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Lexical access of bilinguals and multilinguals

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ABSTRACT. This paper presents studies on the lexical access of bilinguals with the aim of extending the assumptions of the bilingual lexicon to the study with multilinguals. For that, studies that investigated the Revised Hierarchical Model (RHM), the Bilingual Interactive Activation (BIA+) model and the models of speech production, on the serial and interactive views, are presented. Two models specifically designed for multilinguals are also presented in this paper: the Multilingual Processing Model and the Dynamic Model of Multilingualism. Based on this review of literature, research questions are raised to the investigation of the models presented with multilinguals.

Keywords: multilingualism, bilingualism.

Acesso lexical de bilíngues e multilíngues

RESUMO. Este artigo tem como objetivo apresentar estudos sobre o acesso lexical de bilíngues e expandir as pressuposições do léxico bilíngue para o estudo com multilíngues. Para tanto, são apresentados estudos que investigaram o modelo hierárquico revisado (RHM), o modelo interativo bilíngue (BIA+) e os modelos de produção da fala da visão sequencial e interativa. Dois modelos desenhados para multilíngues também são apresentados neste artigo: o modelo do processamento multilíngue e o modelo dinâmico do multilinguismo. A partir dessa revisão de literatura, são levantadas questões de pesquisa para investigar os modelos apresentados, principalmente com multilíngues.

Palavras-chave: multilinguismo, bilinguismo.

Introduction

The literature does not provide single and conclusive answers to explain the organization and processing of the mental lexicon of bilinguals. There are different models and hypotheses, under different perspectives, with the aim of explaining the mental lexicon of bilinguals. Besides, studies focused on the lexical access of bilinguals, on language comprehension and production, present different results. This debate becomes even more intense when addressed from the perspective of the multilingualism, since the addition of another language makes the system more complex. Based on the exposed above, results of a review of literature on the lexical access of bilinguals will be presented, in which the assumptions related to the bilingual lexicon will be expanded for the study with multilingual individuals.

This article has as main objective to raise discussion questions related to the research with the multilingual lexicon, based on the models of bilingual/multilingual lexicon that are found in the literature. A secondary objective of this study is to encourage the research with the multilingual lexicon in Brazil, since the country has a great potential to develop research in different scenarios with different combinations of languages. Thus, we may also contribute to researches on lexical access and multilingualism in the international scenario.

Because of the disproportionate number of studies regarding the bilingual lexicon (KROLL; TOKOWICZ, 2005), a review of literature that contemplates all the research area is beyond the limits of this article. Therefore, selection criteria were necessary. Assuming that the questions related to lexical access are better explained by experiments (DIJKSTRA, 2005), empirical studies focused on the lexical access of bilinguals/multilinguals, related to models extensively investigated in the literature, were selected for this review of literature.

The two most extensively explored models of lexical access – the revised hierachical model (RHM) and the bilingual interactive activation model (BIA) – in this article are frequent in reviews of literature on lexical access, both in articles and book chapters (KROLL; DIJKSTRA, 2002; KROLL; SUNDERMAN, 2003; DIJKSTRA, 2005, 2007;

THOMAS; VAN HEUVEN, 2005; KROLL; TOKOWICZ, 2005; HEREDIA; BROWN, 2012). The revised hierarchical model (RHM) dominates research on bilingual language processing (BRYSBAERT; DUYCK, 2010). This model has as focus the development of bilingual proficiency. On the other hand, the BIA model is the most extensively investigated model in the literature on the word form (KROLL; TOKOWICZ, 2005). Thus, to complete the understanding on lexical access, models focused on lexical production were also explored in this article. Two models of speech production that represent a non-consensual view of lexical access of bilinguals are presented: the Multilingual Processing Model and the Dynamic Model of Multilingualism. These two models were included in this review of literature due to their specific focus on multilingualism.

