. Moreover, they obtained faster translation times and less errors for backward than forward translation which meant that the former is by word to word associations while the latter is conceptually mediated for unbalanced bilinguals. To accommodate these results they propose the Revised Hierarchical Model (RHM) which assumes separate lexical level consisting of two separate lexicons, one for each language, L1 lexicon being bigger than the L2, because bilinguals know more words in their L1; and a shared conceptual level. The RHM assumes asymmetric connections between L1 and L2. The lexical link between L2 and L1 is stronger than that from L1 to L2, in the sense that unbalanced bilinguals will rely on word to word associations. In addition, during the early stages of L2 acquisition, the concepts in L2 are accessed via the much stronger link between L1 words and concepts. Nevertheless, as bilinguals become more proficient, they develop an independent connection between L2 words and concepts, but this will remain weaker than the L1 counterpart. It is worth mentioning, that this model includes the transitory and developmental aspects of bilingualism. During the early stages of L2, the bilingual tends to establish strong connections between new L2 words and their translation equivalents in L1. Nevertheless, as they become more proficient in their L2, they develop a stronger and direct link between L2 words and concepts, thus a proficient bilingual will comprehend and produce L2 words without L1 mediation.

Moreover, Kroll et al. (2002) addressed bilingual lexical access. Therefore, similar to previous studies, they engaged proficient and unbalanced English-French and English-Spanish bilinguals in word naming and translation tasks. They reported slower naming and translation times and more errors for unbalanced bilinguals producing L2 words compared to their proficient counterparts. These results are consistent with the translation asymmetries predicted by the RHM. Interestingly, they obtained slower naming times for unbalanced bilinguals in their L1 which was interpreted as a side effect of L2 learning.

EVALUATION OF THE METHODOLOGY AND RESULTS

As it can be seen, much of the linguistic research addressing the connections between L1 and L2 is based on translation or naming tasks of isolated words (e.g., Tokowicz & Kroll, 2007). In addition, these studies tend to oversimplify the far more complex process of translation. Kroll and Stewart (1994) claimed that especially during the early stages of L2 acquisition, the bilingual tends to associate the new L2 words with their L1 translation equivalents. Nevertheless, translation is not conceived as mere word-to-word mappings, since an L2 word may not shared the same representation at the conceptual level with the L1 word (Perea, Duñabeitia & Carreiras, 2008).

Moreover, translation in these studies has focused on concrete rather than abstract words. Tokowicz and Kroll (2007) stated that concrete words in L2 may share more semantic features with their L1 and thus, are translated faster compared to abstract words which may be weakly connected to more nodes in the semantic memory. Moreover, Basnight-Brown and Altarriba (2007) claimed that there may be language-specific concepts, in the sense that L2 words may not have an L1 representation which captures the full meaning of the word, and thus they may not share the same conceptual representation as the RHM suggests.

In fact, Thierry and Wu (2007) noted that translation creates an artificial context where the bilingual is consciously aware of the use of L1 and L2 simultaneously. Therefore the authors stated that presenting bilinguals with stimuli in which both languages are mixed creates an unnatural situation which encourages the activation of both languages and provides an unreal picture of L2 comprehension.

Hence, past as well as current studies conducted in the area of bilingualism tend to disregard these important considerations in their experiments. Thus, further research on bilingualism should consider other methodological possibilities aiming to show a more natural picture of how the bilingual mind works.

Moreover, the effects of different characteristics of the words used in the experiments seem to be ignored. Potter et al. (1984) do not present examples of the materials used in their study. On the contrary, Kroll and Stewart (1994) provide a complete sample of the stimuli used in their experiments. Moreover, they included words varying in frequency (e. g. *mortar*, *sword*), word-length (e. g. *cauliflower*, *peas*) or form (e. g. *tomato* is the cognate of the Dutch translation of *tomaat*) which may have influenced the translation ease of proficient and non-proficient bilinguals. Nevertheless, the authors do not seem to take into account the disparate effects of these variables. On the contrary, Kroll et al. (2002) seem to be aware of the importance of these features.

