UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL
INSTITUTO DE LETRAS

ALINE PEREIRA DOS PASSOS

THE ROLE OF CO-ACTIVATION OF LANGUAGES IN THE PRODUCTION OF FALSE MEMORIES BY BILINGUALS

Porto Alegre
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Trabalho de conclusão de curso de graduação apresentado ao Instituto de Letras da Universidade Federal do Rio Grande do Sul como requisito para a obtenção do título de Licenciado em Letras - Língua Inglesa e Literaturas de Língua Inglesa.

Orientadora: Profa. Dra. Ana Beatriz Arêas da Luz Fontes

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Aline

RESUMO

Esse estudo visou investigar a criação de falsas memórias por bilíngues português-inglês através da coativação de uma língua não apresentada (português). O estudo testou a hipótese da não-seletividade do acesso lexical bilíngue mesmo quando a língua sendo testada era irrelevante para a tarefa. A ativação do português foi investigada com a manipulação do tipo de palavra crítica não-apresentada em inglês - cognata com o português ou não. A produção de memória falsa se deu através do *paradigma DRM*. Quarenta participantes universitários bilíngues relembraram (*recall test*) e reconheceram (*recognition test*) 18 listas de palavras, sendo nove listas com palavras semanticamente associadas com palavras cognatas críticas não-apresentada (*actor* = ator) com o português, e nove listas com palavras semanticamente associadas com palavras não-cognatas críticas não-apresentadas (*woman* = mulher). Os participantes produziram mais memórias falsas no recognition test do que no recall test. Esperava-se que as listas de palavras semanticamente associadas às palavras cognatas críticas não apresentadas produzissem um maior índice de falsas memórias em ambos os testes. No entanto, esse resultado não foi encontrado e, ao contrário do que era esperado, listas de palavras semanticamente associadas às palavras não-cognatas críticas não apresentadas produziram um maior percentual de falsas memórias no teste de reconhecimento.

Palavras chave: acesso lexical, palavra cognata, falsas memórias, bilinguismo.

ABSTRACT

This study aimed to investigate the creation of false memories by Portuguese-English bilinguals through the co-activation of a language not presented (Portuguese). The study tested the hypothesis of non-selectivity of bilingual lexical access even when the language being tested was irrelevant to the task. The activation of Portuguese was investigated with the manipulation of the type of critical non-presented word in English - cognate with Portuguese or not. The production of false memory occurred through the DRM paradigm. Forty bilingual university participants recalled (recall test) and recognized (recognition test) 18 word lists: nine lists with semantically associated words to cognate critical non-presented words (actor = ator) with Portuguese, and nine lists with semantically associated words to non-cognate critical non-presented words (woman = mulher). Participants produced more false memories in the recognition test than in the recall test. The lists of words semantically associated with the cognate critical non-presented words were expected to produce a higher index of false memories in both tests. However, this result was not found and, contrary to what was expected, lists of words semantically associated to non-cognate critical non-presented words produced a higher percentage of false memories in the recognition test.

Keywords: lexical access, cognate word, false memories, bilingualism.

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1. Introduction

Research points out that human beings can have from 12.000 to 50.000 thoughts a day (THE NATIONAL SCIENCE FOUNDATION, 2012). Remembering all the things we think about or that we see during the day is a hard task; remembering what happened years ago is even more difficult. But what about remembering information, scenes, actions, words that one has lived or seen? Bartlett (1932) presented two categories to define the kinds of memories people may produce. The first one is called *reproductive memory*, which is a real memory, an accurate situation, that is, something that actually happened. The second one is *reconstructive memory*, which is made of elements that the individual creates in order to fill a gap in memory**.** The focus of this study is on reconstructive memory, which underpins the study of false memories.

False memories is a rich field of study for criminal psychologists, for instance. Research show that these professionals can implant false memories in an individual, that is, they have tactics to convince someone that they did, saw or said something they actually did not, as shown in Porter Baker's (2015) study. If creating a false memory in such context is possible, then how can somebody be sure of what they witnessed? How trustworthy are human minds? Just because one is an eyewitness to a situation it does not mean one can remember everything properly. Loftus and Palmer (1975), for example, induced false memories of violent acts through the type of words they used in questions: "about how fast were the cars going when they *smashed* into each other?" The use of the verb *smashed* instead of *hit* or *bumped* made the participants create a false memory about the accurate speed of the car. Participants reported higher speed when the verb used in the question was *smashed*, compared to *hit* or *bumped*. People can also be convinced and confess that they committed a crime (such as theft, assault or aggressive act) they were not involved at all (SHAW AND PORTER, 2015; LANEY & TAKARANGI, 2012). Therefore, it is not possible to believe in all the memories people say they have. The production of false memories may be influenced by many factors, such as the age of the participant (HOWE & WILKINSON, 2010), their emotional state (TOFFALINI, MIRANDOLA, COLI & CORNOLDI; 2015), and whether women are pregnant (BERNDT, DIEKELMAN, ALEXANDER, PUSTAL & KIRSCHBAUM, 2013), for instance.

As seen in the studies previously cited, language plays a strong role in the creation of false memories. However, it is not through the use of suggestive questions only that false

memories may be induced. In one of the most commonly used methods in this area of study, the Deese, Roediger and McDermott (DRM) paradigm (1995), false memories are created through semantic associations. Within this paradigm, participants confidently recall and recognize words they have not seen before, but that are semantically associated to the words they actually saw - the false memory. Semantic associations are, at least to a certain degree, language specific. For example, when Brazilians think of the word *elevator*, they most frequently associate it to the word *building*; when U. S. Americans think of the word *elevator*, on the other hand, they associate it to the word *escalator*. One may question, then, how these semantic associations would interact when there are two languages represented in the brain.

There is a large body of evidence showing that bilinguals access lexical and semantic representations from both of their languages in parallel, even when processing in one of the languages only (KROLL and STEWART, 1994; GOLLAN, FOSTER and FROST, 1997; DIJKSTRA, GRAINGER, and VAN HEUVEN, 1999; ARÊAS DA LUZ FONTES, no prelo). This co-activation may be investigated experimentally through the manipulation of the type of word chosen for the test. Across many languages there are words that look alike, for example. Cognate words have the same origin; same or similar spelling and, mean the same as another word, in another language. For example, the word *human*, in English, is considered a cognate with the word *humano*, in Portuguese. Sometimes, it is difficult to tell if words are cognates or not, because the spelling is similar, but they do not share the same meaning. That is, they are false cognates, also known as interlingual homographs. The words *mayor*, in English, and the word *major*, in Portuguese, are not cognates because they do not share the same meaning, though the spelling is similar. The first means "the political ruler of a town" and the second one is "a rank in the army", for example. Whether a word is a cognate or not may influence the comprehension and production of words in another language. More specifically, cognates facilitate word recognition in reading and oral production (KROLL and STEWART, 1994; GOLLAN, FOSTER and FROST, 1997; DIJKSTRA, GRAINGER, and VAN HEUVEN, 1999; ORTIZ-PREUSS, ARÊAS DA LUZ FONTES and FINGER, 2015) as they can be accessed more quickly than non-cognates by bilinguals because they receive double activation, from both languages (VAN HELL AND DE GROOT, 1998). It is possible, therefore, that the co-activation of languages may also have an impact on bilinguals' performance on the DRM paradigm. More specifically, semantically related words associated to a cognate critical non-presented word may produce

higher rates of false memories than semantically related words associated to a non-cognate critical non-presented word because the first would be more strongly activated due to semantic and orthographic overlap between the languages.

