The influence of contextual cues on representations in the mental lexicon for bilinguals

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The strength of each representation in the mental lexicon depends on factors such as word frequency and conceptual concreteness. For bilinguals, each concept has two lexical representations, and so representational strength also depends on the salience of first- and second-language activation and the dominance of each language. The relative salience of the dominant language is a critical reason for observed asymmetric language switching costs, but the *language* context can reverse this effect. Therefore, context is another important influence on the relative level of activation in the mental lexicon, a factor that is often overlooked in the literature. Here we explore the contribution of contextual cues on salience of representations in the mental lexicon for bilinguals.

1. Introduction

There has been ample research on bilingualism, including investigations of how bilinguals access words in each of their languages (e.g., Finkbeiner, Gollan, & Caramazza, 2006), how they switch between their languages (e.g., Christoffels, Firk, & Schiller, 2007), and how they avoid intrusions from the unintended language (e.g., Gollan, Sandoval, & Salmon, 2011). The speed at which lexical representations in each of a bilinguals' language are accessed depends strongly on the proficiency levels of both languages (Costa & Santesteban, 2004). Unbalanced bilinguals, with one language clearly more dominant than the other, will access their dominant language much quicker than their non-dominant language (e.g., Costa & Santesteban, 2004; Costa, Santesteban, & Ivanova, 2006). Balanced bilinguals, with reasonably equal proficiency in their languages, access word representations in both languages at a similar speed (Costa et al., 2006). Language proficiency has been widely investigated and has been shown to influence the way the mental lexicon is organized and

doi 10.1075/bpa.6.06tim

accessed (e.g., Hernandez & Kohnert, 1999; Schwieter & Sunderman, 2008; Linck, Schwieter, & Sunderman, 2012). However, despite the accumulated research on this topic, studies have largely ignored a possibly crucial factor within this field of investigation, namely, the *language mode*, which is determined by a number of factors that influence the relative activation level of each language (Clyne, 1972; Grosjean, 2001, 2008; Green & Abutalebi, 2013; Hasselmo, 1970; Soares & Grosjean, 1984).

Language context is one such factor and refers to the languages spoken by the people in the environment of a bilingual. It focuses on the relative presence of each language in a particular environment (Olson, 2012). In the rest of this chapter we will use the term '*language context*' in italics to refer to this definition. Other language mode factors include the situation/linguistic environment, the form and content of the message, and cultural objects and faces that influence the relative activation of each language (Grosjean, 2001). A multitude of *language mode* factors have been described in detail from a psycho-social and linguistic perspective (Clyne, 1972; Grosjean, 2001, 2008, Hasselmo, 1970; Soares & Grosjean, 1984). *Language context* can create a shift in *language mode*, but *language context* does not take into account all the factors that can affect *language mode*. This chapter will focus on a couple of important language mode factors. It first focuses on how *language context* affects activation levels in the mental lexicon. Second, it discusses *cultural context*, which will be explored in relation to the relative activation levels of the first (L1) and second language (L2) in the bilingual lexicon.

Not all balanced bilinguals with similar proficiency use each of their languages equally often in a given context, and not all bilinguals switch between their languages to the same extent. The same bilingual can change between different types of bilingual *language contexts* on a daily basis depending on the language(s) the interlocutors speak in a specific context (i.e., *language context*). For example, Green and Abutalebi (2013) distinguished between three *language contexts*: a single-language context, a dual-language context, and a dense code-switching context. In the real world we can see all of these contexts. A real world example of a single-language context is the situation of immigrants who use each of their languages in only one particular environment (e.g., one at home and one at work). In a dual-language context both languages are spoken within the same situation, but language switches are made based on the interlocutor. An example of this is a native Dutch speaker living in the touristic city of Amsterdam. When speaking with native friends and colleagues, Dutch will be used, but when a tourist is encountered on the streets, English will be quickly activated. In a dense code-switching situation both languages are also used within the same context, but most of the interlocutors are familiar with both languages that the bilingual speaks. For example, Catalan-Spanish bilinguals growing up in Catalonia (i.e., a region of Spain where most people speak both these languages) are surrounded by bilinguals who speak both languages and therefore code-switching is an appropriate form of communication. Depending on the *language context*, the relative activation of each language is adjusted. Thus, the ease of access for words in each language changes with the *language context*, regardless of the proficiency level of the bilingual.

