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The influence of a third language on cognate and homograph recognition.

The role of a "hidden" language in bilingual language processing.

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Preface

This thesis was written during the master year 2010 – 2011 at the University of Antwerp.

Not only as a multilingual person but also as a linguist, I have always been interested in the research and findings into the personal or interpersonal situations of multilingualism. Using different languages I was always looking at the interaction between them.

The last year's growing fascination with bilingualism and multilingualism motivated me to conduct some interesting experiments in the appropriate domain of psycholinguistics. In this study I analyse experiments where languages influence each other.

Abstract

This study examined cross-linguistic affects on bilingual word recognition. In four experiments we researched lexical access using interlingual homographs and cognates in the English go/no-go task (participants reacted only when they identified an English word) on native speakers of Dutch with a very good level of English and French. Experiment 1 used interlingual homographs. Condition 1 was a standard experiment, where 2 languages were used, which were seen by the participants. In Condition B and Experiment 2 (Condition A and B), for the first time, we looked at the influence of the “hidden language” (French in Experiment 2A and Dutch in Experiments 1B and 2B). The “hidden language” was not seen in the experiments, but was present in the interlingual homographs (Experiment 2A) or cognates (Experiments 1B and 2B). The results show that the participants were able to “switch-off” the influences of the non-target languages on homograph and cognate identification only to a limited degree. Surprisingly the influence of the “hidden language”, which is not present in the experiment, was still noticed.

Key Words: multilingual word recognition; interlingual homographs; cognates; go/no-go task; hidden language.

1. Introduction. Being bilingual

Linguists have different ideas about the definition of bilingualism. For a long time and in the countries with promoted monolingualism, there is the idea that bilingual is only a person who uses his/her two (or more) languages on the same level. This situation is really exceptional. But in the opinion of other linguists, a person who has only little knowledge of the second language is already bilingual.

In the first chapter of the Baetens Beardsmore book “Bilingualism” (1982) one can find some definitions related to bilinguals. “Bilingual” is someone with the possession of two languages, however it counts also the many people in the world, who have a different level of proficiency and sometimes use two (or even more) languages. Bilinguals can be balanced or unbalanced[1]; maximal or minimal or even semibilingual if he/she understands a second language, in either its spoken or written form, or both, but does not necessarily speak or write it (for more information see Baetens Beardsmore, H, 1982).

Bilingualism is one of the most popular topics in psycholinguistics. Looking at the world population, Li Wei (2002) noticed: “there are a lot of people who use two or more languages regularly for work, family life and leisure. There are even more people who make irregular use of languages other than their native one; for example, many people have learnt foreign languages at school and only occasionally use them for specific purposes. If we count these people as bilinguals then monolingual speakers would be a tiny minority in the world today”.

There are many people in African and Asian countries, who speak three or more languages. Several languages co-exist in the same country because people need to communicate in their own community with the ethnic language and outside with other communities in the language, that has become the medium of communication between different ethnic groups or speech communities. Most of all they also study foreign languages (e.g. English, French or Spanish). And in previously colonised countries the latter languages are often languages of education, bureaucracy and

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[1] balanced bilingual - someone whose mastery of two languages is roughly equivalent (unbalanced – not equivalent); maximal bilingual - someone with near native control of two or more languages; minimal bilingual - someone with only a few words and phrases in a second language (from Baetens Beardsmore, H, 1982).

privilege.

In many European countries, children learn two (or sometimes more) languages at school (mostly English, German or / and French). And of course they use the home or / and residence language too.

“Multilingualism can also be the possession of individuals who do not live within a multilingual country or speech community. Families can be trilingual when the husband and wife each speak a different language as well as the common language of the place of residence. People with sufficient social and educational advantages can learn a second, third or fourth language at school or university, at work or in leisure time” (Li Wei 2000:7).

A.Bentahila (1983) in his book about Arabic-French Bilinguals in Morocco describes the language use of the multilingual speakers for different purposes, who do not typically possess the same level or type of proficiency in each language. “In Morocco, for instance, a native speaker of Berber may also be fluent in colloquial Moroccan Arabic, but not be literate in either of these languages. This Berber speaker will be educated in modern standard Arabic and use that language for writing and formal purposes. Classical Arabic is the language of the mosque, used for prayers and reading the Qur’an. Many Moroccans also have some knowledge of French, the former colonial language.”

Of course that is why there is a lot of interest for the bilingual’s language use. One of the first psycholinguistic research question was, whether the brain of a bilingual speaker functions or is organized differently from a monolingual speaker’s brain.

Till the 1960s there was a belief that bilingualism has a detrimental effect on a personal intellectual and spiritual development. A lot of linguists had a negative vision on bilingualism. An example we can see in the next citation: “If it were possible for a child to live in two languages at once equally well, so much the worse. His intellectual and spiritual growth would not thereby be doubled, but halved. Unity of mind and character would have great difficulty in asserting itself in such circumstances.” (Laurie, 1890:15)

There is a widespread impression that bilingual speakers code-switch because they cannot express themselves adequately in one language. This may be true to some extent when a bilingual is momentarily lost for words in one of his or her languages. However, code-switching is an extremely common practice among bilinguals and takes many forms. A long narrative may be divided into different parts, which are expressed in different languages; sentences may begin in one language and finish in another; words and phrases from different languages may succeed each other (Li Wei, 2000:12). These phenomena lead linguists to investigate on the interlingual influence of the languages.

Nowadays interpretation of bilingualism has changed in the good way. Moreover, not only linguists, but also odd people, bilingual or multilingual are more and more interested in findings about the connection and relations of their languages.

The question, whether bilinguals activate either both their languages or only the one they are using (production and perception). All experiments that were made in this field (e.g. Kroll and de Groot, 1997; Kroll and Stewart, 1994; Dijkstra, van Heuven, 1998) demonstrate a relation between the languages that are known by the bilingual. The majority of researchers believe that lexical access in bilingual speech is non-selective, which means that all languages (known by the bilingual) compete for selection during the use of a single language. Note that this does not imply that "words from the two languages cannot be distinguished anymore; rather, language information is thought to be available at a later point in time than the word activation itself, but it cannot prevent an initial activation of word candidates from the non-target language" (Lemhöfer, Dijkstra, & Michel, 2004:586).

Does the multilingual have all languages simultaneously active also if he or she speaks three, four or five languages? It is hard to imagine that all these languages are activated while using a language.

2. Models of bilingual lexicon

Nowadays the situation of multilingualism is no longer exceptional, but it is well known that in most European countries people are studying one or rather two foreign languages and use these languages often enough to reach a proficient level. Such situation attracts the interest of researchers. Psycholinguists pay a lot of attention to bilingual language use versus monolingual language use.

In recent years there is a growing interest in multilingualism. Bilingualism, and over the last years multilingualism, is one of the popular topics in psycholinguistics. There are different ways to look at this phenomenon, but one of the problems is the way in which the lexicon of all languages of the bilingual is organised.

There are different views on lexical organisation in the bilingual brain. How is the bilingual lexicon organised? Do bilinguals have a shared lexicon across their languages? These questions are still a discussion between different linguists.

There are different models of lexical organisation in the bilingual brain. Each of them has a different view on language connections. Below we look at the main models, which are often used for the study of bilingual word perception. In the general discussion we will see if the results of the experiments of the present study support one or the other model, if there is evidence for one of them.

2.1 The distributed feature model

In past literature, there are two different research traditions that have given rise to alternative accounts of bilingual language processing. One line of research, investigating the representations of words and concepts in two languages, assumes that in most essential respects the same semantic system supports meaning representations in the bilingual's two languages (Kroll, 1993; Kroll and de Groot, 1997). For example, research on picture naming and translation, Stroop-type interference tasks, semantic priming, and semantic categorization all suggest that words in each language access conceptual representations that are common to both languages (e.g. Costa, Miozzo, and Caramazza, 1999; La Heij, Kerling, and Van der Velden, 1996; La Heij et al., 1990).

Moreover, recent neuroimaging studies have shown that the same neural issue appears to support semantic processing in each of the bilingual's two languages, suggesting a common representational system (Illes et al., 1999). Bilinguals may take longer to understand the meaning of words in the second language (L2) than in the first or native language (L1), and they may have more extensive knowledge of the meanings of L1 than L2 words, but the same underlying representations and processes are assumed.

An alternative view is that the larger cultural and linguistic context, in which the bilingual's two languages are used, have profound consequences for the understanding of even common words. Research on linguistic relativity reflects this assumption (for more information see Green, 1998, and Pavlenko, 1999).

Observations of language use both within and outside the laboratory make it clear that not all words in one language possess direct, single-word translation equivalents in another language, and that sometimes translation equivalents are only approximate. Within the literature on bilingual language processing, these ideas have been developed most extensively by the work of de Groot and her colleagues (de Groot, 1995; de Groot, Dannenburg, and van Hell, 1994; van Hell and de Groot, 1998).