This study aims to investigate the creation of false memories by Portuguese-English bilinguals through the co-activation of a non-presented language (Portuguese) during a memory test; that is, it explores the non-selectivity of a bilingual's two languages when the language being tested is irrelevant to the test. The activation of Portuguese will be investigated through the manipulation of the type of critical non-presented word in English - if it is a cognate with Portuguese or not. The DRM paradigm will be used in order to verify whether the cognate status of these critical non-represented words influences the production of false memories. It is expected that cognate words will be more strongly co-activated than non-cognate words, since they have higher orthographic and semantic similarity, thus producing higher rates of false memories. Also, this study seems to be the first one to investigate the co-activation of languages through the DRM paradigm, and the first that takes into consideration the natural semantic association of the Portuguese language.

This study is part of a larger research project coordinated by Professor Dr. Ana Beatriz Arêas da Luz Fontes. In addition to cognates, in the larger project ambiguous words are also manipulated to test for the activation of their most and least frequent meanings through the DRM paradigm.

2. Theoretical Background

1. The production of false memories by monolinguals

Bartlett (1932) was the first researcher credited for conducting a false memory test. The participants were English monolinguals. They would read a Canadian Indian Folklore called *War of the Ghosts* and were asked to remember it and retell it many times. The participants would replace pieces of the story with other elements that were culturally more familiar to them. For example, the word *canoe* would be replaced by *boat*. For Bartlett, people would create false memories in order to complete a gap in memory, since people are subject to errors when remembering situations. But, besides completing gaps, people are able to create memories of situations (or things) that never happened to them when induced to do

so. Deese (1959), then, created a procedure that gave the studies about false memories a new impulse, testing memory through word lists in a single trial, free recall paradigm. He developed 36 lists where he would present 12 words associated to a critical non-presented word. For instance, the words *pin, thread, sewing, sharp* would be presented, with the intention of having participants to recall the critical non-presented word *needle*. As a result, some of these lists of words induced the participants to produce false memory (e.g. *needle*), that is, to recall words that were not studied before, that were not presented to them.

Later, Roediger and McDermott (1995) replicated Deese's method, using the lists that succeeded at producing high levels of false memory in recall trials, and also added new words to the lists. In addition, they added recognition tests after the recall tests. In the recognition test, participants would read 12 studied (including the critical non-presented words) and 30 non-studied words (words that were presented in the recall test), and would judge the words as *old* or *new*. This procedure was an enhanced version of Deese's paradigm, and it has been since called the Deese-Roediger-McDermott (DRM) paradigm. In this paradigm, participants recalled and recognized non-presented words about at the same level they recalled and recognized presented words. The results also showed that "the false-alarm (false memory) rate for the critical non-presented items was much higher than for the other related words that had not been presented" (ROEDIGER & MCDERMOTT, 1995, p. 806). The objective of the current study is to verify if semantically related words associated to a cognate or non-cognate critical non-presented word could induce Portuguese-English bilinguals to a stronger co-activation between languages, and, consequently, produce higher rates of false memory through the DRM paradigm.

2. Bilingual lexical access

A meaningful issue concerning bilingual research is whether there is co-activation of languages in the processing of abilities such as writing, speaking, listening and reading. In a task, do bilinguals simply "turn off" the language that is not needed in that experiment or do they activate it, but less than the target language? Can it influence the test somehow? If bilinguals only access required information in the target language, then it corroborates the selective lexical access hypothesis, which suggests that processing in one language does not necessarily affect the same processing in other language (there is an exclusive access of information) (CARAMAZZA and BRONES, 1979). However, if both languages are activated in the process (even if it is not at the same level), it thus corroborates the non-

selective lexical hypothesis, which suggests that bilinguals have a single integrated memory (DE BRUIN, DIJKSTRA, CHWILLA and SCHRIEFERS, 2001; DIJKSTRA, BRUIJIN, SCHRIEFERS and BRINKE, 2000, DIJKSTRA and VAN HELL, 2003; GOLLAN et al. 1997; JARED and KROLL, 2001; VAN HEUVEN and DIJKSTRA, 1998, SCHAWRTZ, KROLL and DIAZ, 2007).

Usually, in order to find evidence for the hypotheses presented, researchers manipulates two kind of words/stimuli: cognates, which, as explained before, are words that share the same meaning and have similar spelling between two or more languages and interlinguistic homographs, which are words that share similar spelling, but do not share the same meaning. For instance, the word *costume,* in English and Portuguese share the same spelling, but in English it means "a type of clothing people wear to go to a Halloween party", and in Portuguese it means "a habit or cultural practice". Since there is orthographic, phonological and semantic overlap (in cognate words), the words that are very similar, as *costume,* are expected to co-activate two or more languages more intensely than a non-cognate word.

Caramazza and Brones (1979) tested Spanish-English bilinguals and turned out to be one of the first studies to find evidence corroborating the selective language access hypothesis. In this study, the 12 participants performed in a lexical decision task, where they pressed a key if the word displayed was in English or in Spanish and another key if it was a non-word. The stimuli were two lists (one in English and one in Spanish) composed of 120 words each (60 nonwords and 60 words, including 15 cognates). The results showed there was no significant difference in reaction time (RT) between cognate words and non-cognates in Spanish. This was interpreted as evidence that, during the task, only one lexicon was accessed and the cognate status did not provide a facilitation in processing. Nonetheless, the bilinguals recognized cognate words faster than non-cognate words, in English. Therefore, the study also fomented the nonselective lexical hypothesis.

Another study with evidence of selective access is the one from Gerard and Scarborough (1989), also involving Spanish-English Bilinguals. In addition to cognates and non-cognate words, the test also included interlinguistic homographs. The reaction time between monolinguals and bilinguals was not significant for cognates nor for interlinguistic homographs. Again, this study suggested that the participants were processing language in a selective way because they were able to access only the lexicon needed for the task.

The studies cited above supported the selective language access hypothesis. Nonetheless, there is also research evidence supporting the language non-selective hypothesis. Dijkstra; Grainger; Van Heuven (1999) tested the language non-selective hypothesis with Dutch-English bilinguals in a *progressive demasking* task with six conditions involving a manipulation of orthography (O), semantics (S) and phonology (P). Three of these conditions were established in order to analyze different types of language overlap in word recognition; therefore, cognate words and interlingual homographs were tested. Results showed that that cognates were recognized faster than control, non-cognate words, while orthographic and semantic overlaps resulted in faster RTs, phonological overlaps leaded to slower RTs.