Not only does the relative presence of the two languages a bilingual speaks affect speed of lexical access to each of those languages, sociological and linguistic contextual cues also influence the relative activation level of each language. For example, when a Chinese-English bilingual meets a new person who has a typical Chinese face, the Chinese language could unconsciously be activated more strongly than English (Zhang, Morris, Cheng, & Yap, 2013). In addition to facial features, objects in the environment could change relative activation levels. An English-French bilingual from Toronto who mostly speaks English might activate French more when seeing the Eifel Tower in a movie. This is not only the case for landmarks but also for daily objects, like a bowl of soup. A traditional English tomato soup primes the English language, while a traditional Korean soup, more like a stew, will give greater activation to the Korean lexical representation of soup (Berkes, 2013). Therefore, depending on the country an English-Korean bilingual is in at the moment, the *cultural context* changes relative activation of the two languages.

The main purpose of this chapter is to investigate the contextual factors that contribute to speed of lexical access. The chapter is divided into four sections. The first section describes the organization of the mental lexicon of a bilingual and explains how two languages can be stored in a single lexicon with few intrusions from the non-target language. Second, we examine how *language context* influences access to lexical representations in the mental lexicon. Third, we examine *cultural context* as another factor contributing to the speed of selection within the mental lexicon. Other psychological, social, and linguistic factors are not the topic of this review but should be taken into consideration in later studies. Fourth, directions for future research investigating *language context* are discussed to stimulate the development of this research field.

2. Representations in the bilingual lexicon

To utter even a single word such as 'bike', a speaker must undertake a complex planning process consisting of several steps. One needs to decide on the message to be conveyed, the concept needs to be retrieved in the form of a nonverbal representation (i.e., sometimes referred to as semantic retrieval), the word that corresponds to the concept needs to be accessed (i.e., lexical selection), phonology associated with the selected lexical representation needs to be activated, and finally the motor movements necessary to articulate the message need to be executed.

These processing steps in speech production have been organized in different models, and although these models differ slightly, they all agree on these main stages (e.g., Dell, 1988; Levelt, Roelofs, & Meyer, 1999; Starreveld & La Heij, 1996). The sub-process of lexical selection is simple and only includes the activation levels of lexical representations. When activation exceeds the threshold level the word is selected. Many variables influence the speed of the lexical selection process if multiple single words are named after each other. For example, higher word frequency, earlier age of acquisition, shorter word length, more concrete concepts, and similar phonological onset all increase the activation levels and therefore the threshold is reached sooner (e.g., Levelt et al., 1999).

For bilinguals, each concept needs to be accessed in more than one language, adding a level of complexity to the process of accessing lexical representations from a concept. Each concept has at least two lexical representations, one in each language. It has been suggested that bilinguals by definition divide their time between their two languages and have less experience in each of their languages than a monolingual speaker. This has been referred to as the 'weaker links' or the 'frequency lag' hypothesis (Gollan, Montoya, Cera, & Sandoval, 2008; Gollan, Montoya, Fennema-Notestine, & Morris, 2005; Gollan, Sandoval, & Salmon, 2011). Studies have shown that compared to monolinguals, bilinguals retrieve words more slowly from their native language during picture naming (Michael & Gollan, 2005), perform slower on verbal fluency tasks (e.g., Bialystok, Craik, & Luk, 2008a, 2008b), and have an increase in tip-of-the-tongue states (e.g., Gollan, Montoya, & Bonanni, 2005) and for a review of slower naming in L2 during speech planning in general see Kroll and Gollan (2014). Thus, bilinguals seem to access both of their languages slower than monolinguals. But how do bilinguals store the lexical representations from both of these languages to have optimal access to words in both languages?

During speech production, bilinguals must make a choice about which language to use. The language choice seems to be made during the first stage of language production, when the speaker decides on the message to be conveyed. If this is the case, it could be assumed that the stages of speech production that follow are the same as for monolingual speakers. However, there is ample evidence that even if bilinguals have the intention to speak in one language or are only surrounded by one of their languages, the other language is still activated (Colome, 2001; Costa, Miozzo, & Caramazza, 1999; Finkbeiner, Gollan, & Caramazza, 2006; Hermans, Bongaerts, De Bot, & Schreuder, 1998; Martin et al., 2009; Spivey and Marian, 1999; Timmer et al., 2014; Thierry & Wu, 2007; Wu & Thierry, 2010, 2012). If both languages are activated, how do speakers select the lexical representation of the word in the intended language without interference from the lexical representation from the unintended language? Surprisingly, bilinguals rarely speak in the unintended language (e.g., Poulisse & Bongaerts, 1994). Therefore, some kind of control system is necessary to speak in the intended language without many intrusions from the non-target language.