The distributed feature model (see Figure 1) represents the relation between translation equivalents in terms of the overlap of a set of semantic features. As in other recent proposals in the domain of semantics and computational modeling (e.g. Vigliocco, Vinson, Damian, and Levelt, 2002), the notion is that the similarity of word meanings is graded and that the underlying representations account for many of the emergent properties of category structure and word type.

In the case of bilinguals, the similarity of the meaning representations that are retrieved for translation equivalents will be a function of how much the concepts that are activated by words in the two languages overlap. The claim is that some words, notably concrete nouns and cognates (words with similar form and meaning), are more likely to map onto virtually the same pool of semantic features across languages than abstract nouns and noncognates. The more overlap between semantic features, the more quickly the translation will be retrieved and the more likely different bilinguals will produce the same response.

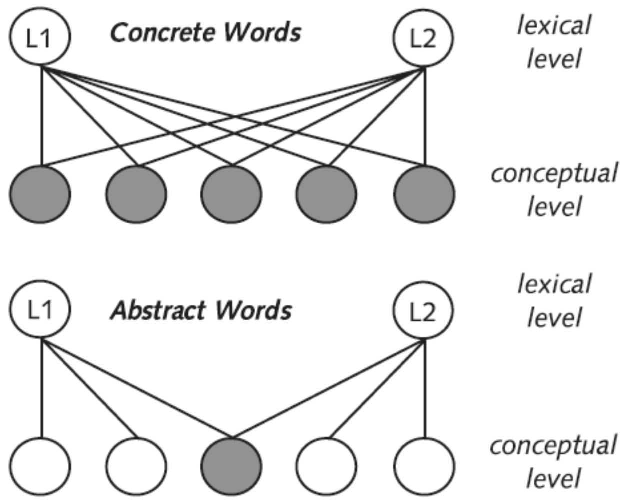

Figure 1. The distributed feature model (adapted from van Hell and de Groot, 1998).

The evidence for the distributed feature model comes primarily from studies of translation by proficient bilinguals (e.g. van Hell and de Groot, 1998). As the model predicts, performance is faster and more accurate for concrete than for abstract words and for cognate than for noncognate words. Critical questions for the distributed feature model are, whether it matters which particular features are shared across languages and whether the number of features required to identify a particular concept is an important factor in determining cross-language similarity. The model as it stands makes predictions that are primarily quantitative so that response time will be fastest when a high proportion of features overlaps, regardless of their status.

Another issue that requires examination is, whether a special similarity mechanism is required in the bilingual case. It is possible that any factor that affects the ease of concept retrieval will also influence cross-language performance in tasks in which semantics is engaged. For example, the concreteness of words within a single language has been shown to affect performance in a variety of tasks (e.g. Kroll and Merves, 1986). It is possible that the observed cross-language effects are only a reflection of more general aspects of semantic and conceptual representation. But the recent set of studies (e.g. Tokowicz, Kroll, de Groot, and van Hell, 2002) show that the time to translate is a function of the number of translation equivalents, with longer latencies when words in one language map to more than one alternative in the other language. These effects are even more robust than the concreteness effects previously reviewed and provide support for the hypothesis that the ambiguity of the lexical and/or semantic representation will have consequences for understanding and speaking words in different languages.

2.2 The revised hierarchical model

A lot of models describe aspects of the bilingual lexicon for individuals who have achieved a relatively high level of proficiency in their second language. However, few bilinguals are balanced across the two languages; typically one language, often the native language, is more dominant than the other. The revised hierarchical model (RHM) was proposed by Kroll and Stewart (1994) to characterize the consequences of differential expertise in the two languages for the connections between words and concepts. The model (Figure 2) includes independent lexical representations for each language, with the mental lexicon of the first or native language (L1) assumed to be larger than second language (L2), and a shared conceptual representation. In other words the first language has not only stronger connection with the concepts, but also has a larger vocabulary. Unlike the distributed feature model, the RHM does not make a detailed commitment to the nature of the lexical and conceptual information, but rather focuses on the connections between them.

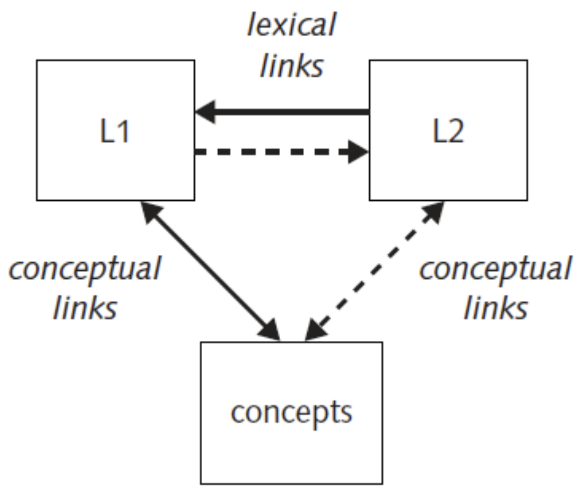

Figure 2. The revised hierarchical model (from Kroll and Stewart, 1994).

The model assumes that words in L1 can more readily access their respective meanings than words in L2. This asymmetry in the strength of connections between words in the two languages and their meaning is an important feature of the model. The unusual claim of the model, and the one that has received the most scrutiny, is that lexical representations in L2 are strongly associated to their translations in L1. In this respect, the model represents the consequences of the learning history of the late second language learner for whom lexical and conceptual representations are already in place for L1 when L2 learning begins. The hypothesis is that L2 words take advantage of the existing lexical-to-meaning connections by accessing the L1 translation. This process will be most salient for learners but still evident even for relatively proficient bilinguals. The model thus assumes asymmetric connections in two ways. At the lexical level, L2 words are more strongly associated to their L1 translations than the reverse. At the level of accessing concepts, L1 words have stronger connections to meaning than their L2 counterparts. The researchers see this phenomenon as the result from the learning process and stronger connections between L2 and L1 with the use of translation methods.

The empirical observation that led to the RHM initially was the finding that translation from L1 to L2, the forward direction, is typically slower and more error-prone than translation from L2 to L1, the backward direction. According to the model, the asymmetry in performance in the translation directions can be understood as a consequence of the asymmetric connections between words and concepts in the two languages. In the L2 to L1 direction, the strongly associated translation equivalents at the lexical level will be accessed directly. In the L1 to L2 direction, the bias to activate the meaning of the L1 word will encourage reliance on a translation route that engages semantics. The L1 to L2 direction is hypothesized to be particularly difficult for less proficient bilinguals for whom the links between concepts and L2 links representations are relatively weak. Experiments on translation generally support these predictions, with a larger translation asymmetry at lower levels of L2 proficiency and L1 to L2 translation changing most dramatically with increasing L2 skill (e.g. Kroll, Michael, Tokowicz, and Dufour, 2002).

If the ideas of the RHM about the two directions of translation are correct, then concepts are accessed in only one of the two translation directions, from L1 to L2. Kroll and Stewart (1994) tested this prediction by examining the effect of a semantic variable, the presence of a list context that was semantically categorized or not (e.g. a list of all animal names), on the two translation tasks. The experiment, performed with highly proficient Dutch-English bilinguals, provided clear support for the predictions. In the L1 to L2 direction, bilinguals suffered interference when translating in the context of categorized lists. In the L2 to L1 direction, hypothesized to be accomplished directly via access to lexical-level translations, there was no effect of the semantic manipulation.

2.3 Bilingual Interactive Activation model

The bilingual interactive activation (BIA) model (Figure 3) is a model that is based on the Interactive Activation model (IA) of McClelland and Rummelhart (1981)

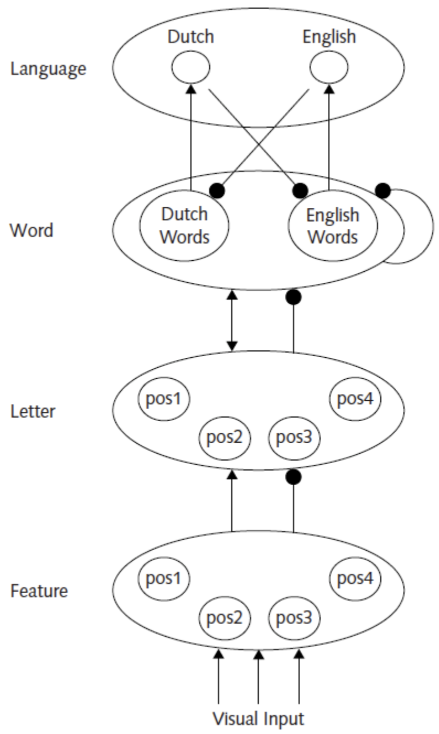

Figure 3 The bilingual interactive activation model (adapted from Dijkstra, van Heuven, 1998).

Like the monolingual model, BIA assumes that there is parallel activation of letter features, letters, and words, with information similar to the input string activated to some degree and producing competition across alternative candidates. However, unlike the monolingual model, BIA includes a layer of language nodes, which serve to represent the top-down contextual biases and subsequently inhibit the bottom-up activation of the non-target language. Unlike the RHM, BIA model represents words of both languages as one lexicon.

