Bilingual Visual Word Recognition in a Lexical Non-meaningful Context: A Word-Search Puzzle Study

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Abstract

Parallel language activation in bilinguals is the currently accepted view of word recognition processing in bilinguals. The mental lexicon is viewed as a network. In bilinguals, these networks can be activated at the same time and, according to the BIA+ model, are connected. Words that have similar orthographic or semantic representations in both languages, such as interlingual homographs and cognates, affect the recognition speed of a bilingual speaker. L2 proficiency can affect the recognition of these words. Most studies on bilingual word recognition use the Lexical Decision Task as a method. Due to the limitations of this method, especially for bilinguals, a new method is used to test which word type, English words, Dutch words, or English-Dutch cognates, participants will recognise most frequently. This method, developed by Dr. Zuckerman, uses a Word-Search Puzzle to study word recognition. This study also investigated the effect of proficiency on the recognition of these words. 50 Dutch-English bilinguals with varying levels of English proficiency were tested, and it was found that both Dutch words and cognates were recognised more frequently than English words. However, English proficiency did not influence the recognition of these words.

Keywords: Word recognition, proficiency, word-search puzzle, bilingualism

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1. Introduction & Theoretical background

The bilingual mental lexicon and its activation in word recognition have been a topic of research for many years, and many questions about its "working" remain to be investigated. A big question is how the mind of people who have two or more languages available to use can activate the correct language and inhibit the other from interfering with the comprehension of the activated language. In the past, the view was that only the language presented will be activated in the mind of the speaker, which is called language-specific lexical access. This system, however, has been researched to a great extent, and Dijkstra (2005) reviews evidence that a bilingual speaker's languages are both activated when that speaker reads a text in only one language. This dual activation is called "language non-selective lexical access" and means that speakers cannot suppress the language that they do not require in a monolingual context.

Most studies on bilingual word recognition that include both the L1 and L2 of the speaker present the words in a sequence (Brenders & van Hell, 2012) and no studies were found that test word recognition in a bilingual context in which both languages are presented at the same time in an equal amount. The question that arises is which language the bilingual speaker will recognise first and most frequently, thus which language has the highest activation level and whether this depends on the speaker's proficiency of each language or whether both languages will be recognised equally. It is also interesting to see whether the cognate effect holds for this situation as well.

It is valuable to know how bilingual speakers recognise words because knowing how the words are represented in the brain helps researchers understand how the complex system of language learning functions. This information can further be used in developing strategies for better reading skills or the acquisition of a second language. Before explaining the method

of this study, the literature on both monolingual and bilingual word recognition will be evaluated.

1.1 Monolingual word recognition

People develop their vocabulary and learn new words throughout their lifetime. These words are stored in the brain, and this storage is called the mental lexicon. It contains knowledge about words, but also its associations with other words. The mental lexicon can be perceived in two ways. An older form of seeing it is the dictionary-like structure, where each word is mapped separately. A newer, more widely accepted model is the network structure in which words are all connected through associations with other words. These associations can be of morphological, semantic, or syntactic origin. Most experiments that have focussed on describing the mental lexicon measured response time to a target word. The response time indicates how fast a word is activated in someone's mental lexicon. If a word is recognised fast, its activation level is considered high (Aitchison, 2012). These experiments have also been used to see whether certain factors can predict the recognition time of a word. In what follows, we will discuss the effect of priming, frequency, age of acquisition and other factors on monolingual word recognition.

1.1.1 Priming

Priming influences word recognition. If a target word is preceded by a prime word which is similar morphologically or semantically to the target word, the target word is recognised faster, or the participant can judge more quickly whether the target word is a real word or not (Rastle, 2016). However, when a participant must choose the correct word out of multiple suggestions, and the options are similar to the target word, it delays the reaction time. This neighbourhood effect was found by Bowers, Davis, and Hanley (2005).

1.1.2 Frequency Another significant factor that influences word recognition is word frequency. Many studies have found that high-frequency words are processed much faster

than low-frequency words. Brysbaert et al. (2011) showed this phenomenon in their research, where they measured lexical decision times of many words from the English Lexicon. Frequency was the variable that caused the most difference between reaction times, with high-frequency words having a shorter reaction time than low-frequency words.

1.1.3. Age of acquisition In the monolingual lexicon, the age of acquisition determines the activation level of a word. Words that have been acquired earlier in life are recognised more quickly than words that have been acquired later (Brysbaert et al., 2000). Although, not all researchers agree on this as some studies mention that age of acquisition and frequency can be joined together as a single variable: cumulative frequency (Zevin and Seidenberg, 2002).