Two types of models have been proposed to explain how bilinguals access their two languages and select a single word in the language they intend to speak. The first suggests that lexical selection is language specific. Each language is stored in a separate mental lexicon. This means that lexical representations from the non-target language do not cause competition, as they are represented in a separate lexicon (Costa, Miozzo, & Caramazza, 1999; Finkbeiner, Almeida, Janssen, & Caramazza, 2006; Finkbeiner, Gollan, & Caramazza, 2006). To explain the selection of a lexical representation in the intended language, with the evidence that lexical representations are accessed in both languages (e.g., Spivey & Marian, 1999), a later control mechanism, applied after lexical selection, must be engaged to select the appropriate word in the correct language. However, if a later control mechanism were to be applied it would be expected that bilinguals would often make errors by speaking in the unintended language. This is because people are more likely to speak in the wrong language if the control mechanism is applied at the last moment before production rather than earlier when more time is allowed to fix the mistake. But these errors are less common in bilinguals than expected with a later control mechanism (e.g., Gollan, Sandoval, & Salmon, 2011). Therefore, these studies provide support for the second type of models that suggest that linguistic access is non-selective and both languages are represented within a single mental lexicon (e.g., Kroll, Bobb, & Wodnieczka, 2006). Because both languages are represented in one lexicon this explains the activation of both languages when only one is needed (e.g., Colome, 2001), and the non-target language is inhibited. Inhibition lowers the activation levels of the lexical representation in the unintended language, to avoid intrusions from the language not in use (e.g., Green, 1998; Guo, Liu, Misra, & Kroll, 2011; Misra, Guo, Bobb, & Kroll, 2012; Linck et al., 2009). Evidence for the presence of inhibitory control comes from studies demonstrating a processing cost when switching from one to the other languages (i.e., switch cost) compared to staying within the same language (e.g., Meuter & Allport, 1999).

One of the most influential models that explains the inhibitory processes during bilingual language production is the inhibitory control (IC) model proposed by Green (1998). This model explains the processing cost during language switching through inhibitory processes. We will first describe the language switching paradigm, and then the IC interpretation. In the language switching paradigm, bilingual speakers name pictures of objects or digits in either their first (L1) or second (L2) language. Usually participants name the pictures in their L1 or L2 based on a visual cue (e.g., a colored line presented around the object). By naming pictures within a block in both languages two trial types are created: repeat trials where the current picture is named in the same language as on the preceding trial and switch trials where the current picture is named in the opposite language of the preceding trial. Slower response latencies are found for switch than repeat trials, referred to as the switch cost (for a review see Bobb & Wodniecka, 2013). This pattern is in line with domain-general task switching literature (for a review see Meiran, 2010). When an object is named in one language its lexical representation receives a language tag. Lexical representations from the opposite language are inhibited, lowering the ease of lexical access for words of the opposite language. When on the next trial an object has to be named in the opposite language the inhibited language needs to be reactivated, creating a delay in naming (Green, 1998).

Language switching has been one of the most important paradigms used to investigate the speed of lexical access in the L1 and L2 for bilinguals (e.g., seminal study by Meuter & Allport, 1999). Language proficiency has been shown to be one of the main factors to influence the relative level of activation between the L1 and L2. Unbalanced bilinguals who are dominant in their L1 and less proficient in their L2 have shown larger switch costs when switching to their dominant language (L1) than to their L2 (e.g., Jackson, Swainson, Cunnington, & Jackson, 2001; Philipp, Gade, & Koch, 2007; Schwieter & Sunderman, 2008; Verhoef, Roelofs, & Chwilla, 2009). This finding is also in accordance with the IC account. For unbalanced bilinguals, the dominant language (L1) needs to be inhibited more strongly than the L2 while speaking in the opposite language, because the L1 has higher activation levels. Therefore, switching from the L2 to the L1 requires more effort to reactivate the L1 following its greater suppression (Green, 1998). In line with this view, L1 dominant bilinguals show asymmetric switching costs, but more balanced bilinguals show symmetric switching costs (e.g., Calabria, Hernandez, Branzi, & Costa, 2012; Costa et al., 2006). Because balanced bilinguals have more equal proficiency in both languages, both languages need to be inhibited equally, causing a symmetric switch cost to the L1 and L2. These studies support the conclusion that inhibition is applied relative to the proficiency levels of a bilingual to optimize performance in both languages during language switching (Green, 1998).