In this scheme, the inhibitory effects occur relatively late in processing, once the initial components of word recognition are set in motion for all possible solutions in either of the bilingual's two languages. BIA has been implemented as a computer model and does an excellent job of simulating bilingual word recognition performance under conditions in which the words to be recognized differ in their within and across-language orthographic properties (van Heuven et al., 1998).

With other words, a critical feature of the BIA model is the assumption that when a bilingual reads words in one language, lexical form relatives of those words are activated in both the target and non-target languages. We can look at the classical examples given by J.F.Kroll and P.E.Dussias (2004:172). "When a Dutch-English bilingual reads the word *room* in English, not only do similar-looking English words become active (e.g. *roof, boom*) but similar-looking Dutch words also become active, including the word *room* itself, which happens to be an interlexical homograph which means 'cream' in Dutch." Bilingual word recognition is therefore thought to reflect the process of sorting out the activation and resulting competition among lexical alternatives in both of the bilingual's languages.

The observation of parallel activity across the two languages during visual word recognition does not necessarily suggest that similar cross-language activation occurs during auditory processing of the speech signal. Since languages differ in their component sounds it can be argued that within the speech signal there are language-specific cues that are not available within printed text. There have been a few studies that have examined cross-language interaction during speech processing. In a seminal study, Spivey and Marian (1999) asked Russian–English bilinguals to view an array of objects as they listened to instructions in either their L1 or L2, which indicated an object that they should select (e.g., "pick up the **marker**"). On critical trials the instructions indicated a target object whose phonological onset was the same as that of another object in the non-target language (e.g., "stamp" in Russian is "**marka**"). To test whether the non-target lexical representation of the object was activated, the authors monitored the bilinguals' eye-movements as they surveyed the array of objects and listened to the instructions. When the instructions indicated an object whose phonological onset was shared across languages, participants initially looked toward the object that shared this onset in the non-target language (Russian or English). This indicated that upon hearing the initial, shared phoneme, the bilinguals activated lexical candidates from both their languages (see also Marian & Spivey, 2003). Using a very different paradigm, Colomé (2001) found converging evidence that bilinguals activate phonemic representations from both languages in a non-selective manner. In that study highly proficient Spanish–Catalan bilinguals performed a phoneme-monitoring task in their L2, in which they decided whether the name of a visually presented picture (e.g., a table) contained a target phoneme (e.g., /m/). On critical trials, the bilinguals had to reject phonemes that were not part of the Catalan name (e.g., /m/ is not present in the Catalan word taula) but were part of the contextually irrelevant Spanish translation of that object (e.g., mesa). The bilinguals took significantly longer to reject phonemes contained in the Spanish translation relative to phonemes that were not part of the picture's name in either language (e.g., /s/).

Subsequent studies have demonstrated that aspects of the linguistic input itself may make it possible to constrain the parallel activation of the non-target language when processing spoken language. Weber and Cutler (2004), tested Dutch–English bilinguals with an eye-tracking paradigm very similar to the one used by Marian and Spivey (2003), and found significant cross-language effects from L1 to L2 (i.e., when bilinguals were processing the spoken targets in the non-native language), but not from L2 to L1. Similar research of Ju and Luce (2004) replicated the basic pattern of cross-language phonological competitor effects, but then went on to demonstrate that cross-language competitor activation could be eliminated when the voice onset times (VOTs) of the initial phonemes were realised as in L1. That is, L2 competitors were no longer activated when the target words were perceived to be native-like speech. These results contrast with results from experiments using written stimuli and illustrate the critical role that access codes play in the activation of lexical and sub-lexical representations in bilingual language comprehension.

A key source of evidence for the BIA model has come from studies in which aspects of word type have been experimentally manipulated. For example, if a Dutch-English bilingual is asked to decide whether the visual word *room* is a valid letter string in English (i.e. to perform language-specific lexical decision), will he or she perform any differently than when asked to decide whether an unambiguously frequency-marked English word is a valid letter string? If access to the lexicon is language-specific, then bilinguals should perform no differently on words that share lexical representations across their two languages than on those that do not. A large number of recent studies taking this approach have provided support for the claim that lexical access is nonselective and that bilinguals cannot help but respond as if information in both languages was active. These studies include the use of interlingual homographs, words that share lexical form but not meaning (e.g. Dijkstra, Timmermans, and Schriefers, 2000), cognates, words that share both lexical form and meaning (e.g. van Hell and Dijkstra, 2002), and cross-language neighbors, words belonging to a cohort of words that resemble the target word in the non-target language (e.g. van Heuven, Dijkstra, and Grainger, 1998).

Dijkstra, van Jaarsveld, and ten Brinke (1998) examined the lexical decision performance of highly proficient Dutch-English bilinguals on English and Dutch words that were unambiguous within each language or interlingual homographs (e.g. "room"). When the task was simply to decide whether the letter string was a real word in English, and to say "no" to pseudo words (i.e. letter strings that are legal in English but not real words), the Dutch-English bilinguals were as fast to make decision on the homographs as on the unambiguous English control words, as if they were able to selectively access English and switch off their Dutch. However, a second condition in that experiment suggested otherwise. When the English words were cognates in both English and Dutch, they were significantly faster to judge them as words than the controls. In a second experiment, Dijkstra et al. increased the difficulty of the task by including real Dutch words among the pseudo words. The task was still English lexical decision, but now the task was to respond "yes" if the letter string was a real English word and "no" otherwise (i.e. to both pseudo-words and real Dutch words). With this change in the composition of the materials, bilinguals were now slower to accept letter strings as English words when they were interlingual homographs, suggesting that it was difficult to ignore the irrelevant sense of the word. This finding indicated that the representation in the non-target language had been activated as well. In a final experiment, Dutch-English bilinguals were asked to perform a generalized lexical decision task, which required them to respond "yes" to any real word in either language. Under these conditions, the bilinguals were faster to judge homographs than controls, again suggesting that both readings of the word were available. Dijkstra et al. argued that the results supported the predictions of the BIA model in that shared orthographic properties of words across both languages affected performance even when the task required attention to one language only.

3. Psycholinguistic research

3.1 Previous research on interlingual homographs and cognates

Interlingual homographs and cognates are frequently used to investigate the bilingual mental lexicon. Interlingual homographs are words with similar or the same orthographic but different semantic representations (e.g. the word “room” refers to a location in English and the word with the same orthographical representation means “cream” in Dutch). Cognates are words, which have the same (or similar) orthographic and semantic representations in both languages (e.g. “half”, “land” mean the same in Dutch and English). As these words have the same words in two languages, they can show whether the bilinguals are influenced by their other language(s). The difference in reaction time on homographs, cognates and control words (pure words that belong to only one language e.g. “mus” in Dutch or “poor” in English) shows whether the “irrelevant” non-target language plays a role.

Many bilingual studies used homographs or cognates, or both types of words to demonstrate the difference in the processing of homographs, cognates and “monolingual” words. Most of them used a lexical decision task in the weaker language (Dijkstra, Grainger, & van Heuven, 1999; Lemhöfer, Dijkstra, & Michel, 2004) or go/no-go task either in the native or in the second language (Dijkstra, Timmermans, & Schriefers, 2000). In all these studies lexical decision on cognates were faster in comparison to the reaction times on control words (the words, which exist only in one language). In contrast, lexical decisions on homographs were slower in comparison to the reaction times on control words. Faster response are called facilitation effect and longer response is referred to as inhibition effect.

Some research on trilinguals has been performed (i.e. van Hell, & Dijkstra, 2002; Lemhöfer, Dijkstra, & Michel, 2004) to confirm or reject the findings of psycholinguistic studies on bilinguals, to find out, whether the lexical access is selective or non-selective and how the languages influence each other.

In the research of van Hell and Dijkstra (2002) trilinguals made a lexical decision task in their native language (Dutch). They had faster reaction times on cognates that also occurred in the second language (English) and also faster reaction time on cognates that occurred in the third language (French) in comparison to pure Dutch words. Their conclusion was that all three languages are active during word recognition. The cognates were either Dutch-English (e.g. “adder”, “ring”) or Dutch-French (e.g. “plafond” – ceiling, “tante” – aunt).

Lemhöfer, Dijkstra and Michel (2004) made a similar experiment with trilinguals, who made a lexical decision task in their third language (German). The first and second languages were Dutch and English, respectively. The researchers took cognates from two languages (Dutch-German “dienst”, “kern”) and also cognates belonging to three languages at the same time (Dutch-German-English “wolf”, “wind”). They found that the reactions on the *three-language* cognates were even faster than on the two-language cognates.

3.2 Present study on interlingual homographs and cognates

In present study we distinguish the influence of the third language (L3) on the use of the first two (L1 and L2). To investigate this issue, we will make use of interlingual homographs and cognates.

In all mentioned studies on bilingual language processing on homograph and cognate representations the non-target language was always present in the experiment.