Before starting the discussion on the multilingual lexicon, a distinction should be made, in this article, with respect to bilinguals and multilinguals. Throughout this article, the term bilingual will be used to designate the individual with knowledge of two languages, while the term multilingual will be used to refer to the person with knowledge of three or more languages (HAMMARBERG, 2001). This distinction is supported by scholars in the area of multilingualism (JESSNER, 2006; DE ANGELIS, 2007; CENOZ, 2008). De Angelis (2007) argues in favor of this distinction, mainly due to the effects that prior linguistic knowledge has on subsequent language acquisition. The author argues that if the term L2 is applied to all languages learned after the L1, this does not imply any differentiation in the learning process of a third and a second language. Similarly, Butler (2012, p. 111) affirms to be important that researchers "[…] do not blindly assume that bilinguals are the same as multilinguals".

This article is organized into five sections. Section 1 has as focus the hierarchical models of lexical access. Sections 2 and 3 are related to the lexical acces in language comprehension and production, respectively. Lastly, section 4 presents the Multilingual Processing Model and the Dynamic Model of Multilingualism. A conclusion is presented after section 4.

Lexical access according to the revised hierachical model

Hierarchical models propose that the words of the two languages of the bilingual are stored in separate lexicons (MARINI; FABBRO, 2007). Potter et al. (1984) proposed the first hypothesis within the hierarchical perspective of organization of the bilingual lexicon: the word association and the concept mediation. These two hypothesis aimed at explaining the connections stablished during L2 vocabulary acquisition According to the word association hypothesis, when L2 words are acquired, they form direct associations with L1 words. On the other hand, the the concept mediation hypothesis suggests that the L2 words are associated with the non-linguistic concepts, which are common to L1 and L2.

Kroll and Stewart (1994) conducted a study to investigate the hierarchical hypotheses proposed by Potter et al. (1984), which consisted of three experiments, which involved picture and word naming and a translation task. The results of the study showed that words were named faster than the corresponding pictures. The results also provided evidence that picture naming requires concept mediation and word naming does not. Additionally, the translation from L1 to L2 took more time than from L2 to L1, since this translation was conceptualy mediated and was not influenced by the semantic context. On the other hand, translation from L2 to L1 was not influenced by semantic context, as naming also was not. Consequently, translation from L2 to L1 seemed to be lexically mediated.

The results of Kroll and Stewart (1994) provided empirical support for an asymmetrical model of organization of the bilingual lexicon, the revised hierarchical model (RHM). This proposes that, for late L2 acquisition, where the L1 lexicon and the conceptual memory are already stablished, the L2 words, are added to the system through lexical links with the L1. However, as proficiency increases, direct conceptual links for the L2 words are also acquired. Although, the lexical connections between the L1 and L2 words do not disappear. The RHM has received empirical support from several studies with bilinguals, as presented in Table 1.

According to Table 1, it is observed that different methodologies were applied in the studies presented. Empirical support for the RHM was found either with the translation asymmetry effect (KROLL et al., 2002), or in a greater N400 effect in backward than in forward translation (PALMER et al., 2010). Additionaly, it was found a faster priming effect in the backward order (L2-L1) than in the order L1- L2 (ALVAREZ et al., 2003). There was also evidence that L2 processing is slower than the L1, due to the necessity to access L2 words through the L1 lexicon (PHILLIPS et al., 2004). Finally, repetition of concepts were shown to be more effective from L1 to L2, than from L2 to L1 (SHOLL et al., 1995).

Table 1. Empirical studies in favor of the revised hierarchical model.

Study	Objective	Participants	Tasks	Results
Kroll et al. (2002)	To investigate lexical access of L1 and L2.	L1-English L2-French or Spanish	- Naming task; - Translation task.	- Translation was faster from L2 to L1 than from L1 to L2 in all levels of proficiency.
Palmer et al. (2010)	To test the assumptions of the RHM.	L1-English L2-Spanish.	- A translation recognition paradigm; - ERP measures.	- A greater N400 effect was observed in backward (L2-L1) translation than in forward (L1-L2) translation.
Alvarez et al. (2003)	To examine the organization and processing of words in L1 and L2 for early bilinguals..	L1-English L2-Spanish.	- A semantic word detection task; - ERP measures.	- The priming effect was faster in the backward order of presentation (L2-L1) than when the L2 word followed the equivalent translation in the L1.
Phillips et al. (2004)	To investigate L2 proficiency variability in semantic priming efficiency.	L1-English L2-French, with different levels of proficiency.	- A semantic classification task; - Measures of ERPs and reaction time	- There was a delay of 50 ms in the effect of the N400 component in L2 for the higly proficient bilinguals, in comparison with the L1 of these bilinguals.
Sholl et a. (1995)	To investigate the relationship between picture naming and translation for bilinguals.	L1-English L2-Spanish.	- A transfer paradigm involving naming pictures and translation.	- Naming pictures produced transference in the translation from L1 to L2, but not in the translation from L2 to L1.
Sunderman and Kroll (2006)	To investigate the prediction of the RHM and the BIA model in L2 lexical processing.	L1-English L2-Spanish, with different levels of proficiency.	- Translation recoginition task.	- Lexical form neighboors were activated for the least and most proficient L2 learners. - Only the least proficient L2 learners activated the L1 translation equivalent.
Perea et al. (2008)	To investigate early and automatic access to shared semantic representation for highly proficient bilinguals	L1-Basque L2-Spanish.	- Lexical decision.	- Both simultaneous and late bilinguals demonstrated priming effects of semantic associtation for pairs of non-cognate words, in the two languages.