The inhibitory processes described above can explain the optimization of lexical access during a switching task but other explanations of the switching cost cannot be fully excluded. For example, instead of inhibiting one language, the target language could receive an increase in activation (Declerck, Thoma, Koch, & Philipp, 2015). Equal lexical access could also be achieved by adjusting the selection criteria for each language individually (Costa & Santesteban, 2004). The dominant view, however, is still the inhibition account and neuroimaging studies have provided converging evidence for a role of inhibition during language switching (Abutalebi & Green, 2007, 2008; Wang, Kuhl, Chen, & Dong, 2009).

To summarize, bilinguals demonstrate slower lexical access in their native language than monolinguals (Michael & Gollan, 2005), and studies have shown that lexical representations for both languages are activated even if bilinguals only intend to speak in one language (e.g., Colome, 2001). These findings support the view that language activation is non-selective (e.g., Kroll, Bobb, & Wodnieczka, 2006). In addition, bilinguals are able to avoid intrusions from the unintended language (e.g., Gollan, Sandoval, & Salmon, 2011). The IC model of Green (1998) describes how inhibitory control processes prevent intrusions from the unintended language. Stronger inhibition is applied to the language in which the unbalanced bilingual is more proficient (Green, 1998), leading to asymmetric switch costs, with larger switch cost to the L1 than L2 (Meuter & Allport, 1999). Thus, the relative proficiency of each language plays an important role in the speed of lexical access. However, other factors also influence the activation levels of lexical representations in both languages but have been largely ignored in the current literature. The next two sections consider the influence of *language context* and *cultural context* on the activation levels of words in the mental lexicon.

3. Language context

The language switching literature has demonstrated how language proficiency influences switching costs (e.g., Meuter & Allport, 1999) but there has been little study of the influence of *language context* on such costs. In a recent study, Olson (2015) investigated *language context* directly during language switching. A 'monolingual context', during which pictures were named in one language 95% of the trials and 5% in the other language, was compared to a 'bilingual context' during which pictures were named equally often in both languages. L1 dominant bilinguals showed a typical asymmetrical switching cost in the monolingual context, with larger switch costs to the L1 than to the L2. This is in line with other studies that have found the same asymmetric switching cost pattern (e.g., Costa & Santesteban, 2004; Costa et al., 2006; Meuter & Alport, 1999; Philipp, Gade, & Koch, 2007; Philipp & Koch, 2009; Schwieter & Sunderman, 2008). In contrast, during the 50%/50% bilingual language context the asymmetry disappeared and there were symmetric switching costs for L1 dominant bilinguals. This symmetric pattern has mostly been associated with balanced bilinguals (e.g., Costa et al., 2006). Thus, *language context* can affect switching costs. This pattern change is not without precedent as other variables have also been shown to affect the typical asymmetric pattern for L1 dominant bilinguals to a symmetric pattern. For example, symmetric switching costs are found when participants are allowed to switch voluntarily (Gollan & Ferreira, 2009), when the inter-stimulus interval is increased (Verhoef, Roelofs, & Chwilla, 2009), and for bilinguals who often switch between their two languages (Christoffels et al., 2007).

In the study by Olson (2015), it is not possible to differentiate between the factors *language context* and language switching. They manipulated the relative presentation of L1 and L2 in a picture naming task. In the monolingual context, 95% of the trials were to be named in one language and during the bilingual context 50% of the trials were to be named in each language. However, this study also manipulated the repeat-to-switch ratio in the same way, with 95% repeat trials during the monolingual context and 50% repeat trials during the bilingual context. Therefore, the factors *language context* and repeat-to-switch ratio are confounded in Olson's study. Thus, the conclusion that *language context* changes the asymmetric switch cost in a monolingual context to become a symmetric switch cost in the bilingual context cannot be stated with certainty. It could be that it is the change in repeat-to-switch ratio that causes the switch cost effect to change. Note that in a typical switching task, a switch-to-repeat ratio is approximately 30% switches to 70% repeat trials; Olson (2015) showed a similar pattern of lexical access in a 5% switch and 95% repeat (monolingual) language context. In contrast, during the 50% repeat and 50% switch context the pattern became symmetric. Therefore, an equal switch-to-repeat ratio might be the cause of equal suppression to both languages. In the domain-general task switching literature, the switch pattern also changes as a function of the switch ratio (e.g., Bonnin, Gaonac'h, & Bouquet, 2011). The preliminary data presented later in this chapter only manipulated *language context* while keeping repeat-to-switch ratio equal. However, systematic investigation of the influence of *language context* and switching ratio will be necessary to determine the influence of both factors and their interaction.