For the present study we took trilinguals, whose first language was Dutch (L1), second language English (L2) and third language French (L3). The innovative aspect of the present research is that only two languages were used in the experiment. The third language was a “hidden” language, i.e. although the stimuli in the experiment were English / French cognates, the French language was not present is the experiment and other stimuli were pure English or Dutch words. In this way we can see if the non-present language in the context can influence word recognition.

We selected English-Dutch homographs, English-Dutch and English-French cognates as stimuli. The participants performed a go/no-go task in their second language (more information about go/no-go task see in the next chapter). The third language was the “hidden” language in Experiment 2A and the first language was the “hidden” language in Experiments 1B and 2B. By “hidden” language we mean the language that does not appear in the experiment (e.g. French in Experiment 2A). In Experiment 2A there were English-Dutch cognates, English-French cognates, English controls and Dutch fillers. With the go/no-go task we expect that participants say "yes" to English words only. Because English-French cognates are English words and the words occur in the context of only Dutch and English words, the third language is not activated in the experiment. Our task is to find out, whether this language (French in Experiment 2A and Dutch in Experiment 2B) nevertheless influences the participants' word recognition. If it does, this would be strong evidence for language non-selective access.

3.2 Go/no-go task

In the experiment we did not use the standard lexical-decision task[2], but a go/no-go task, which was also used in the experiment of Dijkstra, Timmermans and Schriefers (2000) with the difference that in our experiment we did not only have English controls for the homographs (Experiments 1) or cognates (Experiments 2), but also Dutch (in the Experiments A) and French (in the Experiments B) fillers to create equal percentages of words for the two languages (see material description for each experiment for more details). This task has a lot of similarities with the lexical-decision task, but in some respects it is also different. It also investigates the recognition of words in isolation. In the go/no-go task participants must react only to presented words that belong to a certain target language. In our experiments the target language is English. In half of the cases, since 50% of the words are selected from the non-target language (Dutch in Experiments A, French in Experiments B) the participants should not react and wait till the next word appears[3]. That's why the go/no-go task differs from the language and lexical decision tasks, where participants keep their language "ready for use" because any of the languages can occur on the next trial and they should be prepared to react to each of them. In the go/no-go

[2] The procedure that measures how quickly people classify stimuli as words or non-words; words from two different languages (e.g. Dutch or English).

[3] However the non-target language (Dutch or French) will be presented longer, which could induce an unwanted language bias in responding, the task is more to see if the inhibition is strong enough to avoid the language bias and the influence of the non-presented third language.

paradigm the participants are free to optimize their perception and could in principle suppress the activation of the non-target language. If the non-target language can be suppressed or "switched-off" we should measure no or reduced cross-language effects on homographs and cognates.

With respect to homograph processing in the go/no-go task, the language-selective and -non-selective access views predict similar or different outcome patterns depending on their specific instantiation. According to a strong language selective access view, RTs to interlingual homographs and one-language controls will not differ because the bilingual has no reason to activate the non-target language at all. Similarly, according to a non-selective access view that assumes the possibility of complete suppression under strategic control, no differences are expected between interlingual homographs and controls because even though the non-target language reading of a homograph will initially be activated, it will be quickly suppressed. But it is possible that the use of the second language in the experiment activates the 2 representations of homographs and cognates even in the go/no-go task.

We use a "hidden" third language in the present research, because we want to verify whether there is a difference in the processing of English – Dutch and English – French homographs or cognates in different language contexts, where English is the target language and Dutch or French is the "hidden language". In other words, we want to ascertain if the language that is not presented in the experiment, is still active and influences the process of visual word perception.

If the language-non-selective view is correct, there will still be a strong inhibition for the homographs of a language, that is "not presented" in the experiment.

3.3 Selection of the stimuli

Using the CELEX database (Baayen, Piepenbrock, & Gulikers, 1995) a list of English and Dutch words were selected. The French list was selected with WordGen (Dyuck, Desmet, Verbeke, & Brysbaert, 2004). Three- to six-letter words were extracted that had a lemma frequency higher than zero occurrences per million. Appendixes contain all selected stimuli for each experiment.

English / Dutch. Orthographically identical words were selected in the English and Dutch word lists. The words were split into two groups: interlingual homographs and cognates. Twenty stimuli were chosen from each list for Experiments 1 and 2. Each of the chosen words had a higher frequency in Dutch than in English. In some cases summed frequencies were calculated when a word had different parts of speech, which is typical for English (EN “wet” = adjective and verb; “trap” = noun and verb). The mean frequencies for the English words was 55.35 and for the Dutch words identically-spelled 186.85. Students who did not participate in the experiment judged the English words as normal words, which are known by the students of the second year and higher.

English / French. Orthographically identical words were selected in the English and French word lists. 20 cognates were chosen for Experiments 1 and 2. Each of the chosen words has a higher frequency in French than in English. Summed frequency was calculated in the situation when a word had different parts of speech. The mean frequency for the English words was 77.65, for the French words identically-spelled 193.05. Students who did not participate in the experiment judged the English words as normal words, which are known by the students of second year and higher.

English, Dutch and French fillers were added to the certain experiments to make the percentage of the interlingual homographs and cognates less than 50%. To create a bilingual word situation in the experiment 50 % of words from each of the two languages were presented. The fillers were perfectly matched with their pairs. The same students also judged the fillers.

4. Experiments

The innovation is that in the present study we use a "hidden" language because we want to verify whether there is a difference in the processing of English / Dutch interlingual homographs, English / Dutch and English / French cognates in different language contexts, where English is the target language and Dutch or French is the "hidden language". In other words, we want to ascertain if the language that is not presented in the experiment, is still active and influences the process of visual word perception. If the language-non-selective view is correct, there will still be strong inhibition for the homographs of a language, that is "not presented" in the experiment (Table 1).

TABLE 1

Design of the experiments with the titles and short descriptions.

	Condition A (Dutch fillers)	**Condition B (French fillers)**
EXPERIMENT 1* HOMOGRAPH (English / Dutch)	Experiment **1A.** English go/no-go task with English / Dutch interlingual homographs; with Dutch fillers (no "hidden" language)	Experiment **1B.** English go/no-go task with English / Dutch interlingual homographs; with French fillers (Dutch as "hidden" language)
EXPERIMENT 2* COGNATE (English / Dutch and English / French)	Experiment **2A.** English go/no-go task with English / Dutch and English / French cognates; with Dutch fillers (French as "hidden" language)	Experiment **2B.** English go/no-go task with English / Dutch and English / French cognates; with French fillers (Dutch as "hidden" language)

*Note: in each experiment we had 50% of English words (among them interlingual words) and 50% of the second-language-fillers (Dutch in condition A and French in Condition B).

All experiments are split in two parts with respect to two types of interlingual words that were used in the research. In this way we had Experiment 1 with interlingual homographs and Experiment 2 with cognates. Because we decided to introduce the words in different language context, we had Condition A with Dutch fillers and Condition B with French fillers.

4.1 Experiment 1. English go/no-go task with English / Dutch interlingual homographs

Experiment 1 presented English / Dutch interlingual homographs.

In Condition A there were Dutch fillers. The goal was to distinguish whether there is a significant difference in the reaction times on the pure English words and on the English / Dutch interlingual homographs, which had a higher frequency of Dutch reading.

In Condition B there were French fillers. The goal was to distinguish whether there is still difference in the reaction times on the English / Dutch interlingual homographs, when the language context was English – French and Dutch was thus "the hidden language".

4.1.1 Experiment 1. Condition A. With Dutch fillers

Methods

Participants. Thirty students (27 female and 3 male, mean age 21.4 years) of the University of Antwerp. All had normal or corrected to normal vision. 26 of them were right-handed and 4 left-handed. All students were native speakers of Dutch, proficient in English and also had good knowledge of French. The participants had learned English as a foreign language at school for at least 6 years, studied English at the university and had used it regularly during the study for 2 years or more (mean experience with the English language was 9.5 years). They also used the French language occasionally and mostly in informal situations outside their study with friends or relatives.

Stimuli. The chosen 20 English / Dutch homographs were used for this experiment (see previous chapter and Appendix 1). All selected homographs were three to five letters long (mean length 3.9 letters, logfreq = 1,29). For each homograph an English control was selected. The English controls were purely English words that were matched item-by-item with each homograph on number of letters, length and word frequency (mean length: 3.9 letters, logfreq = 1,31).

The frequencies for the two groups of words were compared in a t-test: homographs vs. English controls ($p = 0.19$; $t = 1.35$). In other words the two groups of words did not significantly differ and could hence be compared in statistical analyses.