In contrast to the studies presented in Table 1, the results of the study of La Heij et al. (1996) with bilingual speakers of Dutch and English were contrary to the assumptions of the RHM. The tasks (a modified version of the Stroop task, a translation task and a variant of the picture-word interference task with related and unrelated conditions) performed in the study showed that forward translation was faster than backward translation. Additionaly, semantically related pictures facilitated translation. Based on these results, the authors claim that the two translation directions are conceptually mediated, contradicting the assumptions of the RHM. Other studies also failed to find empirical support to the RHM (ALTARRIBA; MATHIS, 1997; BLOEM; LA HEIJ, 2003; DUYCK; BRYSBAERT, 2004).

In light of this, it is possible to conclude that the RHM has received empirical support in the literature, but this does not represent a consensus among researchers. The studies reported above were carried out with bilinguals. Thus, the question that remains is how this model can be extended to multilinguals. The revised hierarchical model leaves room for the investigation on the multilingual lexicon, since the conections stablished when a third language or an additional language is acquired, are not specified in the model (DE ANGELIS, 2007). In addition, other criticisms have been made to the model, as presented in the next subsection.

Criticism to the revised hierarchical model

De Groot (2002) presents some criticisms to the revised hierarchical model. First, the author affirms that the model does not account for different word form representations (as, for example, the spoken and written form of the word) and the author argues that the phonological and orthographic representations of these words have to be specified. According to De Groot (2002), the model should also contain more layers to encompass the morphological and syntatic knowledge of the word, for instance. Besides, the semantic and conceptual representations have to be differentiated.

Green (1998) also presents some criticicms to the RHM, arguing that it does not explain how a language is inhibited so that the bilingual can name or translate into the target language. Green (1998) argues that there could be control mechanisms present in the translations from L1-L2 and L2-L1. The author explains that, during the translation from L1 to L2, the naming of the word to be translated has to be avoided. Consequently, there will be lemmas of L1 active in the competition for the selection of lemmas and production of L2.

Other criticism presented to the RHM is made by Brysbaert and Duyck (2010). The authors argue that there is good evidence contrary to the separation of the two lexicons, in the literature. For instance, studies focused on word recognition present evidence, favoring the competition of the bilingual's two languages. Additionally, interlingual homographs present interference effects in the two languages of the bilingual, while cognates are recognized faster, even at high levels of proficiency. The authors also argue that translations are not always one to one mapping. On the contrary, words

can have multiple translations, depending on the context.

In relation to the discussion on the RHM, it has to be mentioned the importance of studies to analyze both comprehension and production – so that the understanding on the lexical access of bilinguals/multilinguals can be more complete. Besides, it must be said that the RHM is a simple model, which should not be disregarded. On the contrary, it can be investigated and improved to better accommodate the most recent results of the literature. However, to Brysbaert and Duyck (2010), computational models should replace this model, as the bilingual interactive activation model (BIA), which is presented as follows, in the section that addresses the lexical access of bilinguals in the comprehension and/or recognition of words.