The inhibitory control account explains the different switching cost patterns (i.e., asymmetric vs. symmetric) due to language proficiency by different levels of inhibition to the L1 and L2. The different switching cost patterns, irrespective of whether they are caused by *language context* or switching context, can also be based on different degrees of inhibition to the L1 and L2 in each context. In a monolingual context the language not in use needs to be suppressed more, but in a more bilingual context more equal inhibition is applied to each language.

The inhibitory control account (Green, 1998) does not explicitly differentiate between local and global control, an important difference referring to different levels of control during language switching (de Groot & Christoffels, 2006). At the local level, inhibition is solely applied to the lexical representation previously activated. If the English word 'dog' was activated, only the French word for dog, 'chien', will be inhibited. At the global level, not only the lexical representation for 'chien' will be inhibited, but all lexical items within the French language will receive a certain degree of inhibition. In models of word recognition, like the bilingual interactive activation (BIA) model, this difference is also present. The BIA model assumes a common lexicon containing lexical representations of both languages. At the lexical level, inhibitory processes exert control over specific lexical items only (Dijkstra & Van Heuven, 1998), similar to local control. In addition, activation of a single word at the lexical level activates the language node of the corresponding language. When either the L1 or L2 language node receives sufficient activation, there is global inhibition to the opposite language (Dijkstra & van Heuven, 1998).

This difference between local versus global control, also referred to as transient versus sustained control, reflects the switching versus mixing cost respectively. Support for a global level of control comes from the mixing cost. Mixing costs are calculated by comparing trials in a pure language block with repeat trials in a mixed language block. Even though the analysis is based on repeat trials only, participants are slower on repeat trials in the mixed than pure language blocks. This seems to be due to the need to exert control over the constant competition between the two languages in the mixed blocks (Christoffels Firk, & Schiller, 2007; Declerck, Philipp, & Koch, 2013; Gollan & Ferreira, 2009; Prior & Gollan, 2011). Studies investigating mixing costs have indirectly examined language activation during the monolingual context (i.e., only one language is presented) and a balanced bilingual context (i.e., both languages are presented equally). This effect relates to *language context* in the following way: the pure language blocks can be seen as a monolingual context and the mixed language blocks as a bilingual context. Interestingly, a mixing cost has mostly been found for the dominant L1 language, but not for the non-dominant language (e.g., Christoffels et al., 2007). This might suggest that the L1, but not the L2, is suppressed during a bilingual language context. This is indirect evidence that *language context* affects lexical access at a global level.

However, it has been suggested that the mixing cost cannot fully differentiate between local and global control and that the mixing cost is better referred to as sustained control (Baus, Branzi, & Costa, 2015). This is because most studies investigating mixing cost have used the same items during the pure and mixed blocks. To differentiate between global and local costs a couple of studies have used both the same and different lexical items between languages (Branzi, Martin, Abutalebi, & Costa, 2014; Finkbeiner, 2006; Van Assche, Duyck, & Gollan, 2013). These studies differentiated between local and global control by presenting participants with pictures in two pure blocks. First they name pictures in their L1 and then in their L2, with order counterbalanced between participants. Half of the pictures in the second block were the same as in the first block and the other half were new (e.g., Branzi et al., 2014). Results showed that when the second block was in L1, new items were named more slowly. Thus, mainly global control is applied, where not just the specific lexical item is inhibited but some degree of control is applied to all items of the unintended language (for an overview see Baus et al., 2015; note that

Assche et al., 2013 found both local and global control). Therefore, it cannot be stated with certainty whether the mixing cost that reflects *language context* effects (e.g., Christoffels et al., 2007) takes place at a global level.

Other evidence for a global level of control comes from the n-2 repetition cost, which shows slower responses for switching into the same language as performed two trials ago (e.g., ABA) than for switching into a language not encountered 2 trials ago (e.g., CBA). This cost has often been suggested as an index of the after-effects of inhibition. It is the residual activation from earlier trials that still has an influence on new trials. Additional evidence for global control comes from the global slowing effect in language switching paradigms. During mixed language blocks/contexts, picture naming is slower in the L1 than in the L2 (e.g., Christoffels et al., 2007; Costa & Santesteban, 2004; Costa et al., 2006; Gollan & Ferreira, 2009; Verhoef et al., 2009). This is surprising because naming in the L1 is faster than naming in the L2 if the languages are presented in blocks (e.g., Christoffels et al., 2007; for reviews see: Hanulíková, Davidson, & Indefrey, 2011 and Runnqvist, Strijkers, Sadat, & Costa, 2011). It has been suggested that bilinguals suppress or adjust the selection threshold for the L1 to bias towards L2 naming during language switching. This L1 slowing could reflect global (sustained) inhibition (Bobb & Wodniecka, 2013; Costa & Santesteban, 2004; Kroll, Bobb, Misra, & Guo, 2008). To conclude, the mixing cost, global slowing of the L1, and n-2 repetition cost all reveal a form of global control of the non-intended languages. It seems likely that different degrees of global control are applied during monolingual and bilingual *language contexts*.