1.1.4. Other factors Other factors that influence word recognition in both isolation and sentence context can be word length (Vitu, O'Regan and Mittau, 1990), regularity, consistency, and semantic richness (Yap & Balota, 2019), as well as concreteness, imageability, and neighbourhood effects (Bowers, David & Hanley, 2005).

1.2 Bilingual word recognition

An increasing number of people can speak at least one second language. The bilingual lexicon contains two or more languages, which coexist together. The view of how they are activated when they encounter visual input in isolation has changed from language-specific lexical access to language non-selective lexical access or parallel activation, which means that both languages will be activated regardless of the lexical input that is provided. This theory is supported by three different lines of studies of the bilingual mental lexicon, which focus on interlingual homographs, interlexical neighbours, and cognates (Starreveld et al., 2014). These concepts are all word-types that cause mental representations in both languages. The difference in recognition reaction time for these word types provides evidence that the parallel activation model is correct.

1.2.1. Interlingual homographs The first line of research utilises the fact that two languages may share a word in their lexicon but map different meanings upon that word. For example, the Dutch word *"room"* and the English word *"room"* have the same form but have different meanings (The Dutch word 'room' means 'cream' in English). Dijkstra, Grainger, and van Heuven (1999) found that these interlingual homographs, which are also called false friends, take longer to recognise than words that are both different in form and meaning. The phonological overlap between the words caused speakers to have a longer reaction time, and thus an inhibitory effect was found. Some studies, such as Lemhöfer and Dijkstra (2004), did not see this effect. They discovered that interlingual homographs had a shorter reaction time than control words. There is thus no clear consensus on this phenomenon, but most studies provide evidence for a delay in reaction time, caused by the contradiction between meanings, which indicates that both languages are activated simultaneously.

1.2.2. Interlexical neighbours The second group of studies that provides evidence for the language non-selective lexical access approach focus on interlexical neighbours. These are words that look similar to each other but differ slightly and have different meanings in both languages. For example, the Dutch word 'mand', which means basket, is similar to the English word 'sand'. Therefore, they are interlexical neighbours. Studies found that the presence of interlexical neighbours that were presented before the target word caused interference in recognising the target word. It created a delay in the reaction time in a lexical decision task (Grainger et al., 1989) and eye-tracking experiments (Paterson, Liversedge, and Davis, 2009).

1.2.3. Cognates On the other hand, it has been proven that cognates, which are words that exist in both languages and have the same meaning in these languages, are recognised faster than words that are non-cognates. Cognates were found to have a shorter reaction time than control words, but this cognate facilitation effect was only present when the speaker was

proficient enough in both languages. (Brenders, van Hell & Dijkstra, 2011; van Hell & Tanner, 2012). The explanation for this shorter reaction time was that cognates are mapped on two languages with an overlapping semantic connotation. Due to both languages being activated when a word is processed, the cognate word will be recognised faster.

1.2.4. Bilingual word recognition models These interlingual factors positively or negatively influence language processing and have been used in models that explain the word recognition process of bilingual speakers, such as the Bilingual Interactive Activation Model (BIA) (Dijkstra and van Heuven, 1998) and the BIA+ model. The BIA+ model shows how representations of different languages are activated and how these representations are used in a decision and response selection mechanism. This mechanism is then used in a task schema. The model makes a distinction between linguistic context effects and non-linguistic context effects. Examples of linguistic context effects are sentence structure or word order, while non-linguistic context effects are effects caused by other factors, such as participant strategies. There is a distinction between these two categories because they affect different parts of the word recognition system. Linguistic context effects have a direct impact on word recognition, but non-linguistic context effects only influence the response or decision part of bilingual word recognition (Dijkstra and van Heuven, 2002).

1.2.5 Other factors Beside these factors that exist on the interlingual level, other factors that can affect the recognition of visual word input are similar to the ones that affect monolingual word recognition, such as the age of acquisition, frequency and priming.

The word frequency effect in bilinguals is higher in speakers' L2 than in their L1. Diependaele et al. (2013) researched this, and their explanation of this is the fact that lexical entrenchment causes the representations of words to be less susceptible to interference from similar words and causes faster activation. The more a word is encountered, the more entrenched it becomes, and the faster it will be recognised. This was true for both their L1

and L2 of speakers. Therefore, word frequency is a factor that should always be considered when selecting words to use in a study.

1.2.6 Proficiency Factors that do not exist in a monolingual context are the proficiency in both languages of a speaker and the switching between presented languages.