Lexical access in word recognition according to a computational model

The bilingual interactive activation model (BIA) is a very important model in studies of word recognition with bilinguals. Grainger and Dijkstra (1992) explain that the BIA model consists of three levels of representation, which are: letter, word and language. Dijkstra and Van Heuven (2002) affirm that, in 1998, the BIA model was a model of word recognition, focused on the recognition of ortographic representations. The BIA+ model (DIJKSTRA; VAN HEUVEN, 2002) incorporated some changes in relation to the BIA model (1998 apud DIJKSTRA; VAN HEUVEN, 2002), regarding the linguistic nodes, as well as the addition of representations and a component of task decision. Dijkstra and Van Heuven (2002) afirm that the BIA+ model distinguishes between a word identification system and a task decision system. Additionally, the model assumes interactivity with the word identification system and higher order systems, such as the *parser*. The BIA model defends non-selective access and an integrated mental lexicon for the two languages. According to the model, ortographic neighbors of the two languages influence the recognition of the target word.

In the 2002 version of the model, the BIA+, bilingual word recognition is not affected only by effects of ortographic similarity of the two languages, but also by phonological and semantic overlap between the two languages. When ortographic representations are activated, they also activate associated phonological and semantic representations. The activation of ortographic codes in the BIA+ model is the same as in the BIA model: a series of lexical candidates are activated in parallel. The model proposes that, in orthographically related languages, the number of activated items will be higher than in more distinct languages. The authors affirm that the BIA+ model is a system that identifies which information is activated in the different languages in a given task or task schema. The authors explain that task schemas are just like mental algorithms with the necessary steps for the processing of a specific task. Table 2 presents studies that found empirical support for the BIA+ model.

As can be observed in Table 2, all the studies presented found empirical support for the BIA+ model some how, whether non-selectivity (SUNDERMAN; KROLL, 2006; LIBBEN; TITONE, 2009; TITONE et al., 2011), or inhibition of the non-target language (JARED; KROLL, 2001). Other studies favored the model, because the context affected the activation of the bilingual lexicon (SCHWARTZ; KROLL, 2006; CHAMBERS; COOKE, 2009). The cognate facilitation effect was also found (VAN ASSCHE et al., 2013), as well as the effect of the N400 component, showing that, as proficiency increases, the difference of activation between L1 and L2 decreases (DUÑABEITIA et al., 2010). The parallel activation of the bilingual's two languages on the knowledge of interlingual homographs (KERKHOFS et al., 2006) and the results of automatic and early semantic priming between the bilingual's two languages (PEREA et al., 2008) were also interpreted as evidence, favoring the BIA+ model.

In short, it is observed that the studies showed that the BIA+ model can be investigated in a diversity of tasks with different combinations of languages. It is also observed that the number of studies that investigated the BIA+ model is higher than the number for the RHM model. However, studies with trilinguals are still scarce in the literature. The next subsection presents the criticism to the BIA+ model.

Criticism to the BIA+ model

Although the BIA+ model has not received such extensive criticisms, Jacquet and French (2002) present some suggestions to improve the model. The authors affirm that the model could evolve into a distributed connectionist model, instead of being a modular model, as proposed. The authors also argue that the separation of the lexical forms in the two languages of the bilingual is not explained in the model.

Table 2. Empirical support to the BIA+ model.