Timmer, Christoffels, & Costa (in preparation) examined how *language context* affects lexical access for the L1 and L2 in the mental lexicon on a global level by looking at the global slowing effect. During a cued language switching task, Dutch-English bilinguals named pictures in Dutch (L1) or English (L2) depending on the frame color around the picture. *Language context* was manipulated between participants by having an unequal distribution of L1 and L2 with more trials in the L1 (83%) during the L1 context (23 participants) or more trials in the L2 (83%) during the L2 context (19 participants). Note that the manipulation in this study was implemented during stimuli presentation; the language of instruction always was Dutch as the general environment of the participants was also Dutch dominant. During the L1 context, pictures were named more slowly in L1 than in L2 (see Figure 1). This is in line with global slowing of the L1 compared to the L2 found during mixed blocks in earlier studies (e.g., Christoffels et al., 2007; Costa & Santesteban, 2004; Costa et al., 2006; Gollan & Feirrera, 2009; Verhoef et al., 2009, 2010). Now during an L2 context, when the dominant language (L1) is not the most common language presented, a reverse pattern is found with slower naming for L2 than L1 (see

Figure 1; Timmer, Christoffels & Costa, in preparation).[1] These results support the interpretation that *language context* can reverse the effects of language proficiency on naming times. Global slowing during an L1 context might occur to equalize the activation levels of both languages to create efficient performance (Gollan & Feirrara, 2009; Green, 1998). The inhibition of L2 in an L2 *language context* could indicate that the activation level of L2 has to be lowered to equalize with the L1. It is remarkable that a non-dominant L2 *language context* can override the effects of the dominant L1 effects and potentially even reverse them. Future studies should strengthen the effects of *language context* and give more insight into the underlying mechanisms adjusting the levels of lexical access to create optimal performance for bilinguals during differing *language contexts*.

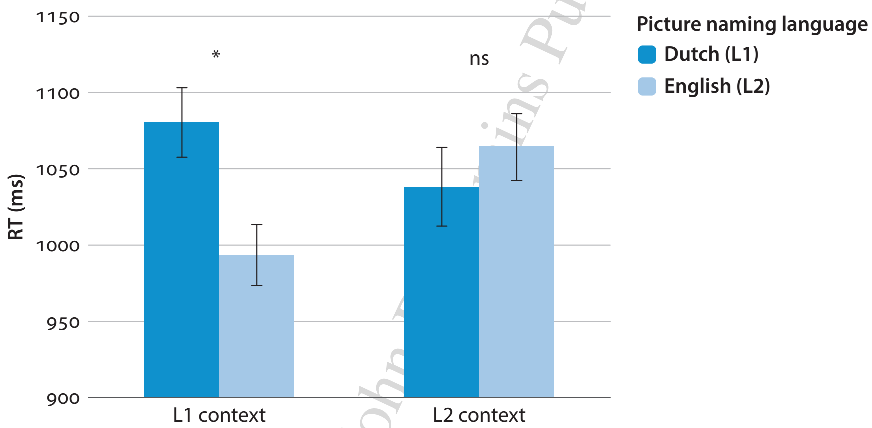

Figure 1. Reaction times (RTs) in milliseconds (ms) for picture naming by Dutch-English bilinguals in Dutch (L1; dark blue) and English (L2; light blue) during a mainly L1 context (83% Dutch) or L2 context (83% English)

1. Note that the interaction between Context (L1 context vs. L2 context) and Language (Dutch vs. English) is significant (F (1,40) = 9.63, MSe = 3600.39, p < .001). During the L1 context Dutch is named significantly slower than English (F (1,22) = 21.01, MSe = 4138.39, p < .001). During the L2 context English is named slower than Dutch, but not significantly (F (1,18) = 2.18, MSe = 2942.83, p = .157).