Arêas da Luz Fontes e Schwartz (2008) also investigated whether semantics and orthography could cause language co-activation. Through a mediated priming task (in single-word and sentence context), undergraduate students who were native speakers of Spanish and had English as second language had to tell whether pairs of words (prime-target) in English were related in meaning. The words were related to Spanish through semantics or orthography. For instance, the words in English *bark*-BOAT are related to Spanish through orthography, because in Spanish bark looks like *barco*. However, the pair *boat*-BARK has a semantic connection with Spanish (*barco* means boat). The word bark might elicit strong activation of the word barco, because they have similar form. Also, it was expected that there would be a semantic co-activation when the word order (prime-target) was changed. Results showed that RT was slower when there was a mediator (in Spanish, *barco*), which provides evidence supporting the non selectivity of bilingual lexical access, since the mediator was never shown to the participants.

The majority of studies concerning bilingual language co-activation has been conducted with undergraduate students. Trying to extend findings to a different sample, Brenders, Van Hell e Dijkstra (2011) tested the influence of cognate words and false cognates (false friends) on the lexical access of Dutch children who were early learners of English. The processing of language might differ because the children in the study were learning both languages at the same time. The researchers tested three groups of children who had been in English classes for different amount of times (5 months, 3 years and 5 years) The children completed a lexical access task in English and Dutch. Results showed that the children were faster to recognize cognate words in the English task (in both beginners and advanced level). However, there was no such effect in the Dutch task. It is then possible to say that proficiency

had a role in co-activation in this test. Dutch language was capable of influencing the processing of English, but not the other way around.

All of these studies providing evidence to the non-selective lexical access hypothesis support the Bilingual Interactive Activation Plus Model (BIA+) (DIJKSTRA & VAN HEUVEN, 2002). The BIA+ covers two different word recognition systems: 1) a task/decision control system and 2) a word recognition system. The task/decision control system can be affected by nonlinguistic information, such as characteristics and strategies of the interlocutor (DIJKSTRA & VAN HEUVEN, 2002 apud. ARÊAS DA LUZ FONTES, no prelo). On the other hand, the word recognition system "adds representations and components in lexical processing, addressing aspects related to the inclusion of semantic representations, the representation of cognate words and interlinguistic homographs, language nodes, among others aspects" (DIJKSTRA & VAN HEUVEN, 2002 apud PICKBRENNER, 2017, p.54).

Some researchers go further and investigate language co-activation in trilinguals. Trilinguals have two more lexicons to be activated and that compete for selection. Therefore, would cognate words be triply activated (and more intensely activated than in bilinguals)? Or would the addition of a lexicon be distracting to the trilingual, since it is one more lexicon competing for activation? In Barcelos' (2016) study, participants spoke Portuguese (L1), English (L2) and French (L3). The purpose of the research was to investigate whether there would be a cognate facilitation effect across languages, focusing on the influence of the L1 on the L3, and the L2 on the L3, through a lexical decision task. Results revealed that there was greater accuracy of response for cognates between the L1 and the L3, and the L2 and the L3, but RT's were not faster for cognate words, as it was expected. A cognate facilitation effect across the three languages was also expected, but it was also not found. Thus, the results mentioned above show that trilinguals in this study would have no advantage in lexical access over bilinguals. However, since the accuracy of response for cognate is greater, this study contributes with evidence to support the non-selective lexical access hypothesis.

In contrast to Barcelos' (2016) study, Pickbrenner (2017) also tested trilinguals, but the researcher's objective was only to check cognate facilitation between the L2 (English) and the L3 (German). The hypothesis was not corroborated, since the participants did not recognize cognate words faster than control words. The researcher pointed out that maybe the participants were not fluent enough in German to perform the test in that language, even though the words selected to the test had a high frequency.

After this review of bilingual and trilingual lexical access, it may be suggested that there is more evidence for the non-selective lexical hypothesis of bilingual lexical access, than for the competing selective access hypothesis. In the present study we expect to find that the co-activation of languages would also affect the production of false memories by bilinguals. This is expected because when semantically related associates of a critical non-presented word activate a cognate target, it will be more strongly activated than non-cognates due to the orthographic and semantic overlap between cognates. Such stronger activation may make the lexical item (e.g. the cognate target) more salient and thus produce more false memories.

3. The production of false memories by bilinguals

One of the first studies investigating the production of false memories by bilinguals was conducted by Kawasaki-Miyaji, Inoue and Yama (2003). In this study, bilinguals who had Japanese as the dominant language studied 12 DRM lists, 6 of which were presented in English and 6 in Japanese, translated from English. Participants were given a recognition test in which they had to identify the words from the lists they had studied in either the same language (study in English - test in English or study in Japanese - test in Japanese) or in a different language (study in English - test in Japanese or study in Japanese - test in English). The results revealed that participants recognized more words correctly when the language of study and the language of test corresponded, and that there was a greater propensity for false memories when both study and test were in Japanese. One limitation of this study is that some of the participants did not have a level of proficiency in English high enough to produce false memories across languages. The study classified this participants as *unbalanced bilinguals*, "because they were not raised in an English environment or born in an English speaking country" (KAVASAKI et al, 2003,p. 258). The results may have been arisen due to a lack of linguistic ability, since participants had learned English as a second language and were more competent in Japanese. Another limitation is that the lists have been translated from English to Japanese, which may have disregarded the specific semantic associations of the Japanese language.

Similar to Kawasaki et al. (2003), Sahlin, Harding and Seamon (2005) also translated DRM lists from English, but in this case, into Spanish. However, the participants of Sahlin et al (2005) were bilinguals who had a more balanced level of proficiency than those of Kawasaki-Miyaji et al. (2003), since they had learned both languages, English and Spanish,

at home since birth. Another difference between the two studies lies in the procedure and materials used by the researchers. Participants in Sahlin's et al (2005) study would hear the lists for recall (just like in the original experiment testing the DRM paradigm), rather than read them. The researchers were also a little more attentive about the type of words selected to the experiment: "some words were not used because their membership in a list was based on an idiomatic association that was culturally constrained or language specific (e.g., the needle–haystack association does not exist in Spanish)" (SAHLIN et al. 2005. p. 1415). Bilinguals in Sahlin's et al. (2005) test studied the lists in one language and, during the recognition test, they read presented words, non-studied (words that were not presented in the recall test) and critical non-presented words (the false memory expected) in the same language or in another language. The results revealed higher rates of false memories when there was a match between study and test language, but a significant number of false memories were also found when there was no such correspondence. The researchers concluded that false memories can be observed across languages regardless of whether the test language matches the study or not.