Study	Objective	Participants	Tasks	Results
Sunderman and Kroll (2006)	To investigate the assumptions of the RHM and BIA models in L2 lexical processing.	L1-English L2-Spanish, with different levels of proficiency.	- Translation recognition.	- Orthographic neighbors were activated both for the least and the most proficient L2 learners. - Only the least proficient L2 learners activated the L1 translation equivalent.
Jared and Kroll (2001)	To investigate whether bilinguals activate speeling- to-sound correspondences in the non- target language when naming in the other language.	L1-French L2-English.	- A naming task, where neighbor words with different pronunciations were named in the dominant language.	- French phonology was not activated when participants were naming in the dominat language, English. - However, there was influence of French after the participants naming pictures in this language.
Schwartz and Kroll (2006)	To investigate the effects of sentence context on cross-language activation .	L1-Spanish L2-English, with different levels of proficiency.	- Reading of sentences of low and high contextual restriction, containing cognates and interlingual homographs.	- Cognate facilitation effect; - Interference of the interlingual homographs for the least proficient bilinguals. - The context did not affect deeply the results.
Chambers and Cooke (2009)	To investigate the effects of sentence context and proficiency on parallel language activation.	L1-English L2-French, with different levels of proficiency.	- Visual world eye tracking technique, containing interlingual homographs.	- There were no effects of proficiency in the interlingual competition.
Liben and Titone (2009)	To investigate the effects of semantic constraint on lexical access.	L1-French L2-English.	- Reading sentences with interlingual homographs and cognates, while monitored by the eye- tracker.	- There was little interference of the interlingual homographs in high constraint sentences for late comprehension measures. - Cognates facilitated reading.
Titone et al. (2011)	To investigate non-selective lexical access during L1 reading.	L1-English L2-French.	- Reading paragraphs containing interlingual homographs and cognates, while monitored by the eye tracker.	- The cognate facilitation effect was greater when the L2 was acquired earlier. - There was cross- language activation, both for cognates and interlingual homographs.
Kerkhofs et al. (2006)	To investigate the recognition of interlingual homographs in the bilingual's two languages.	L1-Dutch L2-English.	- A lexical decision task with homographs in L2, preceded by primes semantically related or unrelated. - ERP measures.	- Related primes elicited a smaller amplitude for the N400 component than unrelated primes.
Van Assche et al. (2013)	To investigate the effects of cognate verbs on bilingual lexical access.	L1-Dutch L2-English.	- Lexical decision. - Reading sentences containing cognate verbs in the present and past tense, while being monitored by the eye- tracker.	The cognate facilitation effect was not influenced by grammatical tense.
Duñabeitia et al. (2010)	To investigate if there is a symmetrical masked translation priming effect for non-cognate words in a group of highly proficient bilinguals.	L1-Basque L2-Spanish.	- Masked priming translation with ERP measures.	- There was a symmetric effect of the N400 component in the two translation directions.
Perea et al. (2008)	To investigate access to shared semantic representation, early and automatically, for highly proficient bilinguals.	L1-Basque L2-Spanish.	- Lexical decision.	- Priming effects of semantic association, automatic and early, for pairs of non-cognate words within the same language and between the languages of the bilingual, for both simultaneous and late bilinguals.

Jacquet and French (2002) still affirm that there is no explanation on how the new language is incorporated to the system. Besides, according to the authors, the model does not explain how the information concerning the language to which the word belongs is provided. Additionally, the linguistic nodes present in the model are associated with each module, which, according to the authors, is not necessary, because, by performing a certain task, the bilingual does not need to be reminded all the time about the language that is being used. Besides, the authors affirm that further studies on the model could incorporate learning dynamics and mechanisms to the model. Finally, the authors affirm that the model could incorporate both top-down and bottom-up processes; thus, the model could explain the processes of language in its totality.

This criticism of Jacquet and French (2002) is very interesting, mainly, in the context of this review of literature, in which three points should be highlighted. The first refers to the suggestion to incorporate the learning mechanisms to the model. This suggestion is strongly related to the existing debate in the literature (BRYSBAERT; DUYCK, 2010; KROLL et al., 2010) between the RHM and BIA+ model: the first considers the development of the learner proficiency, and the second does not consider. A second aspect to be highlighted from the

criticism of Jacquet and French (2002) concerns the dynamics aspect. The Dynamic Model of Multilingualism, which will be presented in subsection 5.2 of this article, emphasizes the need to look at the linguistic system from a dynamic perspective. Finally, the third aspect to be highlighted of this criticism refers to the fact that the lexical access models, normally, are divided into processes of language comprehension or production, and, according to the authors, the union of the two processes in a single model would make the understanding more complete. Although most studies deal with one aspect or the other (comprehension or production), the fundamental results of studies on lexical access should not be so divergent, because the main question of research is the same: the lexical access of bilinguals/multilinguals.

In relation to this differentiation on speech comprehension and production, Costa (2005) affirms that L2 learners usually report to have more difficulty in producing the language than to understand it. Paradis (2004) also affirms that speech production requires greater activation than comprehension. Therefore, it is necessary to investigate the processes involved in both the production and comprehension of the language, so that a greater understanding of the issue can be achieved. Since comprehension was the focus of this section, the next is dedicated to lexical access in the speech production of bilinguals.