4. Cultural context

Another factor that influences language selection is the *cultural context* of the target item, whereby a mismatch between the expected language associated with an object based on cultural norms and the actual target language create interference. Zhang et al. (2013) had Chinese-American participants first listen to a fictional character named Michael Lee speak in a typical American accent while a picture of a Chinese or American face was presented. Following this, participants were instructed to speak in English into a microphone about what they had heard. Despite the fact that the audio in both the Chinese and American face conditions was identical, Chinese participants showed less fluency and slower speech rate when the audio was paired with a Chinese face than with an American face. They replicated this effect with non-face *cultural context* items (e.g., Great Wall vs. Statue of Liberty). Another recent study found similar results with faster picture naming latencies for L1 (Chinese) production when the pictures were paired with L1 congruent (Chinese) faces compared to L1 incongruent (Caucasian) faces (Li, Yang, Scherf, & Li, 2013). Molnar, Ibáñez-Molina, and Carreiras, (2015) further showed that this effect can be observed during a lexical decision task, whereby early bilinguals were faster to make lexical judgments when these decisions involved the language in which the interlocutor usually spoke. Most recently, Woumans and colleagues (in press) showed that these language-priming effects could be eliminated when the interlocutor no longer provided a reliable language cue for *language context*.

Similarly, Berkes (2013) had Korean-English bilinguals name pictures in both their L1 and in their L2 under congruent or incongruent cultural contexts. Participants were shown pictures while simultaneous audio was presented and were asked to indicate whether or not the picture and the audio corresponded to the same item. For example, if the word "soup" was presented auditorily and the picture displayed was also that of a bowl of soup, participants would indicate that the trial was a match. The critical manipulation was that of the cultural congruency of the picture and the audio. For example, the auditory presentation of the word "soup" in English could be accompanied by a picture of a traditional bowl of English soup, such as tomato soup, and this would be considered a congruent context; in contrast, the same word could be accompanied by a picture of a typical Korean soup, and this would be considered an incongruent context. The manipulation is subtle, but the effects on performance between these two situations are critically different. The culturally congruent match condition resulted in faster reaction times than culturally incongruent conditions, demonstrating the role of *cultural context* on language selection. Thus, language selection and production appear to be influenced automatically by *cultural context* cues and these contextual cues can cause interference across languages within the mental lexicon.

Only a handful of recent empirical studies supporting the role of *cultural context* cues in language selection and production exist, but these studies are pivotal in paving the way for an important line of future research regarding how the mental lexicon is accessed and functions more generally among bilinguals. Appropriate selection from the mental lexicon is thus influenced by not only language proficiency and *language context*, but also by the *cultural context*.

5. Conclusions and implications for bilingual models

Three language mode factors that affect lexical access of the L1 and L2 are language proficiency, *language context*, and *cultural context*. A large body of research has shown that relative language proficiency in a bilinguals' languages changes the switching cost pattern (e.g., Calabria et al., 2012; Costa et al., 2006; Jackson et al., 2001; Philipp et al., 2007; Schweiter & Sunderman, 2008; Verhoef, Roelofs, & Chwilla, 2009). Each language is suppressed to a different degree depending on relative proficiency to balance the ease of access to each language and optimize performance during the switching task for both languages (Green, 1998). *Language context* has also been shown to affect access to the L1 and L2 in the mental lexicon through the mixing cost (e.g., Christoffels et al., 2007; Declerck et al., 2013; Gollan & Ferreira, 2009; Prior & Gollan, 2011), changes to the pattern of the switching cost (Olson, 2015), and global slowing of the language presented most during a language switching task (Timmer, Christoffels, & Costa, in preparation). The type of *language context* a bilingual is in adjusts the inhibition placed on each of the bilinguals' languages to optimize language production performance during each *language context*. Further, *cultural context* slows down access to the target language when it is in the context of a culturally mismatching object/concept. All three factors show that some form of inhibition is necessary for bilinguals to control their language output.

The conclusion that inhibitory processes are at play does not answer the question of what the locus of this inhibitory control process is. The IC account seems to assume similar levels of control in language production as the BIA model does for language comprehension. The BIA model assumes control at the lexical level for specific lexical items only and at the language level where strong activation of the L1 or L2 language all lexical representations from the other language are inhibited at a global level (Dijkstra & van Heuven, 1998). The experimental paradigms that investigated the role of inhibition during language control have differentiated between local (i.e., transient) and global control (i.e., sustained) control through switching and mixing costs respectively (Christoffels et al., 2007; Declerck et al., 2013; Gollan & Ferreira, 2009; Prior & Gollan, 2011). At the local level, inhibition is only applied to the lexical representation previously activated. At the global level, all lexical items of the unintended language will be inhibited. How do these two levels of control relate to the processing stages of language production and can the locus or loci of control be identified?