In contrast to Kawasaki-Miyaji et al (2003) and to Sahlin et al. (2005), Anastasi, Rhodes, Marquez and Velino (2005, Experiment 2) used DRM lists in Spanish that were created by native Spanish speakers, enabling the maintenance of natural semantic associations of the language. Thirty eight native speakers of Spanish wrote down the first three words that came to their minds related to a critical non-presented word. For example, for the critical non-presented word *silla*, some of the associates were: *descanso* (rest), *sentarse* (sit) and *mesa* (table). Fifteen words out of all responses were selected to compose the lists. These lists were then used to investigate the creation of false memories in Spanish-English bilingual individuals who used Spanish more frequently at home and English at work and also with friends. Participants had to read aloud words displayed on a computer screen in both languages and then performed a recognition test in which they were instructed to select only words that appeared in the same language previously studied. The bilinguals recognized an equivalent number of words presented in the study list in English and Spanish, but produced a greater number of false memories in English than in Spanish, which was not expected. However, the authors explain that experience and linguistic exposure were not tested in the experiment, and the greater effect of false memories in the second language may have occurred due to their immersion in an English context primarily, which may result in a change of dominance from the native language to the second language.

In Anastasi's et al. (2005) study, bilinguals studied the DRM lists in each of their native languages (English and Spanish) and they should indicate, later in the recognition test, if they had studied those words in a specific language. In contrast, in the study by Marmolejo, Diliberto-Macaluso and Altarriba (2009), bilinguals studied DRM lists in Spanish and English, but they were asked to do the recognition test regardless of the study language. Participants should indicate whether they had studied that word before, with a yes or no answer, and to point out how confident they were about their response. Again, the results showed that bilinguals recognized a greater number of words presented on the list when the study and recognition test were performed in the same language. In addition, bilinguals produced more false memories, and reported a higher index of misconfidence when the languages of study and test were different than when they were the same.

These results highlight the importance of compatibility between the language used in encoding and retrieval of information. In other words, when the encoding language and the retrieval language were not compatible, there was a higher frequency of false memories and misconfidence in recognition. These results also suggest that bilinguals activate conceptual representations of both languages when performing a task in the DRM paradigm, which contributes to the current knowledge about bilingual memory processing.

The study by Arndt and Beato (2017) contributes to the discussion that bilinguals activate concepts between languages in studies of false memories. More specifically, these authors suggest that proficiency and dominance in a language have an effect on the automaticity of access to concepts in bilingual memory. In their study, Arndt and Beato (2017) conducted three experiments that demonstrated that Spanish-English bilinguals produced more false memories when tested in their native/dominant language than in their non-dominant language. In addition, bilinguals who were more proficient in the second language produced more false memories than the less proficient. The authors suggest that these results are consistent with research that suggests that greater proficiency in the second language increases the automaticity with which lexical representations activate conceptual representations in bilingual memory (ARNDT AND BEATO, 2017).

The studies described above show that bilingualism may influence the production of false memories. For instance, bilinguals do not "switch off" one language while using another as they perform tasks in different contexts. Such parallel co-activation of languages has been shown to explain much of bilingual linguistic processing in reading. Thus, it is possible that the effect of co-activation may also have an impact the creation of false memories. The co-

activation of languages, with the methodology commonly used in psycholinguistic studies, as far as we can verify, has not yet been tested with the DRM paradigm.

Thus, the objective of the present study is to verify if semantically related words associated to a cognate critical non-presented word could induce Portuguese-English bilinguals to a stronger co-activation between languages, and, consequently, produce higher rates of false memory through the DRM paradigm. The type of word manipulated (cognate or non-cognate) is expected to influence the co-activation between Portuguese (non-presented language) and English (target language). More specifically, when semantically related associates of a critical-non presented word activate a cognate target, it will be more strongly activated because of the orthographic and semantic overlap, compared to non-cognates, and thus produce more false memories. Besides, the study contributes with list of English semantic associations that were natural to Portuguese-English bilinguals

3. Method

In the following sections, the two parts of the methods used in this study will be explained: the pre-test of the materials and the main study. In the pre-test of the materials, the process of selecting the stimulus words, the semantically associated words, for the main study will be described. In the main study, the DRM procedure, in which we used the materials selected in the pre-test, will be described

3.1 Pre-test of materials

The objective of this study was to create lists of English semantically associated words that were natural to Portuguese-English bilinguals.

3.1.1 Participants

Participants were 25 Portuguese-English bilinguals, all of them students of the Modern Languages course at Universidade Federal do Rio Grande Do Sul, who were enrolled in the English 8 class in 2017.

3.1.2 Materials

Modern Languages students were given sheets of paper containing pairs of semantically associated words and were requested to point out in a scale from 1 to 5 (with 1 being *extremely unlikely* and 5 being *extremely likely*) how likely they were to think of the second word, given the first word of the pair. For example, they saw the pair *wall - brick* and had to rate how likely they were to think of *wall* when they saw *brick*. These pairs were created based on data from a previous study conducted by a member of our laboratory as part of his research assistantship (i.e. his *bolsa de iniciação científica*). In that study, participants wrote down all the words they could think of when given a target word. For example, participants were asked to write down all the words they could think of when they saw the word *brick*. From their answers, we created the pairs of words which were used in the pre-test of materials of the present study.

3.1.3 Procedure

The participants read and signed a consent term before the tests started. They were given sheets of paper including the pairs of semantically associated words and were instructed to rank the pair of words from 1 to 5 (as explained above). The test lasted about one hour. After they finished the test, we thanked them for their time.

Next, we calculated the mean of each pair and ranked them. The 12 best ranked words were selected to compose the lists of words used to induce false memories in the current study. For example, the word *woman*, the 12 selected associated were, respectively: *queen, feminist, female, mother, lady, gender, man, girl, suffragists, human, person, wonder.*

In case the participants did not provide words enough for setting the lists (12 words per list), we would select words (associated) from different corpora, such as the "University of South Florida Free Association Norms" and the Thesaurus dictionary, in order to complete the lists.

3.2 **Main study**

In this study, participants recalled and recognized lists of words, using the DRM paradigm. The lists of words were created based on data from the pre-test of materials, as described above.

3.2.1 Study Design

The **Independent Variable** of the present study was whether the critical non-presented words were cognates or non-cognates with Portuguese. The **Dependent Variables** were the following:

- percentage of correctly recalled and recognized words (presented words/associates);
- percentage of incorrectly recalled and recognized semantically related words, i.e. false memories (cognate and non-cognate critical non-presented words)
- percentage of recalled and recognized erros, that it, words that participants did not see in the lists (non-studied words).