Also 10 English fillers (mean length: 4.62 letters, logfreq = 1,18) were added and 50 Dutch fillers, which were matched item-by-item with all English words (pure English words, English / Dutch homographs) in number of letters and word frequency (mean length: 3.9 letters). The mean frequency of the fillers was logfreq = 1,30. The frequencies for the two groups of words were compared in a t-test: English / Dutch homographs vs. Dutch fillers ($p = 0.83$; $t = 0.22$); English controls vs. Dutch controls ($p = 0.23$; $t = 1.26$). The groups of words did not significantly differ and could hence be compared in statistical analyses

To summarize, the experiment consisted of 100 stimuli (see Table 2): 20 English / Dutch homographs, 20 English controls, 40 Dutch fillers, 10 English fillers, and 10 Dutch fillers. Four blocks were constructed with the restriction that each block consists same number of homographs and their matched controls across the experimental list. This was very important because in this way we could measure the time on the target words and not the personal factor. In this way the mean tiredness is the same for homographs and controls. Two dummy items were placed at the beginning of each list, 12 items were selected for the practice set.

TABLE 2

Count of the stimuli per type of words and per block in Experiment 1A (English go/no-go task with English / Dutch interlingual homographs; with Dutch fillers)

Type words	Count (n)	Block in the experiment	Count (n)
English / Dutch homographs	20	Trial set	12
		Block 1**	22
English controls	20	Block 2	22
Dutch fillers*	50	Block 3	22
English fillers	10	Block 4	22
Sum	100		100

*Note: although the Dutch words were only fillers, they were also matched with all English words in the experiment to make sure that only frequencies of the English / Dutch homographs are different and not one of the languages.

** Note: each Block of the experiment consists of 2 dummy items, 5 English / Dutch homographs, 5 English controls and 10 Dutch fillers matched with the English words.

Procedure. The experiments were run on DELL computers “Optiplex 380” connected to a 15’’ DELL monitor. The stimuli were presented and reaction time on the words was registered with the DMDX programme (Foster, &Foster, 2003). Game controllers Logitech ‘Wingman precision’ were used for responding and to give certain instructions (using the upper button and START button). A written instruction in English was given, explaining that in this task, the participants needed to decide as quickly as possible and as accurately as possible whether the letter string, presented on the screen, was an English word. If the presented word was a non-word or a word from the other language, participants were introduced to wait till the next word appeared. The button on the side of the dominant hand was assigned to the “go” button.

At the beginning of each trial, a (fixation) plus sign appeared in the middle of the screen for 500 ms. After that the test word appeared. The stimuli were presented in the centre of the computer screen in lowercase letters. The item stayed in view until a response had been made or until a time out of 2500 ms had passed. The next trial was initiated 500 ms after the response or time out.

A set of 12 practice trials (see Table 2) different from the test trials preceded the main task (6 were exclusively English and 6 exclusively Dutch). The order of items was pseudo-randomised. The main experiment consisted of four blocks. The participants received he following instructions before each block: “BLOCK 1”; after 2000 ms “Press button for English words only.”; after 3000 ms “ Start experiment. (press START)”. Each block consisted of 22 words. The first 2 words of each block were dummy items one of which was an exclusively Dutch word and the other one an exclusively English word. The practice trials and dummy items were not included in the analyses. Participants were free to take short breaks between the blocks. The order of items between the words was randomized with the DMDX programme (Foster, &Foster, 2003).

The experiment took about 15 minutes after which the participants were asked about their language use and their own impression on how they thought they decided about the words.

Results

The data were analyzed using the R software (free download software for statistical computing, www.r-project.org), and particularly with the lmer function (linear mixed model with two random effects, i.e. participants and items). Three students were excluded from the analyses because they did not understand the task clearly and made too many mistaken responses.

Error analyses. Mean error rates were computed for homographs, English controls; Dutch and English words separately. In this task errors on homographs and English controls are “no go” responses, i.e., the participants did not react on the word and did not press the button even though the word existed in English (“misses”). For the Dutch words, “go” responses were errors (“false alarms”) Table 3 presents hit rates on homographs and English controls.

Misses on English words were 10,9 %, false alarm rates on Dutch words were 10,5 %, RTs on Dutch fillers were not analyzed.

TABLE 3

Mean error rates, mean latencies (RT), percentages correct for the English reading of international homographs and for the English control words in Experiment 1A (English go/no-go task with English / Dutch interlingual homographs; with Dutch fillers)

Word type	Correct (%)	p-value	RT (ms)	p-value
Homographs	81.7	$p < .0089$	827	$p < .0001$
English controls	96.3		614	

There was a highly significant difference in error rates between homographs and English controls ($z = 2.62$; $p = .0089$). It means that there is a trend to make more errors on homographs.

There were also no significant differences found between the number of errors for English and Dutch words ($z = 0.59$; $p = 0.056$)

Reaction-time analyses. In these analyses, only the RT latencies on homographs and English controls were analyzed. Missing responses on homographs and English controls were excluded from the analyses. Error responses on Dutch fillers were also excluded. Table 2 presents mean RTs on homographs and English controls. A significant effect was found ($p < .0001$)

Discussion

Relative to one-language controls, slower RTs and higher miss rates were observed for Dutch / English homographs, which had a higher frequency of Dutch reading. This finding supports a language-non-selective access view in which both languages affect the target recognition process. During target recognition a competitive race takes place between the two readings of the homographs. In this situation the Dutch reading of the homograph may slow down or even block the response to the English reading.

It is relevant to compare this experiment with the similar experiments of Dijkstra, Timmermans and Schriefers (2000). In their experiment, participants performed an English go/no-go task with English / Dutch homographs. The same inhibition was observed in the English go/go-go task with the words, which had a higher frequency of Dutch reading. The observed inhibition was not the consequence of the instruction to respond to one language only, but was rather due to the intermixing of items from two different languages. In other words, due to the lower English frequency of the homographs, the Dutch language influenced the lexical decision.

4.1.2 Experiment 1. Condition B. With French fillers

It would be interesting to see the influence of the Dutch language on the English / Dutch homographs if the Dutch language is absent in the experiment. In Experiment 1B we will introduce the English / Dutch homographs in an exclusively English – French context to investigate this issue.

Methods

Participants. Thirty students of the University of Antwerp different from Experiment 1A (25 female and 5 male, mean age 22.4 years). All had normal or corrected to normal vision. 26 of them were right-handed and 4 left-handed.

All students were native speakers of Dutch, proficient in English, which have also good knowledge of French. The participants had learned English as a foreign language at school for at least 6 years, studied English at the university and had used it regularly during the study for 2 years or more (mean experience with the English language was 10.5 years). They also used the French language occasionally and mostly in informal situations outside the study with friends or relatives.

Stimuli. The same chosen 20 English / Dutch homographs were used for this experiment (see Experiment 1A). The English controls were purely English words that were matched item-by-item with each stimulus on number of letters, length and word frequency (mean length: 3.9 letters, logfreq = 1,31). The frequencies for the two groups of words were compared in a t-test: homographs vs. English controls ($p = 0.19$; $t = 1.36$; i.e. no significant difference).

Also 10 English fillers (mean length: 4.62 letters, logfreq = 1,18) were added and 50 French fillers, which were matched item-by-item with all English words (pure English words, English / Dutch homographs) in number of letters and word frequency (mean length: 3.9 letters). The mean frequency of the fillers was logfreq = 1,63. The groups of words were compared in a t-test: English / Dutch homographs vs. French controls ($p = 0.03$; $t = 2.35$); English controls vs. French controls $p = 0.04$; $t = 2.21$; i.e. no significant difference).

TABLE 4

Count of the stimuli per type of words and per block in Experiment 1B (English go/no-go task with English / Dutch interlingual homographs; with French fillers)

Type words	Count (n)	Block in the experiment	Count (n)
English / Dutch homographs	20	Trial set	12
		Block 1**	22
English controls	20	Block 2	22
French fillers*	50	Block 3	22
English fillers	10	Block 4	22
Sum	100		100

*Note: although the Dutch words were only fillers, they were also matched with all English words in the experiment to make sure that only frequencies of the English / Dutch homographs were different and not one of the languages.

** Note: each Block of the experiment consists of 2 dummy items, 5 English / Dutch homographs, 5 English controls and 10 Dutch fillers matched with the English words.

To summarize, the experiment consisted of 100 stimuli (Table 4): 20 homographs, 20 English controls, 40 French fillers on the homographs and

English controls, 10 English fillers, and 10 French fillers. Four blocks were constructed with the restriction that each block consists same number of homographs and their matched controls across the experimental list. Two dummy items were placed at the beginning of each list, 12 items were selected for the practice set.

Procedure. The same procedure was used as in the Experiment 1A.

A set of 12 practice trials different from the test trials preceded the main task (6 were exclusively English and 6 exclusively French). The first 2 words of each block were dummy items from which one was exclusively French word and other one exclusively English word.

The experiment took about 15 minutes after which the participants were asked about their language use and own vision on how they decided about the words.

Results

The data were analyzed using the R software, and particularly with the lmer function (linear mixed model with two random effects, i.e. participants and items). Two students were excluded from the analyses because they did not understand the task clearly and made mistaken responses.