In addition, La Heij, Hooglander, Kerling and van der Velden (1996) conducted a similar study to that of Kroll and Stewart (1994) in which Dutch-English bilinguals were required to translate words accompanied by the context of a picture. They obtained concept mediation effects in both translation directions. Unlike Kroll and Stewart (1994) who explained the translation asymmetry as different processing routes for backward and forward translations, La Heij et al. (1996) concluded that L2 words find more difficulty in activating their meanings than their L1 counterparts. Moreover, Dong, Gui and Macwhinney (2005) noted that this different results may be due to the character of the words used in the experiments. Thus, these authors noticed that the words used by La Heij et al. (1996) were more frequent, more familiar (e. g. *dog, pig, rabbit*) and the context was more apparent (colours and pictures) compared to the relatively infrequent words (e. g. *cardinal, buzzard, lark*) and implicit context (semantic category) presented by Kroll and Stewart (1994). Furthermore, Dong et al. (2005) argued that the words used by La Heij and colleagues (1996) were more familiar for bilinguals and thus, their association with the L1 counterparts was semantically related. Thus, it appears to be of great importance to consider the specific features of the stimuli used in the experiments, since the results obtained may be strongly influenced and biased by these aspects.

Furthermore, it is worth mentioning that studies considering bilingual participants posed the problem of determining the proficiency level of speakers. Kroll and Stewart (1994) and Kroll et al. (2002) assessed the linguistic skills of their participants through a questionnaire in which participants rated their experience in their L2 and provided information of other languages and the context in which they were acquired which might be of great importance.

Nevertheless, in some experiments the language proficiency seems to be vaguely or even abstractly specified. For example, Potter et al. (1984) described the language level of their bilinguals as a group of "relative novices" English-French bilinguals who have studied their L2 for 2 or 3 years (p. 24). In addition, proficiency level constitutes a sometimes determining factor in the accuracy of the studies. In fact, it has been argued that the reason why Potter and colleagues (1984) failed to report differences in translation and naming patterns for proficient and unbalanced bilinguals may lie in the relatively fluent bilinguals who were inaccurately categorised as unbalanced bilinguals (Kroll & Stewart, 1994). Therefore, further research should consider specific methods to specify the proficiency level of the participants to provide more reliable and precise results.

In addition, since bilinguals are not usually required to name words without a linguistic context when communicating, but they are engaged in more complex tasks, it seems to be necessary to implement tasks considering words within a meaningful context to provide a picture of bilingual production with consistent ecological validity. Thus, further research on the field should address the effects of contextual information exercises in bilingual production. For example, Hatzidaki and Pathos (2009) examined whether the predictions of the RHM regarding word translation asymmetries could be extended to text translation. Therefore, they engaged Greek, English and French fluent bilinguals in a text translation and word recognition task. They reported more lexical errors for backward translation and more semantic errors (e.g. coherence) were obtained for forward translation consistent with the RHM, but they failed to provide evidence of semantic effects in forward translation in the word recognition task as the RHM would predict.

IMPLICATIONS OF THESE STUDIES FOR BILINGUAL RESEARCH

The RHM proposed by Kroll and Stewart in 1994 has undoubtedly borne a pervasive and central influence for bilingual research. In fact, this model could easily account for the subsequent findings on the character of the bilingual mind. It could easily accommodate the asymmetries found in L2 translation and priming, the conceptual character of forward translation and importantly the developmental aspect of bilingualism as it predicts a transition from a word association model at early stages of L2 acquisition to a concept mediation model assumed at more proficient stages (e. g., Basnight-Brown & Altarriba, 2007, Brysbaert & Duyck, 2010). Nevertheless, during the last decades a lot of research in the field of bilingualism has attempted to challenge the assumptions made by the RHM and have failed to find evidence supporting these claims.

In addition, some studies have failed to report the translation asymmetries assumed by the RHM (Brysbaert & Duyck, 2010). Consistent with La Heij et al. (1996), Duyck and Warlop (2009) have recently conducted a masked priming lexical decision experiment involving Ducth-French bilinguals. They found a backward translation priming effect which was interpreted as (frequent) L2 words being able to quickly access their conceptual representations.