3.2.2 Participants

Participants were 40 Portuguese/English bilinguals (22 females and 18 males), all of them are students of the Modern Languages course at Universidade Federal do Rio Grande Do Sul. All of the participants are native speakers of Portuguese. The average age of the participants was *M* = 24.2. The mean of speaking, listening, writing and reading abilities in English was *M* = 5.8, in a scale of 1 to 7, which is classified as a *very good* rate of abilities. The mean for use of English *M* = 3.8 indicating that they use English *regularly* in their everyday lives. The average time for reading and speaking skills per day were higher (*M* = 125.9 and *M* = 95.9, respectively) than average time for writing and listening skills (*M* = 71.4 and *M* = 58.2, respectively) per day.

The following tables show the participant's self-evaluation of their language proficiency. They answered the Language History Questionnaire (LI, ZHANG, TSAI AND PLUS, 2014).

Table 1 and 2: Language experiences and self-assessed proficiency ratings of the Portuguese–English bilingual participants (n = 40). Self-assessed ratings based on a scale 1–7, and frequency of use was measured in minutes.

	Mean (*M*)	Standard Deviation (*SD*)
Age	24,2	5,7
Ability of listening	6,0	0,9
Ability of speaking	5,6	1,21
Ability of reading	6,3	0,77
Ability of writing	5,4	1
Mean of abilities	**5,8**	**0,4**
Often use for thinking	5,0	1, 44
Often use for talking to yourself	5,1	1, 67
Often use for expressing emotion	4,1	2,4
Often use for dreaming	2,8	0,8
Often use for remembering numbers	2,2	1,36
Mean of use of English	**3,8**	**1,8**

Table 2

Min/day using English	Mean (M)	Standard Deviation (SD)
Watching tv	121,5	106,1
Listening to radio	58,2	86,1
Reading for fun	135,7	174
Reading for school/work	116,1	55,4
Mean of reading contexts	**125,9**	**13, 9**
Writing email to friends	40,2	111,6
Writing for school/work	102,6	69,6
Mean of writing contexts	**71,4**	**43,2**
Speaking with family members	2,4	8,3

Speaking with friends	102,6	118,2
Speaking with classmates	178,9	356,8
Speaking with coworkers	100,4	109,6
Mean of speaking contexts	**95,9**	**21,4**
Mean min/day	101,8	

3.2.3 Material

For our version of the DRM paradigm, eighteen words were selected to be the critical non-presented words: 9 of them were cognate, 9 were non-cognate. For each word, 12 associates were selected. For instance, for the cognate critical non-presented word *piano*, the associates were: *classical, instrument, Beethoven, orchestra, music, keyboard, notes, songs, harmony, talent, fingers, black.* All the associates are semantically related to the word *piano*. The words selected as cognate and non-cognate critical-non presented words were matched in frequency and word length based on data from the CELEX Lexical database.

The participants also were given the Language History Questionnaire (LHQ) (Li, Zhang, Tsai e Puls, 2014), and a Recall booklet, where there was a single page for every list that the participants should recall.

3.2.4 Procedure

The participants read and signed a consent term before the tests started. All communication with the participants, as well as the instructions of the tests were in English. The participants completed first a recall test, then the questionnaire and finally a recognition test. All these steps will be explained below.

3.2.4.1 Recall test

Participants were all together in a classroom, sitting in rows. The researcher reinforced that the test was a memory test and that they should try to remember as many

words as possible. The lists of words were presented in a screen on the wall (through a multimedia projector). The participants would see one list of words at a time. Before every list started there was a screen with the list number. For instance: "List 12: Get ready!". Then, participants would see one word at a time. Each word was displayed for 2 seconds. After the 12 associates were presented, a "RECALL" screen would appear (in red capital letters). The participants were also given a Recall booklet. They were informed to write down on the booklet all the words they could remember seeing only when the "RECALL" screen appeared. The recall booklet was composed of blank sheets, with only the number of the lists on the top of it. So when the participant saw "List 12" they would write down on the booklet on the page where it was written "List 12". They had 1.5 minutes to recall. In total, the participants saw 216 words, divided in 18 lists. This part of the experiment lasted about one hour.

3.2.4.2 Language History Questionnaire (LHQ)

After the participants studied and recalled the 18 lists, they completed the *Language History Questionnaire* (LI, ZHANG, TSAI AND PLUS, 2014). It is a self-evaluation proficiency questionnaire that enables participants to report their linguistic background in several languages (use of language, exposure, abilities). They self-rated their skills on reading, writing, listening and speaking. They reported the amount of time per day or longer period they use English (and other languages). Thus, they also reported in which context (school, home, media, work) and with whom (classmates, friends, family) they communicated in English. The time for completing this questionnaire was 20 minutes, on average.

3.2.4.3 Recognition test

After filling out the LHQ, participants received a sheet containing 4 cognate critical non-presented words and 4 non-cognate critical non-presented words. For every critical non-presented word, 4 associates were selected (the first, second, seventh and eighth words from the original the lists used in the recall test). We also selected 35 non-studied words, that is, words that are completely unrelated to the critical words. These words are inserted in the test

in order to check whether participants could really differ words they studied from the ones they did not (to test their memories).

All the words were randomly distributed in columns (Appendix 1). Next to each column, there were the words "yes" and "no". If the participant remembered seeing/studying a word in the recall test, he/she should circle yes. If they did not remember, they should circle no. The recognition test was divided in two lists: A and B. This part of the experiment lasted about 15 minutes. After the recognition test was completed we thanked the participant for their time and gave them candy.

4. Results

4.1 Data trimming procedures

After analyzing the lists, three of them were discarded. In both lists A and B, the presented word *healthy* is an associated to the critical non-presented word *diet*. However, *health* is also one of the critical non-presented words. Since *healthy* was presented (in *diet*'s list) before, it is possible that this was why the word *health* was not elicited from the participants. Thus, at some point of the test, it is possible that participants would not want to write down words that looked so similar. Also, on list A, the word *farm* was presented on the list of the critical non-presented word *farmer*. It was a mistake, since the proper associated word is *laborer* (which was correctly presented on the list B). On list B, the word *contagious* was presented instead of *courageous* on the list of the critical non-presented word *hero*. Therefore, *health*'s list was discarded from both lists A and B, *farmer*'s list was discarded from list A and *hero*'s list from list B. From the recognition test, we only had to discard *health* from list B (because it was only presented on that list).

4.2 Organization and results of recall test

After the recall test was completed, the *Recall booklets* from all the participants were analyzed. As a first step, we counted the number of correctly recalled words (presented/associated words), the number of incorrectly recalled (cognates or non-cognates) critical non-presented words (in order to check if the participants produced false memories),

and the number of errors (words that were not studied/presented). As a second step, we calculated the percentages for each of these variables. We then entered these data on Excel and exported it to SPSS, where we calculated the mean (*M*) percentage and the standard deviation (*SD*) of each type of word (presented words, cognate critical non-presented words, non-cognate critical presented words and non-studied words). On SPSS, we also ran a Paired-Sample t-test comparing the percentage of incorrectly recalled cognate critical non-presented words and non-cognate critical non-presented words. Below, there are three tables portraying the data from the recall test generated through the SPSS program.