Lexical access in speech production

Costa (2005) argues that studies focused on lexical access on word recognition have shown that activation flow is not language specific, as reported in the previous section. However, the processes involved in speech production are top-down processes, while those related to word recognition are bottom-up processes. This occurs because, in comprehension, the external stimulus activates the representation of the person, while in speech production, lexical representations are activated according to the conceptual representations activated, because of the intention of communication of the speaker. In speech production, the speaker also has a greater control on certain aspects, such as: the language that will be used for production, the content of the message and the words that will be used.

There is an agreement in lexical access research regarding the existence of a process in which the lexical representations are specified and another in which the orthographic and phonological representations are specified (CARAMAZZA; MIOZZO, 1998). This would constitute two levels of representation, the lemma and lexeme level. The lemma level consists of the syntactic properties of the word, while the lexeme level consists of the phonological and orthographic information of the word (CARAMAZZA; MIOZZO, 1998).

Roelofs (1992) argues that there are three processes involved in speech production. The first process is the conceptualization, where the concepts that are going to be expressed are specified. The second process is the formulation, in which the words corresponding to the desired concepts are selected. In this process, the representation of syntactic and phonological structures are formed. The third process is the articulation, in which the speech is uttered.

It is known that two principles govern these processes: activation and selection (COSTA, 2005). The availability of representations (concepts, words and phonemes), at the different levels of processing, is determined by their corresponding levels of activation (COSTA, 2005). According to Costa (2005), the first representation activated is that of the concepts, which, subsequently, propagates the activation of the corresponding lexical representations. Costa (2005) argues that, in this moment of speech production, a decision has to be made in relation to the lexical node that will be chosen from many possible candidates, which consists in the process of lexical selection. Thus, lexical selection is one part of the process of lexical access.

According to Costa (2005), the activation of the lexical node also spreads to the sublexical or phonological level, since the final stage is the speech production. Besides, there is competition among the representations of the possible candidates at all levels of representation. However, the greatest question regarding bilingual speech production is whether the activation of the representations at different levels is restricted to one or two languages (COSTA, 2005).

Current models of lexical access propose that the activation of the conceptual system flows to the lexical representations of the bilingual's two languages (COSTA, 2005). This means that

activation from the semantic to the lexical level is language non-specific. The question that remains is whether the activated lexical representations also activate phonological representations in the bilingual's two languages.

Regarding the two processses that form lexical retrieval – the lemma and lexeme – Morsella and Miozzo (2002) claim that there is a controversy on whether they occur in a fixed or dynamic order. In the serial view of lexical access, the order of these two stages is hypothesized to be fixed. Morsella and Miozzo (2002) argue that the serial models originated from reaction time experiments. According to this serial view, phonological activation consists only of the selected lexical node. On the other hand, an opposite view to this is the interactive. Morsella and Miozzo (2002) explain that the interactive models originated from speech errors research, in which the errors were both semantic and phonological, and were called mixed errors. This is a dynamic view, in which phonological activation can occur before lexical selection. For this reason, in this view, there might be phonological activation of unselected lexical nodes. In other words, Hermans et al. (1998) explain that, in the fixed order of lexical access, lemma selection precedes lexeme retrieval. On the other hand, in interactive models, lexeme retrieval can affect lemma selection, and these are not seen as separated processes.

As previously reported, it is observed that, in speech production, there may be some consensus regarding the non-selective nature of lexical access of the bilingual's two languages. However, there is still a debate regarding the activation on the phonological level. On this question, there is a serial view, which proposes a fixed order for the retrieval of lemmas and lexemes. According to this view, only the selected lexical node will have its phonological segments activated. On the other hand, interactive models propose a more dynamic view of lexical access, in which phonological activation of unselected lexical nodes is also possible. Table 3 presents empirical studies that investigated questions related to the serial and interactive views of lexical access and the selective or non-selective aspect of speech production.

According to Table 3, it is observed that the literature on the lexical access of bilinguals in speech production presents different results, among which the study of Costa et al. (1999) favored the language-specific selection hypothesis, while Colomé and Miozzo (2010) argue that both languages of the bilingual have their phonological representations activated in speech production. However, Colomé and Miozzo (2010) did not take specific position in relation to the serial or interactive models of lexical access. In relation to these models, other studies found different results. A study found results that contradict serial models (COLOMÉ, 2001). Other study favored interactive models (COSTA et al., 2000). On the other hand, Hermans et al. (1998) affirm that their results can be discussed based on the two models.