Error analyses. Mean error rates were computed for homographs, English controls; French and English words separately. In this task errors on homographs and English controls are "no go" responses, i.e., the participants did not react on the word and did not press the button although the word exists in English ("misses"). For the French words, "go" responses were errors ("false alarms") Table 5 presents hit rates on homographs and English controls.

Mean misses on English words were 6,96 %, false alarm rates on French words were 4,73 %, RTs on French fillers were not analysed. There was no significant difference in error rates between English and French words ($z = - 0.23$, $p = 0.81$).

There was no significant difference in error rates between homographs and English controls ($z = 1.669$; $p = 0.095$). This means that there is a trend to make more errors on homographs, but this effect is not significant.

TABLE 5

Mean error rates, mean latencies (RT), percentages correct for the English reading of international homographs and for the English control words in Experiment 1B (English go/no-go task with English / Dutch interlingual homographs; with French fillers)

Word type	Correct (%)	z-value	p-value	RT (ms)	t-value	p-value
Homographs	90.72			704		
English controls	95.18	1.669	.095	606	2.33	.02
				Difference in RT = 98		

Reaction-time analyses. In these analyses, only the RT latencies on homographs and English controls were analyzed. Missing responses on homographs and English controls were excluded from analyses. Error responses on French fillers were also excluded. Table 5 presents mean RTs on homographs and English controls.

The effect of the second language of the homograph, which is the hidden language in this experiment (Dutch), is significant: $t = 2.33$, $p < .02$. In other words, items, which also occur in Dutch, causes longer response times (704 ms) than control items, which obviously occur only in English (606 ms).

When the second language of the homographs is Dutch and the language is present in the experiment (see Condition A) an inhibition effect occurs (213 ms.). When the second language is **not** present in experiment, the inhibition is smaller (98 ms.), but it is still present (Condition B). It could be caused by the difference in the subjects' response speed, i.e., the participants in Condition B react much more quickly, but we can compare their responses on the control words, which are nearly the same: 614 ms. and 606 ms. in Condition A and Condition B respectively (see Table 6).

TABLE 6

Mean latencies, difference in reaction time (RT) for the English reading of international homographs and for the English control words in Experiment 1A (English go/no-go task with English / Dutch interlingual homographs; with Dutch fillers) and Experiment 1B (English go/no-go task with English / Dutch interlingual homographs; with French fillers)

	Second language of experiment*	Word type		Difference in RT (ms)
		Homographs	English controls	
RT (ms)	Dutch (Experiment 1A)	827	614	213
	French (Experiment 1B)	704	606	98
Difference in RT (ms)		123	8	115
t-value		t = 5.30		
p-value		p < .0001		

*Note: second language of all homographs in both experiments was Dutch, but in the Experiment 1A Dutch was present and in Experiment 1B it was the “hidden” language.

Discussion

In this experiment support for the view of language-non-selective access view is found. Relative to one-language controls, slower RTs and higher miss rates were observed for Dutch/English homographs, which had a higher frequency Dutch reading. During target recognition a competitive race takes place between the two readings of the homographs. In this situation the Dutch reading of the homograph may slow down or even block the response to the English reading. In other words, due to the lower English frequency of the homographs, the Dutch language influences the lexical decision. This is evident for the situation when both languages are present in the experiment (see Condition A and the experiments of Dijkstra, Timmermans and Schriefers, 2000).

But the same inhibition effect is present in Condition B when the second language of the homographs is absent and, even though it would be reasonable to think that there is no need to keep the language active, it influences the lexical decision. However when the second language of the homographs also appears in the experiment (i.e., Dutch), the effect is considerably longer (213 ms in Condition A) than when the second language is absent (98 ms in Condition B). One type of inhibition is larger than the other one. In other words the inhibition of the English / Dutch homographs versus their English controls is more intense when the language corresponding to the non-target reading of the homograph is present in the experiment. The effect of the interaction is significant: $t = 5.30$, $p < .0001$ (see Table 6).

4.2 Experiment 2. English go/no-go task with English / Dutch and English / French cognates

Experiment 2 presented English / Dutch and English / French cognates.

In Condition A there were Dutch fillers. The goal was to distinguish whether there is still a significant inhibition or facilitation effect on the English / Dutch cognates. Whether there is the same effect on the English / French cognates, when French is the "hidden" language in the Dutch-English language context.

In Condition B there were French fillers. The goal was to distinguish whether there is still difference in the reaction times on the English / Dutch and English / French cognates, when the language context is English – French and Dutch is thus "the hidden language", whether the influence of the Dutch language on the English / Dutch cognates changes if the Dutch language will be absent in the experiment.

4.2.1 Experiment 2. Condition A. With Dutch fillers

Methods

Participants. The same thirty students from Experiment 1A.

Stimuli. The chosen 20 English / Dutch cognates were used for this experiment (see Appendix 2). All selected cognates were three to five letters long (mean length 3.85 letters, logfreq = 1,51). For each stimulus an English control was selected. The English controls were purely English words that were matched item-by-item with each stimulus in number of letters, length and word frequency (mean length: 3.85 letters, logfreq = 1,54). The groups of the words were compared in the t-test: cognates vs. English controls ($p = 0.09$; $t = 1.79$; i.e. no significant difference).

We also took 20 English / French cognates. The cognates were three to six letters long (mean length 5.05 letters, logfreq=1,55). For each stimulus an English control was selected. The English controls were purely English words that were matched item-by-item with each stimulus on number of letters, length and word frequency (mean length: 5.04 letters, logfreq=1,56). The frequencies for the two groups of words were compared in a t-test: cognates vs. English controls p = 0.24; t = 1.21; i.e. no significant difference).

Also 20 English fillers were added (mean length: 4.62 letters logfreq = 1,61) and 100 Dutch fillers, which were matched item-by-item with all English words (pure English words, English / Dutch and English / French cognates) on number of letters and word frequency (mean length: 4.45 letters). The mean frequency of the fillers were logfreq = 1,61. The groups of the words were compared in the t-test: English / Dutch cognates vs. Dutch controls (p = 0.94; t = 0.08); English controls vs. Dutch controls (p = 0.85; t = 0.19); English/French cognates vs. Dutch controls (p = 0.97; t = 0.04); English controls on it vs. Dutch controls (p = 0.68; t = 0.42; i.e. no significant difference).

TABLE 7

Count of the stimuli per type of words and per block in Experiment 2A (English go/no-go task with English / Dutch and English / French cognates; with Dutch fillers)

Type words	Count (n)	Block in the experiment	Count (n)
English / Dutch cognates	20	Trial set	20
English / French cognates	20	Block 1**	36
English controls	40	Block 2	36
Dutch fillers*	100	Block 3	36
English fillers	20	Block 4	36
		Block 5	36
Sum	200		200

*Note: although the Dutch words were only fillers, they were also matched with all English words in the experiment to make sure that only frequencies of the English / Dutch homographs were different and not one of the languages.

** Note: each Block of the experiment consists of 4 dummy items, 4 English / Dutch cognates, 4 English / French cognates, 8 English controls and 16 Dutch fillers matched with the English words.

To summarize, the experiment consisted of 200 stimuli (see Table 7): 20 English / Dutch cognates, 20 English controls, 40 Dutch controls on cognates and English controls; 20 English / French cognates, 20 English controls, 40 Dutch controls on the cognates and English controls, 20 English fillers, and 20 Dutch fillers. Five blocks were constructed with the restriction that each block consists same number of homographs and their matched controls across the experimental list. Four dummy items were placed at the beginning of each list, 20 items were selected for the practice set.

Procedure. The same procedure was used as in Experiment 1A. But because of more stimuli, they were split in more groups and each group consisted of more words too.

A set of 20 practice trials (see Table 7) different from the test trials preceded the main task (10 were exclusively English and 10 exclusively Dutch). The order of items was pseudo-randomised too. The main experiment consisted of five blocks.

Each block consisted of 36 words. The first 4 words of each block were dummy items from which one was exclusively Dutch and the other one exclusively English word.

The experiment took about 20 minutes after which the participants were asked about their language use and own impression on how they decided about the words.

Results

The data were analyzed using the R software, and particularly the lmer function (linear mixed model with two random effects, i.e. participants and items). Three students were excluded from the analyses because they did not understand the task clearly and made mistaken responses.

Error analyses. Mean error rates were computed for English / Dutch cognates, English / French cognates, English controls; Dutch and English words separately. In this task errors on cognates and English controls are "no go" responses ("misses), while for Dutch words, "go" responses were errors ("false alarms") Table 2 represents hit rates on cognates and English controls.

Mean misses on English words were 2,6 %, false alarm rates on Dutch words were 8,84 %, RTs on Dutch fillers were not analyzed. There was a significant difference in error rates between Dutch and English words ($z = 6.56$; $p < 0.0001$). The participants made more mistakes in Dutch.

Mean misses on English / Dutch cognates were 5.74 %, on English / French cognates 1.48 %, on English controls (for English / Dutch cognates) 0.55 %, on English controls (for English / French cognates) 3.15 %. $z = - 0.035$; $p = 0.097$). This means that there is a trend to make more errors on cognates, but the effect is not significant.