Table 3 - Percentage of presented words, critical non-presented words (cognate and non-cognate) and non-studied words in both lists A and B.

Recall - List A + List B		
	Mean (*M*)	Standard Deviation (*SD*)
Presented words	64. 4	11.4
Critical non-presented words (cognate)	7.8	12.5
Critical non-presented words (non-cognate)	11	12.3
Sum of critical non-presented words	9.4	9.7
Non-studied words	2	2.4

When we consider data from both lists together, we see that the recall percentage of presented words was average. However, it is higher than Marmolejo et al.'s study (2009), which had 56% of correctly recalled presented words, and Anastasi et al.'s study (EXPERIMENT 1, 2005), which was 39%. More false memories were produced with lists of words semantically associated to non-cognate critical non-presented words than cognate critical non-presented words, although the difference is not statistically significant.

Table 4 - Percentage of presented words, critical non-presented words (cognate and non-cognate) and non-studied words in the list A.

Recall - List A		
	Mean (M)	Standard Deviation (SD)
Presented words	65	7.4
Critical non-presented words (cognate)	10.3	14.5
Critical non-presented words (non-cognate)	13.5	13.3
Sum of critical non-presented words	12	11.5
Non-studied words	1.7	1.3

Similar to the data from both lists combined, the recall percentage of presented words in list A was also average, similar to Sahlin et al.'s (2005), who reported an average recall of 62% of the presented words. Again, more false memories were produced when the lists of semantically associated words induced participants to think of a non-cognate target than a cognate one. This difference was not statistically significant, though.

Table 5 - Percentage of presented words, critical non-presented words (cognate and non-cognate) and non-studied words in the list B.

Recall - List B		
	Mean (M)	Standard Deviation (SD)
Presented words	61. 9	13.8
Critical non-presented words (cognate)	5.8	10.4
Critical non-presented words (non-cognate)	9.1	11.2
Sum of critical	7.4	7.7

non-presented words

Non-studied words	2.1	3.1

The recall percentage of presented words in list B was also average. However, the rate of presented words was higher than in Marmolejo et al.'s study (2009), which reported a rate of 56% recall of presented words, and Anastasi et al.'s study (EXPERIMENT 1, 2005), which reported a rate of 39%. More false memories were produced with lists of words semantically associated to non-cognate critical non-presented words than to cognate critical non-presented words, although the difference is not statistically significant. The total percentage of false memories in list B was lower than in list A, but the difference is also not statistically significant.

As mentioned above, data from the experiment were analyzed in the SPSS program. In the recall test (overall recall), there was no statistically significant difference between the number of incorrectly recalled cognate critical non-presented words (M = 7.8; SD = 12.5) and non-cognate critical non-presented words (M = 11; SD = 12.3), t = -1. 325, p =.193.

4.3 Organization and results of recognition test

After the recognition test was completed, we counted the number of correctly recognized words (presented/associated words), the number of incorrectly recognized (cognates or non-cognates) critical non-presented words (in order to check if the participants produced false memories), and the number of errors (words that were not studied/presented). However, in this test, we counted how many times the participants were able to reject (circle *no)* the words that were not presented. . We then entered these data on Excel and exported it to SPSS, where we calculated the mean (M) percentage and the standard deviation (SD) of each type of word (presented words, cognate critical non-presented words, non-cognate critical presented words and non-studied words). On SPSS, we also ran a Paired-Sample t-test comparing the percentage of incorrectly recalled cognate critical non-presented words to the non-cognate critical non-presented words. Below, there are three tables portraying the data from the recognition test generated through the SPSS program.

Table 6 - Percentage of presented words, critical non-presented words (cognate and non-cognate) and non-studied words in both lists A and B.

Recognition - List A + List B		
	Mean (M)	Standard Deviation (SD)
Presented words	84.3	8.1
Critical non-presented words(cognate)	39.1	25.5
Critical non-presented words (non-cognate)	44	31.4
Sum of critical non-presented words	43.9	25.2
Non-studied words	94.2	8.6

Data from the recognition test considering both lists showed that the recognition percentage of presented words was high, similar to previous studies, such as Kawasaki-Miyaji's et. al study (2003), who reported a rate of 80% of correctly recognized presented words. More false memories were produced with lists of words semantically associated to non-cognate critical non-presented words than to cognate critical non-presented words. However, the difference is not statistically significant.

Table 7 - Percentage of presented words, critical non-presented words (cognate and non-cognate) and non-studied words in the list A.

Recognition - List A		
	Mean (M)	Standard Deviation (SD)
Presented words	86.6	8.6
Critical non-presented words(cognate)	48.6	26.4
Critical non-presented words (non-cognate)	41.6	40

Sum of critical non-presented words	51.5	27.7
Non-studied words	95.2	5.8

The percentage of correctly recognized presented words in list A was high, compared to Arndt and Beato (2017), who reported a rate of 76.7% correctly recognized presented words. More false memories were produced with lists of words semantically associated to cognate critical non-presented words than to non-cognate critical non-presented words, but the difference is not statistically significant.

Table 8 - Percentage of presented words, critical non-presented words (cognate and non-cognate) and non-studied words in the list B..

Recognition - List B		
	Mean (M)	Standard Deviation (SD)
Presented words	82.4	7.3
Critical non-presented words(cognate)	31	22.2
Critical non-presented words (non-cognate)	46	32.4
Sum of critical non-presented words	37.4	21
Non-studied words	93.3	10.5

The percentage of correctly recognized presented words in list B was high, compared to Arndt and Beato's (2017) study, in which a rate of 76.7% correctly recognized presented words was reported. There was a statistically higher percentage of false memories produced with lists of words semantically associated to non-cognate critical non-presented words than to cognate critical non-presented words. The total percentage of false memories in list B was not as high as in List A.

In the recognition test (list B), there was a significant difference between the number of incorrectly recalled cognate critical non-presented words (e.g. false memories) (M = 31; SD = 22.2) and the non-cognate critical non-presented words (M = 46; SD = 32.4), t =.960, p = .052, with a higher production of false memories in lists of words semantically associated to non-cognate targets. We expected that more false memories would be produced with lists of words semantically associated to cognate targets. This result is not in the direction that it was expected; it is the opposite. The mean of presented (from both lists A and B) words is high (*M* = 84.3; *SD* = 8.1), as well as the non-studied words (*M* = 94.2; *SD* = 8.6) which means that the participants were able to distinguish words they had studied from the ones they did not. The sum creation of false memories (the production of critical non-presented words) was satisfactory (*M* = 43.9; *SD* = 25.2*)* and higher than the sum in the recall test (*M* = 9.4; *SD* = 9.7).

5. Discussion

This study analyzed if semantically related words associated to a cognate critical non-presented word would induce Portuguese-English bilinguals to a stronger co-activation between languages than words associated to a non-cognate critical non-presented, and, consequently, produce higher rates of false memory through the DRM paradigm.