Thus, it is observed that there is no consensus in the literature for lexical access of bilinguals in relation to the serial and interactive hypotheses. Therefore, there is space for more studies in this area, mainly with focus on multilingual lexicon, since most studies are concentrated on the lexical access of bilinguals or monolinguals. The results of Colomé and Miozzo (2010), for instance, could be investigated with trilinguals; thus, it could be analyzed if all languages remain activated during speech production and which mechanisms are responsible for controlling this activation. Besides, other factors could be analyzed, such as the type of task, the participants' level of proficiency and the frequency of use of the languages involved.

Table 3. Empirical studies on lexical access in speech production.

Estudo	Objective	Participants	Tasks	Results	Favored model
Hermans et al. (1998)	To investigate lexical access of a less dominant language.	L1-Dutch L2-English.	Word-picture interference paradigm.	- There was evidence of activation of the Dutch name during lexical access of English.	Interactive and serial models.
Costa et al. (1999)	To investigate parallel activation of the bilingual's two languages.	L1-Catalan L2-Spanish.	Picture- word interference paradigm.	- There was facilitation of identical words of different languages. - Same language pairs facilitated more than different language pairs.	Language specific models of lexical selection.
Colomé (2001)	To investigate if the bilingual common semantic representation activates lexical units in the two languages.	L1-Catalan L2-Spanish.	Phoneme monitoring tasks.	- Participants took longer to reject phonemes belonging to the translation than to reject phonemes that did not exist in Spanish or Catalan words.	Hypothesis of the language independence and contrary to the restricted serial models.
Costa et al. (2000)	To investigate if the unselected lexical nodes	L1-Catalan L2-Spanish;	Naming pictures that consisted of cognate	Bilinguals named pictures with cognate names faster than pictures	Interactive models, in which both the selected and

	activate their phonological representations.	Monolingual speakers of Spanish.	and non-cognate words.	with non-cognate names.	unselected items activate their phonological segments.
Colomé and Miozzo (2010)	To investigate if the non-target words are also activated in the non-used lexicon.	Experiment 1: L1-Spanish L2-Catalan. Experiment 2: L1-Catalan L2-Spanish.	Picture-picture interference paradigm.	Experiment 1: no difference was found in the reaction time between related and unrelated words. Experiment 2: there was phonological effect with cognates, indicating activation of non-target words in the unused language.	The results show that phonology can be activated, even in the unselected language.

After having presented the different models and studies focused on lexical access in both comprehension and speech production of bilinguals, the next section presents two models designed specifically for the study with multilinguals.

Models of multilingual lexical access

In the previous sections of this article, lexical access models focused on bilinguals were presented and discussed. In this section, two lexical access models designed with particular consideration to multiple languages are presented. First, the Multilingual Processing Moodel is presented in Section 5.1. Next, a dynamic view of lexical access is presented in the Dynamic Model of Multilingualism, in Section 5.2.

Multilingual processing model

The multilingual processing model (DE BOT, 2004) has as focus multilingual speech production. This model supports the non-selective view of lexical access. The model was designed in such a way that it can be applied both for bilinguals and for multilinguals, independently on the number of languages. The model is basically divided into three compartments: one contains the conceptual characteristics, other contains the syntactic properties and the third contains the form of the elements. These three compartments are subdivided into subsets, which are specific to each language. In these subsets, there is overlap of similarities between the different languages. In the model, there is a linguistic node responsible for controlling the language that will be used. The language selection, in these linguistic nodes, is regulated by the level of activation. In other words, when a specific language is required for comunication, the linguistic node sends information to activate the right language. However, since there is overlap of similar elements among the languages, these can also be activated.

This model provides many possibilities to investigate the multilingual lexicon. Besides, the Multilingual Processing Model is similar to the BIA+ model in some aspects: both models have the activation level of the languages as a starting point and both consider the influence of the similarities between the different languages on lexical access. The next subsection presents a dynamic view of multilingualism.