Reaction-time analyses. In these analyses, only the RT latencies on English / French cognates, English / Dutch cognates and English controls were analyzed. Missing responses on cognates and English controls were excluded from analyses. Error responses on Dutch fillers were also excluded. Table 8 presents mean RTs on cognates and English controls.

When the second language of the cognate is Dutch (i.e., the language that also appears in the experiment), the effect is considerably longer (121 ms) than when the second language of the cognate is French (i.e., the language that is absent in the experiment; 38 ms). One type of inhibition is higher than the other one. In other words the inhibition of the English / Dutch cognates versus their English controls is more intense than the inhibition of the English / French cognates versus their matched English controls. The effect of interaction is significant: $t = -3.48$, $p = 0.0005$.

The effect of target type (cognate vs. control) is non-significant: $t = -1.19$, $p = .23$.

TABLE 8

Mean error rates, mean latencies, difference in reaction time (RT), percentages correct for the English reading of English / Dutch, English / French cognates and for the English control words in Experiment 2A (English go/no-go task with English / Dutch and English / French cognates; with Dutch fillers)

Word type	Correct (%)	p-value	RT (ms)	
English / Dutch cognates	94.26		737	
English controls	96.85	p < .0001	616	
			Difference in RT = 121	
English/French cognates	98.52		624	
English controls	99.45	p < .0001	592	
			Difference in RT = 32	p (interaction) < .0005

Discussion

Substantial miss rates and slower latencies were still noticed for cognates when English was the target language of the go/no-go task. Participants often overlooked an English word if the same word also existed with a higher frequency in Dutch. The same effect was noticed in the situation of the English / French cognates. However, the French language was absent in the experiment, still the inhibition effect in the latencies for the cognates was observed because the French frequency of the words, which also exist in English and were presented in the experiment, was higher than the frequency of the same words in English.

Although there was stronger inhibition from the present language (Dutch) on the English / Dutch cognates, the inhibition of the absent language (French) on the English/French cognates was still present. The results provide convergent evidence in favour of non-selective access to the bilingual lexicon.

4.2.2 Experiment 2. Condition B. With French fillers

It would be interesting to switch the languages. What will be the influence of the Dutch language on the English / Dutch cognates if the Dutch language will be absent in the experiment? In Experiment 2B we will introduce the same English / Dutch and English / French cognates in an exclusively English – French context.

Methods

Participants. The same thirty students from Experiment 1B

Stimuli. The same chosen 20 English / Dutch and 20 English / French cognates from Experiment 2A were used for this experiment (see above). The same English controls and fillers. But in this Experiment we took 100 French fillers instead of Dutch to create different language situation from Experiment 2 A.

It means that the English / Dutch cognates appeared in an English-French context. Cognates and their paired controls were matched item-by-item in number of letters and word frequency.

To summarize, the experiment consisted of 200 stimuli (Table 9): 20 English / Dutch cognates, 20 English controls, 40 French fillers on cognates and English controls; 20 English / French cognates, 20 English controls, 40 French controls on the cognates and English controls, 20 English fillers, and 20 French fillers. Five blocks were constructed with the attention that the cognates and their matched controls were at the same position across the experimental list. Four dummy items were placed at the beginning of each list, 20 items were selected for the practice set.

TABLE 9

Count of the stimuli per type of words and per block in Experiment 2B (English go/no-go task with English / Dutch and English / French cognates; with French fillers)

Type words	Count (n)	Block in the experiment	Count (n)
English / Dutch cognates	20	Trial set	20
English / French cognates	20	Block 1**	36
English controls	40	Block 2	36
French fillers*	100	Block 3	36
English fillers	20	Block 4	36
		Block 5	36
Sum	200		200

*Note: although the Dutch words were only fillers, they were also matched with all English words in the experiment to make sure that only frequencies of the English / Dutch homographs were different and not one of the languages.

** Note: each Block of the experiment consists of 4 dummy items, 4 English / Dutch cognates, 4 English / French cognates, 8 English controls and 16 French fillers matched with the English words.

Procedure. The same procedure of go/ no-go task was used for the experiment (see Experiment 1A).

A set of 20 practice trials different from the test trials preceded the main task (10 were exclusively English and 10 exclusively French). The order of items was pseudo-randomised. Each block consisted of 36 words. The first 4 words of each block were dummy items from which two were exclusively French and the other two exclusively English. The practice trials and dummy items were not included in the analyses. Participants were free to take short breaks between the blocks. The order of items between the words was randomized with the DMDX programme (Foster, & Foster, 2003).

The experiment took about 20 minutes after which the participants were asked about their language use and own impression on how they decided about the words.

Results

The data were analyzed using the R software, and particularly with the lmer function (linear mixed model with two random effects, i.e. participants and items). Two students were excluded from the analyses because they did not understand the task clearly and made mistaken responses.

Error analyses. Mean error rates were computed for English / Dutch cognates, English/French cognates, English controls; French and English words separately. In this task errors on cognates and English controls are "no go" responses ("misses), while for French words, "go" responses were errors ("false alarms"). Table 10 represents hit rates on cognates and English controls.

Mean misses on English words were 4,24 %, false alarm rates on French words were 4,87 %, RTs on French fillers were not analysed. There was no significant difference in error rates between French and English words ($z = 1.29$; $p = 0.194$). The participants did not make much more mistakes in French than in English.

Mean misses on English / Dutch cognates were 2.32 %, on English / French cognates 9.1 %, on English controls (for English / Dutch cognates) 4.29 %, on English controls (for English / French cognates) 1.75 %. $z = 4.56$; $p < 0.0001$). It means that participants made significantly more errors on cognates than on English controls.

Reaction-time analyses. In these analyses, only the RT latencies on English / French, English / Dutch and English controls were analysed. Missing responses on cognates and English controls were excluded from analyses. Error responses on French fillers were also excluded. Table 10 presents mean RTs on homographs and English controls.

TABLE 10

Mean error rates, mean latencies, difference in reaction time (RT), percentages correct for the English reading of English / Dutch, English / French cognates and for the English control words in Experiment 2B (English go/no-go task with English / Dutch and English / French cognates; with French fillers)

Word type	Correct (%)	p-value	RT (ms)	p-value
English / Dutch cognates	97.68		631	
English controls	95.71	$p < .0001$	623	$p < .0001$
			Difference in RT = 8	
English/French cognates	90.9		741	
English controls	98.25	$p < .0001$	618	$p < .0001$
			Difference in RT = 123	

When the second language is French (i.e., the language that also appears in the experiment), the effect is considerably longer (123 ms) than when the second language is Dutch (i.e., the language that is absent in the experiment; 8 ms). One type of inhibition is higher than the other one. With other words the inhibition of the English / Dutch cognates versus their English controls are more intense than the inhibition of the English / French cognates versus their matched English controls. Effect of interaction is significant: $t = 3.45$, $p = 0.0006$

The effect of target type (cognate vs. control) is significant: $t = -4.309$, $p < .0001$.

Discussion

As in the previous experiments of this paper (Experiments 1A, 1B, 2A) slower RTs and higher miss rates were observed for the words, which can also exist in other languages (homographs and cognates). This experiment also supports the language-non-selective access view. In this experiment, with English as the target language of the go/no-go task, there were Dutch / English and French / English cognates present, which had higher frequency in the non-target language (i.e., Dutch or French).

During target recognition competitive race takes place between the two readings of the cognates. In this situation the Dutch or French reading of the homograph may slow down or even block the response to the English reading. With other words, because the lower English frequency of the homographs, Dutch language influences the lexical decision.

Interestingly that like in the Experiments 2A and 1B of the present study the influence of the hidden language (in this experiment Dutch) is still notable. Although the participants try to switch off the absent language (Dutch), it still affects the reading of the words. When the second language of the English / Dutch cognates also appears in the experiment (i.e., Dutch), the effect is longer (121 ms) than when the second language is absent (8 ms). The same effect is noticed with French, the RTs are also longer on the English / French cognates. When the language was present in the experiment, it took 123 ms longer than the RTs on the English controls; when the language was absent, the inhibition was also noticed, however the difference was less, 32 ms. (see Table 8).

One type of inhibition is higher than the other one. In other words the inhibition of the English / Dutch cognates versus their English controls are more intense in Experiment 2A, where the second language of the cognates (Dutch) was present, than the inhibition of the English / Dutch homographs versus their matched English controls in Experiment 2B where the second language of the cognates (Dutch) was absent. Effect of interaction is significant: $t = 5.30$, $p < 0.0001$ (see Table 8).

If we compare the cognate recognition in the Experiment 2A and Experiment 2B, we can see a significant influence of the second language of the cognates, but different strength of the inhibition in different language situations, $t = -9.85$, $p < 0.0001$ (Table 11).