The production of false memories (the incorrect recognition of critical non-presented words) in the recognition test (*M* = 43.9; *SD* = 25.2) was higher than in the recall test (*M* = 9.4; *SD* = 9.7). In the recognition the test (list B), there was a significant difference between the number of incorrectly remembered cognate critical non-presented words (*M* = 31; *SD* = 22.2) and non-cognate critical non-presented words (*M* = 46; *SD* = 32.4), *t* = -2.063, p = .052. This result indicates that participants incorrectly recognized non-cognate critical non-presented words at a higher rate than cognate critical non-presented words. This result supports the non-selective lexical access hypothesis, since a cognate interference effect was observed. In contrast to what was expected, a facilitation effect caused by the double activation of semantic and orthographic information in cognates was not observed. Thus, it may be possible to claim that the co-activation of languages through cognate words hindered the creation of false memories in the DRM paradigm. Another way to interpret this result is to consider that cognates may facilitate the distinction between presented and non-presented words. In other words, the co-activation of languages would more strongly activate an item in

memory, which would help participants identify it as a presented or non-presented word, and thus reduce the production of false memories.

In the current study, lists of semantically related words associated to a non-cognate critical non-presented word were able to induce the production of false memory in higher rates than lists of semantically related words associated to a cognate critical non-presented word in all tets, except in List A of the recognition test. In fact, the lists that were able to elicit more false memories from the participants had non-cognates as their critical non-presented items, such as the words: *woman, danger and beauty.* These three lists have associated words that are probably more strongly related to the critical non-presented words. For instance, *wonder* is in *woman*'s list, which can strongly remind participants of the DC comics' character *Wonder Woman.* Therefore, maybe the lists related to cognate critical non-presented words did not have a semantic association strong enough to elicit false memories with the same power as the lists associated to a non-cognate critical non-presented word did. , Nonetheless, this would be unexpected because all lists of semantically associated words were built and pre-tested by the same group of students, who were supposed to be proficient learners of English since they have been studying the language in college for at least three years.

To better understand the results of the current study, we must discuss them in the context of the literature in area, comparing them to previous studies. The false memory production rate in the current study was low, especially in the recall tests, if compared to other studies. Marmolejo et al. (2009), for example, presented an average of 40 falsely recalled items. Their study had a larger number of participants (119) compared to the current one (40). Also, Marmolejo et al.'s (2009) study did not develop a filler tests between recall and recognition tests, which could be and advantage for the participants, who would have information still very fresh in memory when changing tasks.

Another aspect that could have caused a low rate of false memory production in the present study is participants' proficiency in English, the language of the tests. The participants in this current study self-evaluated themselves and the mean rates for abilities/skills in English, were around M = 6, an intermediate level, while the average use of English was 101,8 min/per day. Because they were students enrolled for (at least) three years in the Modern Languages course and had classes in English frequently, we expected their self-reported proficiency and frequency of language use to be higher.. Proficiency was also an important aspect in Kawasaki et al.'s (2003) study. The results of their study showed that *unbalanced bilinguals* (students with high proficiency in the L1 and low proficiency in the

L2) produced lower rates of false memories (*M* = 62; *SD* = 34) in the recognition test than *balanced bilinguals (M = 76; SD = 35).* However, the bilinguals in the present study correctly recognized more presented words (*M* = 84.3; *SD* = 8.1) than the balanced bilinguals in Kawasaki et al.'s (2003) study (*M* = 62; *SD* = 24). It means that the participants of the current study are able to to tell whether they have seen a word or not more accurately than the participants in Kawasaki et al.'s (2003) study. This may be help explain why our participants had lower production of false memories.

In Anastasi et al.'s (2005) study, in Experiment 3 (recognition task), bilinguals created a lower rate of false memory (*M* = 18; *SD* = 29) than in list A (*M* = 51.5; *SD* = 27.7) and B (*M* = 46; *SD* = 32.4) of the present study. Besides, the rate of overall recognition of presented words in the current study (*M* = 84.3; *SD* = 8.1) was higher than Anastasi et al.'s (2005) study (*M* = 42; *SD* = 18), even when the participants were tested in their native language (Spanish) (M = 57; SD = 14). It may be possible to argue that our lists, created by Brazilian bilinguals, have stronger semantic associations than the ones created by native Spanish speakers, who were also bilinguals, in Anastasi et al.'s (2005) study.

Similar to the current study, Arndt and Beato's (2017) bilinguals recognized presented words with high accuracy (*M* = 86.81, *SD* = 11.20; English-Spanish bilinguals and *M* = 86.36, *SD* = 10.75; Spanish-English bilinguals). However, the bilinguals in the current study created more false memories (*M* = 43.9; *SD* = 25.2) than Arndt and Beato's (2017) bilinguals (*M* = 15.08*; SD* = 13.93 for English-Spanish bilinguals and *M* = 13.75, *SD* = 10.49 for Spanish-English bilinguals) IN RECOGNITION. Through these results, it might be possible to say that the lists in the current study, created based on the semantic associations made by bilinguals, for a bilingual study, worked better than translations of previous lists, as in Arndt and Beato's (2017).

6. Conclusion

Even though it was not as high as expected, the participants (Portuguese-English bilinguals) were able to create false memories when tested in the DRM paradigm (Roediger and McDermott, 1995). In the present study we expected to find that the co-activation of languages would also affect the production of false memories by bilinguals. This pattern was expected because when semantically related associates of a critical non-presented word activate a cognate target, it will be more strongly activated than non-cognates due to the

orthographic and semantic overlap between cognates. This would make these cognate targets more salient in memory and thus produce more false memories.

Although we did not find support for our hypothesis, our data support, at least partially, the non-selective lexical access hypothesis.. There are some aspects that could have brought us to these results: lack of proficiency, small number of participants and lists that could not actually induce participants to produce a false memory.

Although the lists did not work as successfully as expected, the study contributes with a corpus of lists of words created by Portuguese-English Brazilian bilinguals, taking into consideration the semantic associations of the Portuguese language. The study seems to be the first one to do so. Also, the study seems to be the first one to test for the co-activation of bilinguals' both languages in the DRM paradigm using only one language.

For future studies, it may be important to have a larger sample, and that these participants are more proficient than the ones in this study. Also, it could be investigated another ways to search co-activation of languages besides cognate words with the DRM paradigm.