The Dynamic Model of Multilingualism

The Dynamic Model of Multilingualism (DMM) (HERDINA; JESSNER, 2002) proposes that the multilingual system is dynamic and adaptable. This model considers the development of new qualities of the multilingual individual; the DMM is in line with the assumption supported by Cook and Grosjean that bilinguals cannot be compared to monolinguals because of their multicompetence (JESSNER, 2006).

Jessner (2008) affirms that, in the multilingual context, due to the increase in the number of languages involved, the dynamics, or the changes and the complexity to learn a language, are more evident. The DMM applies the dynamic systems theory (DST) to the acquisition of multiple languages. Lowie and Verspoor (2011) affirm that DST is a theory of change. The authors determine that the first models (such as Levelt's model) were proposed in a linear way; however, a more recent view of language is the one of a complex dynamic system.

The DMM also postulates that language learning is dependent on the time and energy dedicated to that. However, since the model assumes that leaners' resources are limited, access to the language knowledge will depend on the investiment of the learner. The DMM also proposes that the different language systems of the multilingual are interdependent. Besides, the model adopts a holistic view of multilingualism, which is necessary for the understanding of the complexity involved in the system.

Jessner (2006, p. 33) affirms that the DMM

> […] stresses the non-linearity of language growth, the interdependence between language systems and the change of quality in the language learning process as well as learner variation.

Jessner (2006) claims that the non-linear view of language growth has to be considered because of the dynamics of the language system.

Conclusion

Although the objective of this article was to colect information concerning the multilingual lexicon, most of the reviewed studies were related to the bilingual lexicon. The reason for this selection of studies is the fact that the studies with focus on multilingualism are based on previous research on the bilingual memory or the representation of the bilingual lexicon (DE ANGELIS, 2007). The models of lexical access that have been extensively investigated in the literature – the RHM, the BIA+ and the serial and interactive models of speech production – all have as focus the bilingual lexicon.

However, many questions concerning lexical access are relevant for the study with multilinguals. In the specific case of the RHM model, it has to be mentioned that research could be conducted with trilinguals to achieve conclusions regarding the organization of the three languages. Since language dominance is the criterion of lexical organization for the RHM model, it could be investigated the hypothesis that, independently on the number of languages, the lexicon would be organized according to proficiency. However, with multilinguals, the case is even more complex because the individual can have two weaker languages, for instance, and two more dominant languages. In this case, what other factors would determine the organization of the multilingual lexicon? Would it be the similarity between languages or the order in which the languages were acquired? These are only some questions to exemplify that the study of the multilingual lexicon provides a great variety of possibilities.

The BIA+ model, on the other hand, seems to be more easily adapted to the study with multilinguals. This model is based on the activation level of languages of the bilingual. Therefore, if more languages are added to the system, as in the case of trilinguals, the principle of lexical organization can remain the same. Thus, the frequency of use of each language could be a decisive factor in the ease or difficulty of accessing the lexicon. Additionally, the facilitation or interference of one language in the other could continue being based on the frequency of use of the language and on the similarity between the forms of the elements of the different languages. These hypotheses could be investigated based on the model.

Despite being a model of speech production and not of word recognition, the multilingual processing model also has the language activation as a starting point, as well as the BIA+ model. The two models favor the non-selective vision for the lexical access and the similarity between languages. The multilingual processing model is more interesting for studies with multilinguas, mainly, because there are no limits for the number of languages involved in the system.

The serial and interactive models of speech production also provide a series of possibilities for research on the multilingual lexicon, since most studies are concentrated in individuals who speak only one or two languages. The addition of more languages to the system can increase the discussion on the lexical access with regard to the serial and interactive views. The first question to be considered in relation to these models is if a trilingual has all the languages activated during lexical access. Additionally, research could investigate which factors can regulate the activation or inhibition of the unwanted items in speech production.

Moreover, the models of bilingual lexicon could be incorporated in the most dynamic perspective of multilingualism, in which systems are in constant change, as proposed by the DMM. This model shows that language is a dynamic system, in which changes occur all the time. Additionally, in this model, languages are not seen as separated but as highly connected systems. According to Lowie and Verspoor (2011), the models should be revisited in this new perspective of dynamic systems, in which there is interaction in the different modules in order to explain a dynamic processing.

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