TABLE 11

Mean latencies (RT) for the English reading of English / Dutch, English / French cognates and for the English control words in Experiment 2A (English go/no-go task with English / Dutch and English / French cognates; with Dutch fillers) and Experiment 2B (English go/no-go task with English / Dutch and English / French cognates; with French fillers)

	Second language of experiment*	Second language of cognates*	Word type	
			Cognates	English controls
RT (ms)	Dutch (Experiment 2A)	Dutch	737	616
		French	624	592
		Mean	681	604
	French (Experiment 2B)	Dutch	631	623
		French	741	618
		Mean	686	621
t-value		t = -9.857		
p-value		p < .0001		

The cognate recognition is slower in both experiments (Table 11). The mean reaction time (RT) on the cognates in the Experiment 2A is 681 ms. and in the Experiment 2B is 686. The mean RTs on the matched English controls are 604 ms. and 621 ms. respectively. With other words the brain tries to switch-off the non-seen (hidden) language, but it is not really possible because of the shared lexicon.

5. General discussion

In four experiments response times and language choice on interlingual homographs and cognates in the mixed-language lists were found to depend on the influence of the second or third non-target language. This research leads to several important findings. First, all four experiments support a view about language non-selective recognition process of word forms. Second, the effect on the second language (English) recognition was found not only from the dominant side of the first native language (Dutch), but even from the non-dominant third language (French). The experiments 1B, 2A and 2B represent that the non-selective process is notable even for the third language of experiment and even if the third language is not present in the experiment. Thus, the results support the non-selective BIA model with respect on second language and makes important addition about the third language influence on the word recognition. Fourth, surprisingly cognates in all experiment caused inhibition effect and not facilitation effect as it is normally suspected. Fifth, all these findings were supported by analyses of cumulative RT distributions and by regression analyses.

According to the language-selective access hypothesis, only the target language should be active in the go/no-go task. The experiments of the present research contrast this idea. In all experiments a large difference was noticed between the reaction times on international homographs or cognates and the control words (Experiment 1, Condition A - 827 vs. 614, Condition B – 704 vs. 606; Experiment 2, Condition A – 737 vs. 616 and 624 vs. 592, Condition B – 631 vs. 623 and 741 vs. 618). The corresponding analyses and response proportion provided clear evidence of systematic effects of the non-target language reading on homograph and cognate recognition.

Because of the non-selective lexicon of the common words, the presented letter strings in the experiments activate words from both languages, even if the possible second language of the presented word is not present in the experiment. As a result we see inhibition and competition between the word candidates (also van Heuven, Dijkstra & Grainger, 1998). Because of the maximal orthographic overlap between the word forms of the presented stimuli, the competition is stronger.

The originality of the present study is in the use of the third language, which was not present in the experiment and the participants did not expect the third language in the experiment and their "decision method" cannot consciously control the reaction. The results of the Experiments 1B, 2A and 2B made it clear; that the brain "breaks-down" if the interlingual word was presented. The participants were not capable to suppress the non-target language independent if the language was present in the experiment or not.

Results of the present study are compatible with the Bilingual Interactive Activation (BIA) model (Dijkstra & van Heuven, 1998; van Heuven et al., 1998). The BIA model assumes an integrated lexicon for two languages of a bilingual. With the findings in this study one can see the interaction between three (and possibly more) languages of a multilingual.

The form-identical interlingual homographs and cognates are represented by the same orthographic form (e.g. "rug" or "wild"), they are connected to two languages (Dutch and English). Selecting the most active language may perform the language representation, i.e. the first selection should be chosen for the language, where the presented word is more frequent. In present study we conflicted the word frequency and the target language, with other words, to see a clear picture if the lexicon is shared between the languages, the target language (English) was not the language where the word had higher frequency (Dutch or French).

Surprisingly, although in most of the experiments on cognate recognition (e.g. van Hell, & Dijkstra, 2002; Lemhöfer, Dijkstra, & Michel, 2004) a facilitation effect was noticed, in present study inhibition effect was present in both experiments (Experiment 2A and B) on cognate recognition. In Experiments 2A and 2B there were two groups of cognates presented: English / Dutch and English / French. They were presented in a different bilingual context: English – Dutch and English – French (Experiments 2A and 2B, respectively). In all four situations the inhibition on the cognates was significant.

Taking into account this entire finding, it is evident that the participants cannot suppress their second and third non-target languages (Dutch or French) in the mixed-language experiment situations. Although they are able to optimize their response criteria. This conclusion confirms the idea of the Bilingual Interactive Activation model with the non-selective language view.

Afterword

The experiments have been analysed and the thesis has been written, but I am still thinking about my research. Can it be useful for more experiments in appropriate scientific fields? What can I do next to continue my own academic development?

Although it was a hard work to write this thesis and conduct the experiments, it was a great pleasure to do this psycholinguistic research at the University of Antwerp. As written in the description of each experiment, I asked students for their feedback and the way they behaved.

I made some interesting observations.

First, some students were looking at the orthographic appearance of the word while the experiments. Words as “duif”, “muis” have a specific Dutch combination of the letters ‘ui’ which makes the word recognisable as Dutch; and words as “buy”, “crow” recognisable as English. Some students were working more auditively and were pronouncing the words in their heads in English or Dutch (French for Experiments 1B and 2B) to decide if the word sounds perfectly in one or other language. Some students were translating the words into their native language (Dutch) and if the word was “not translatable” (because already Dutch), it was a Dutch word for them.

Second, although the task was English go/no-go, which means that the participants normally act in English, some students were busy the whole time in their native language (Dutch) with pronouncing the words, or in both languages (English and Dutch) because of translation.

Third, I asked all participants about the way they used their foreign language (English or French) and the methods, they studied it at school. Surprisingly, almost all students, who learned the language with translational methods memorising new words with translation into Dutch, were working in the experiment in their native language (Dutch) pronouncing the words or translating them to see if the word is an English word or not. The students, who learned English with a direct method, by reading and conversations, were busy in the foreign language during the experiment.

I think it would be an interesting task for further study to look at the teaching methods and the use of the language: do the mental processes and structures, involved in second language use, depend on the particular didactic method? In other words: do the teaching methods organise our lexical access and the way the languages influence each other? Maybe the translation method will result in considerable cross-language activation, whereas the direct method will lead to functionally separate lexicons for native and foreign languages, with no or very little cross-language activation.

The question is interesting to answer and it would be a great job for investigation in the next years.

Appendixes

Appendix 1

Stimulus materials used in Experiment 1. Condition A (English go/no-go task with English / Dutch interlingual homographs; with Dutch fillers) and Condition B (English go/no-go task with English / Dutch interlingual homographs; with French fillers)

English / Dutch homograph	logfreq	English control	logfreq
kin	0,48	row	0,48
rug	1,23	ray	1,23
wit	1,28	jaw	1,36
toe	1,51	cry	1,49
wet	1,84	cat	1,85
arm	2,36	use	2,35
leek	0,30	clip	0,60
hoop	0,48	cold	0,60
rust	0,85	duck	0,85
slot	0,95	trip	0,85
loop	1,11	kick	1,11
slim	1,15	rude	1,11
slap	1,32	ride	1,32
boot	1,61	bell	1,62
trap	1,71	dear	1,85
kind	2,68	word	2,68
slang	0,60	birch	0,60
brand	1,20	spoon	1,20
breed	1,43	guide	1,43
brief	1,70	broad	1,71

Appendix 2

Stimulus materials used in Experiment 2. Condition A (English go/no-go task with English / Dutch and English / French cognates; with Dutch fillers) and Condition B (English go/no-go task with English / Dutch and English / French cognates; with French fillers)

English / Dutch cognate	logfreq	English control	logfreq
bar	0,85	owl	0,85
bed	2,46	buy	2,40
lip	1,92	egg	1,94
elf	0,00	oar	0,30
net	1,26	oak	1,26
pan	1,45	cap	1,61
golf	1,52	hint	1,52
half	2,37	poor	2,40
hand	2,92	life	2,93
land	2,48	food	2,49
nest	1,30	worm	1,30
norm	1,04	howl	1,08
ring	0,90	crow	0,90
warm	2,08	nice	2,12
wild	1,00	fame	1,00
wind	1,26	horn	1,28
wolf	1,11	clap	1,11
model	1,92	taste	1,93
motor	1,43	trunk	1,43
water	0,95	growl	0,95

English / French cognate	logfreq	English control	logfreq
art	2,23	leg	2,24
six	0,00	raw	0,00
aide	1,00	barn	1,11
port	1,51	tail	1,56
page	1,99	seat	2,03
cause	2,01	adult	1,97
image	2,02	board	2,01
train	1,91	noise	1,89
point	2,64	money	2,61
quart	0,60	trash	0,60
queue	1,15	spoon	1,18
saint	1,26	sauce	1,26
trace	1,49	reply	1,51
double	0,48	shrimp	0,48
empire	1,18	gossip	1,15
menace	0,90	nephew	0,95
parent	2,50	reason	2,51
phrase	1,65	search	1,68
regard	1,28	sleeve	1,26
secret	1,68	target	1,67

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