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APPENDIX 1

A. Lists of cognate critical non-presented words and their semantic associates.

elevator	**astronaut**	**actor**	**hero**	**virus**	**piano**	**symbol**	**poet**	**diet**
building	nasa	movies	marvel	vaccine	classical	icon	poem	fat
lift	spaceship	television	superman	sick	instrument	code	literature	calories
stairs	gravity	oscars	powers	flu	beethoven	representation	writer	diabetic
floor	rocket	script	comics	bacteria	orchestra	meaning	rhyme	fit
high	moon	character	dc	hospital	music	mark	rhythm	eat
buttons	planets	artist	brave	cure	keyboard	image	inspiration	food
skyscraper	stars	hollywood	fearless	fever	notes	messege	emotions	nutrition
door	universe	role	savior	spread	songs	concepts	passion	healthy
apartment	astronomy	celebrety	strong	ill	harmony	avatar	novel	weight
claustrophobia	alien	stage	couragous	doctor	talent	idols	deep	vegetables
wait	atmosphere	fame	fly	fungus	fingers	riddle	dreamer	carbohydrates
awkwardness	explore	award	mask	cold	black	font	culture	nutrients

APPENDIX 1

B. Lists of non-cognate critical non-presented words and their semantic associates.

clothes	**woman**	**rabbit**	**brick**	**beauty**	**health**	**holy**	**farmer**	**danger**
shorts	queen	bunny	wall	beautiful	fitness	sacred	agriculture	crimminals
wearing	feminist	easter	concrete	handsome	medicine	christ	plantation	risk
pants	female	carrot	build	pretty	exercise	bible	harvester	accident
sweater	mother	alice	clay	makeup	alimentation	jesus	chickens	beware
jeans	lady	animal	red	model	hydratation	saint	countryside	caution
coats	gender	fluffy	hard	elegance	fruits	god	horse	toxic
shirt	man	chocolate	material	beast	sports	religion	lands	explosive
dress	girl	ears	base	eyes	running	church	cows	burgler
jackets	sufragists	white	shelter	natural	lifestyle	miracle	field	warning
skirt	human	cute	protection	stereotypes	habit	trinity	organic	hazard
blouse	person	eggs	mud	inner	checkups	pray	sheep	safety
suits	wonder	jumps	solid	fair	water	cross	laborer	distress

APPENDIX 2

Recognition test – List A: Read each word below and decide whether you have seen it before during the recall test. If you believe you have seen the word before, please circle "yes". If you believe you have not seen the word before, please circle "no".

lift	yes	no	wearing	yes	no	spaceship	yes	no	feminist	yes	no
put	yes	no	another	yes	no	confess	yes	no	leave	yes	no
calendar	yes	no	financial	yes	no	root	yes	no	rise	yes	no
elevator	yes	no	clothes	yes	no	astronaut	yes	no	woman	yes	no
spot	yes	no	explanation	yes	no	soul	yes	no	absence	yes	no
building	yes	no	shorts	yes	no	nasa	yes	no	queen	yes	no
date	yes	no	interest	yes	no	plant	yes	no	rose	yes	no
burden	yes	no	suddenly	yes	no	similar	yes	no	friction	yes	no
month	yes	no	concern	yes	no	garden	yes	no	arise	yes	no
man	yes	no	hollywood	yes	no	chocolate	yes	no	fearless	yes	no
appointment	yes	no	taxes	yes	no	herb	yes	no	increase	yes	no
replace	yes	no	method	yes	no	reveal	yes	no	cavern	yes	no
upright	yes	no	gadget	yes	no	judge	yes	no	pilot	yes	no
buttons	yes	no	coats	yes	no	planets	yes	no	gender	yes	no
laughter	yes	no	concentration	yes	no	shout	yes	no			
television	yes	no	easter	yes	no	superman	yes	no	concrete	yes	no
belong	yes	no	maybe	yes	no	cigarette	yes	no	return	yes	no
talisman	yes	no	school	yes	no	airplane	yes	no	word	yes	no
actor	yes	no	rabbit	yes	no	hero	yes	no	brick	yes	no
twice	yes	no	statue	yes	no	beger	yes	no	wrong	yes	no
movies	yes	no	bunny	yes	no	marvel	yes	no	wall	yes	no
charm	yes	no	ruler	yes	no	plane	yes	no	letter	yes	no
corner	yes	no	mistaken	yes	no	horizon	yes	no	perspect ive	yes	no
amulet	yes	no	monarch	yes	no	flight	yes	no	book	yes	no
material	yes	no	birthday	yes	no	economy	yes	no	soil	yes	no
brooch	yes	no	king	yes	no	aircraft	yes	no	languag e	yes	no
subtle	yes	no	irritate	yes	no	settle	yes	no	alley	yes	no
study	yes	no	skyscraper	yes	no	shirt	yes	no	stars	yes	no
artist	yes	no	fluffy	yes	no	brave	yes	no	hard	yes	no

APPENDIX 2

Recognition test – List B: Read each word below and decide whether you have seen it before during the recall test. If you believe you have seen the word before, please circle "yes". If you believe you have not seen the word before, please circle "no".

fitness	yes	no	put	yes	no	mistaken	yes	no	perspective	yes	no
beast	yes	no	personality	yes	no	another	yes	no	ruler	yes	no
inspiration	yes	no	piano	yes	no	letter	yes	no	burden	yes	no
leave	yes	no	companion	yes	no	romantic	yes	no	soul	yes	no
virus	yes	no	suddenly	yes	no	architecture	yes	no	emotions	yes	no
agriculture	yes	no	similar	yes	no	cigarette	yes	no	friction	yes	no
sacred	yes	no	flat	yes	no	symbol	yes	no	attention	yes	no
date	yes	no	rooms	yes	no	fever	yes	no	bloom	yes	no
cure	yes	no	centimeters	yes	no	lands	yes	no	poet	yes	no
want	yes	no	belong	yes	no	confess	yes	no	explanation	yes	no
return	yes	no	maybe	yes	no	attractiveness	yes	no	plantation	yes	no
corner	yes	no	keyboard	yes	no	sending	yes	no	classical	yes	no
plant	yes	no	flower	yes	no	religion	yes	no	horizon	yes	no
spot	yes	no	beauty	yes	no	health	yes	no	numbers	yes	no
code	yes	no	twice	yes	no	handsome	yes	no			
holy	yes	no	absence	yes	no	horse	yes	no	poem	yes	no
beautiful	yes	no	farmer	yes	no	messege	yes	no	concentration	yes	no
sick	yes	no	charm	yes	no	plane	yes	no	fruits	yes	no
reveal	yes	no	christ	yes	no	construction	yes	no	vaccine	yes	no
cavern	yes	no	replace	yes	no	settle	yes	no	shout	yes	no
sports	yes	no	medicine	yes	no	alley	yes	no	god	yes	no
conventions	yes	no	love	yes	no	notes	yes	no	enchantment	yes	no
interest	yes	no	surface	yes	no	elegance	yes	no	sheet	yes	no
beger	yes	no	statue	yes	no	icon	yes	no	relationship	yes	no
image	yes	no	literature	yes	no	subtle	yes	no	text	yes	no
mathematics	yes	no	curiosity	yes	no	drawing	yes	no	instrument	yes	no
mail	yes	no	planning	yes	no	pink	yes	no	petals	yes	no
wrong	yes	no	rose	yes	no	measuring	yes	no	lovely	yes	no
irritate	yes	no	laughter	yes	no	method	yes	no	writing	yes	no