Moreover, current research in bilingual visual word recognition has reported evidence claiming that there may be more interaction between the separate lexicons of a bilingual than the separate nature that RHM predicts (e. g., Brysbaert & Duyck, 2010, Duyck, 2005). The RHM claims that L2 words can only activate their concepts through L1 mediation. Nevertheless, recent studies consistently maintain that lexical access in bilinguals is nonselective, in other words, when a bilingual reader confronts a string of letters the orthographic, semantic and phonological representations of both the target and the non-target languages get unavoidably co-activated (e. g. van Assche, Duyck, Hartsuiker & Diependaele, 2009). Moreover, although bilinguals are able to maintain both languages separate, it is evident that cross-language interferences between L1 and L2 occur (e. g., Dijkstra, Timmermans & Schriefers, 2000). In fact, bilinguals have proved to show facilitation in recognition of cognates and interference when presented with interlingual homographs (e. g. *pain* in French means bread compared to *pain* in English) for bilinguals (e. g., Lemhöfer et al., 2008). Therefore, growing evidence supports that there are permanent interactions between L1 and L2 which pose serious problems to be explained by the RHM which considers two separate lexicons and does not seem to account for these cross-linguistic interconnections. However, it is worth mentioning that to accommodate these cross-linguistic activations according to the activation of the lexical form Dijkstra and van Heuven (2002) have proposed the Bilingual Interactive Model (BIA) and its extension the BIA+. Nevertheless, as Kroll et al. (2002) noted that even if the RHM is concerned with the "interlanguage connections" (p.166) it is of great importance to combine both models in order to create a consistent simulation which could account for how the bilingual brain works.

Accordingly, an important interference between L1 and L2 has also reported in current research on bilingual lexical access. Since recent studies support a cascade model of language production, not only lexical representations in both languages will be activated but their respective phonological representations as well (e. g., Costa, La Heij, & Navarrete, 2006).Thus, in the bilingual case, both the target word and its translation equivalent receive equal semantic activation as they both share the same conceptual node. Therefore, a lexical selection mechanism is required by the bilingual speaker in order to be able to retrieve the intended word. This is the so called 'hard' problem (Finkbeiner, Gollan & Caramazza, 2006) and different solutions have been proposed. Some advocate for a language non-specific selection mechanism in which lexical representations of both languages get activated and in order to speak in a target language, one language needs to be inhibited. It is worth mentioning that that this inhibition mechanism tends to be adopted by unbalanced bilinguals, since it is at these early stages when L1 exercises a stronger influence over L2 and thus, more inhibition for the bilingual's native language is required. In fact, Kroll et al. (2002) seems to be concerned with this important aspect of the bilingual mind and the need of this inhibitory mechanism. Nevertheless, further research on the area has found different suggestions. For example, Costa and Santesteban (2004) stated that at the later stages of L2 acquisition the bilingual tends to assume a language-specific selection mechanism by which only lexical representations of the target language get activated and thus there is no need of any inhibition as their L2 has a similar influence as L1. Therefore the combination of the inhibitory model at the early stages of L2 acquisition with a more language specific adopted at later stages may account for the developmental aspect of bilingualism.

CONCLUSION

In conclusion, the studies of Potter et al. (1984), Kroll and Stewart (1994) and Stewart et al. (2002) seem to constitute a perfect summary of past and current research on bilingualism. The study conducted by Potter et al. (1984) even if not providing stimuli samples or inaccurately describe the proficiency level of their participants, appeared to be concerned with the developmental nature of bilingualism. Nevertheless, due to their methodological problems failed to find evidence supporting this transitory nature of bilingualism. However, the word association and concept mediation models contributed to creating the bases for the RHM proposed by Kroll and Stewart (1994). In fact, this model seems to perfectly accommodate some of the main findings concerning the different interconnections between L1 and L2 of the time. In fact, since their presentation until the present, research on bilingualism has been mainly centred on challenging its assumptions. Moreover, Kroll et al. (2002) although still finding evidence supporting the translation asymmetries between L1 and L2, they seem to be aware of other aspects of the bilingual mind that deserve attention such as lexical access or the combination of the BIA model with the RHM to completely account for bilingual production and comprehension. Furthermore, as stated in this critical review further research should consider other experimental conditions to provide a more accurate picture on how the bilingual mind works. Finally, as Brysbaert and Duyck (2010) have recently pointed out there are more aspects of bilingualism which deserve attention rather than continue testing the assumptions of the RHM.

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