Spoken word production occurs on the following stages: concept/semantic retrieval, lexical selection at the lemma level, retrieval of sound representations at the phonological level, and articulation (e.g., Levelt et al., 1999). Some models assume the locus to be at the concept level (La Heij, 2005; Poulisse & Bongaerts, 1994). Other models adopt the lemma level as the locus of inhibitory control processes (Declerck, Koch, Philipp, 2015; Grainger, Midgley, & Holcomb, 2010; Green, 1998). According to Schwieter and Sunderman (2008), the locus of control changes as a function of language proficiency, from the concept level for highly proficient bilinguals to the lemma level for second language learners. The IC account of Green (1998) seems to assume two levels of control: at the lemma level and the language level (through schemas). It seems logical to suggest that the switching cost occurs at the lemma level and the mixing cost at the language level. Language proficiency mostly affects the local level of control (Costa & Santesteban, 2004) and *language context* the global level of control (Christoffels et al., 2007; though see Olsen, 2015 for local effects). However, the IC model does not differentiate explicitly between local and global control (Green, 1998) and inhibition at both the lemma and language level might play a role during both types of costs.

This ambiguity is strengthened by fMRI studies showing activation in executive control regions during language switching (e.g., Abutalebi et al., 2013; Abutalebi & Green, 2007; Garbin et al., 2010; Hernandez, 2009; Kong et al., 2014) and behavioral studies that suggest a role for executive processes during the resolution of conflict between their languages (Rodriguez-Fornells et al., 2002, 2005, 2006, van Heuven et al., 2008). According to an updated version of the BIA model, the brain region involved in executive control are related to the task/decision system that is newly implemented in the BIA+ model (Dijkstra & van Heuven, 2002; van Heuven & Dijkstra, 2010). The task/decision system is influenced by non-linguistic factors such as strategies and expectancies about the task at hand. The word identification system can only be influenced by linguistic context, such as the preceding sentence. In this updated model the language nodes do not affect the activation levels of the word identification system. Instead the locus of control is outside the word identification system, in the task/decision system. The IC model also assumes that the control at the language (schema) level is outside language processing (Declerck et al., 2015). If language control is similar to domain-general executive control a link between language- and task switching should be present. Even though both tasks find similar costs, switching, mixing, and N-2, the size of these effects does not seem to correlate between tasks (e.g., Calabria et al., 2015). However, bilinguals, who frequently switch between their languages show enhanced executive functioning during domain-general control compared to monolinguals (Bialystok, 2009). Wu and Thierry (2013) demonstrated that the presence of words from two languages compared to a single language (these words were non relevant for the task at hand) improved performance during the flanker task. Thus, there is conflicting evidence to whether the language control processes occur within (e.g., Abutalebi et al., 2013; Abutalebi & Green, 2007; Garbin et al., 2010; Hernandez, 2009; Kong et al., 2014) or outside (e.g., Declerck et al., 2015; Dijkstra & van Heuven, 2002; van Heuven & Dijkstra, 2010) of the language processing system.

It is clear that models of language production do not yet agree on the locus of control or even of how many loci of control there are (for a review see Declerck et al., 2015). Therefore it is important to make a clear link between studies investigating bilingual language control and the stage(s) of language production at which the inhibitory control processes could occur. For example, does the effect of *language context* occur within the language processing system or outside of the processing system? It could occur within the language system as it relates the linguistic context, or outside as there is evidence of a relation to executive control. For other contextual factors, like *cultural context*, it is more likely they affect processing outside of the linguistic system as *cultural context* refers to non-linguistic cues. Another possibility is that the locus of control changes depending on the language and *cultural context* as has already been suggested for language proficiency by Schwieter and Sunderman (2008). For example, in a monolingual language context the locus of language control might be found at a certain level, but in a bilingual language context at another level. Further, it is also important to differentiate differences between the processes of language comprehension, language production, and translation. While for language comprehension the bottom-up input is already in a specific language, but during language production the speaker can decide in which language to speak before starting the speech production. This could change the level at which inhibition takes place during language control. Thus, future investigation into the effects of contextual cues on lexical access to the L1 and L2 of a bilingual might also give more insight into the locus or loci of inhibitory processes during language control.

Author note

Preparation of this manuscript was partially supported by grant R01HD052523 from the US National Institutes of Health and by grant A2559 from the Natural Sciences and Engineering Research Council of Canada awarded to the corresponding author, Ellen Bialystok, and by the Dutch Organization for Scientific Research (NWO) with Grant 446-14-006 awarded to the first author, Kalinka Timmer.

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