Van Hell and Tanner (2012) reviewed L2 proficiency in relation to cross-language lexical activation. The studies they evaluated all include the three cross-language word types, i.e., cognates, interlingual homographs, and interlexical neighbours, to investigate the effect proficiency has on word recognition in both the native and second language of bilingual speakers. Most studies found compared one of these three word types with non-cognate control words. Poarch and van Hell (2012) found that the cognate facilitation effect transpired in both the L1 and L2 in a picture-naming task. This effect was found more strongly in L2- than in L1 processing. This was discovered by van Hell and Dijkstra (2002) as well. This was attributed to the co-activation of the L1 and L2 during word processing, but participants needed highly developed L2 proficiency for this cognate effect to be possible. Not all studies found an effect of speakers' proficiency on visual word recognition. A study by Duyck, Diependaele, Drieghe, and Brysbaert (2004) explored the impact of masked primes on word recognition on groups with different L2 proficiency. A positive effect of a similar phonological representation in both languages was found, but proficiency did not influence the results. Other studies found no relationship between L2 proficiency and word recognition either (Dijkstra, Hilberink-Schulpen & van Heuven, 2010).

Diependaele et al. (2013) also looked at the proficiency of the L2 but in regard to the frequency effect and found that proficiency in both native and second language speakers caused a difference in English word recognition response times. It was also argued that higher language proficiency increases the entrenchment of that language, which improves the reaction time to lexical input.

1.2.7. Priming Priming is also a factor that plays a role in bilingual word recognition. When a word is processed, it will be recognised faster when the words surrounding it are from the same language, and thus are congruent. Words of other languages, non-congruent words, delay the recognition of the target word. This implies that a speaker is more likely to recognise a word when the previous word was in the same language (Declerck, Snell & Grainger, 2018).

1.3 Goal of the study

The results in the above-mentioned studies have often been acquired by presenting the test material in isolation or a sequence, not all test items together at once. However, this setting does not reflect most realistic settings, especially in countries such as the Netherlands, where English can frequently be found in the public domain, through advertisements or social media. A new method has been created where participants encounter real words in a context without lexical meaning. This method might yield new results and can be a new form of presenting research material to participants. Before discussing this method, the advantages and disadvantages of the previously used methods are discussed.

1.3.1 Disadvantages of the previously used method The findings in word recognition studies are often found using the lexical-decision task (LDT) method, semantic categorisation method, or eye-tracking method. The LDT is the most used of these methods and asks participants to identify whether a stimulus is a real word or not. For example, the non-word "blerp" is considered false. The reaction time to the stimuli can indicate the activation level of that stimulus. The advantages of this method are that reaction times to each word can be measured and are therefore precise. However, there are disadvantages which make this method subject to noise. 80 to 90% of high-frequency word recognition responses can be explained by response choice, and the rest is noise. For reaction times, the percentage of noise is up to three times higher (Diependaele. Brysbaert & Neri, 2012). These percentages

are already good, but not all noise can be explained, and, therefore, this method is not perfect. The words are presented in isolation which makes it difficult to see how a participant would have reacted when the stimulus was encountered in a context filled with other stimuli and thus says something about the word's activation level in isolation, but not when encountered in a context with other lexical input. The setting is often artificial and therefore, unnatural for a speaker to access words. On the other hand, some studies examine word recognition in a sentence context. The disadvantage of this method is the presence of a meaningful lexical context. This method can be extra challenging to investigate bilingual speakers, because bilingual speakers, according to the Bilingual Interactive Activation Model, activate both languages when they are presented with a word. This may cause a delay in reaction time. However, De Trizio (2008) found that bilinguals answered more accurately than monolinguals. De Groot et al. (2002) found that for the L1 and L2 recognition, different factors, such as word length or meaning, had an effect. All in all, monolinguals and bilinguals react differently to LDTs, and this method is therefore not always suitable for comparing the two groups.

1.3.2. Advantages and disadvantages of the new method A new method has been created by Zuckerman (2015), called the Word-search puzzle (WSP). In this method, participants must find as many words as possible in a word-search puzzle within a specified timeframe. The advantage of this method, compared to the LDT, is that the participants do not have a limited number of choices. All stimuli are presented at the same time. They have an equal chance to be detected, instead of being presented in a predetermined sequence. An example of the Word-Search Puzzle is presented below in figure 1.

Figure 1. An example of the Word-Search Puzzle

s	k	s	u	f	a	r	e	e	d
r	k	l	a	p	l	o	p	e	r
q	e	y	e	g	a	s	r	o	q
s	s	a	c	h	z	t	c	i	z
v	m	e	e	t	n	u	a	u	w
s	c	h	r	o	e	v	e	n	d
k	r	o	k	o	d	i	l	e	r
g	e	o	d	r	i	e	m	e	t
f	l	u	i	d	s	p	r	a	k
k	r	a	a	k	e	r	w	o	n

This method can be carried out digitally and has a broader reach, it is suitable for teenagers or adult individuals, and the detection value of each word, which gives a representation of the activation level in the mental lexicon. The detection value means the total number of times a word has been found divided by the total number of times the words has been presented (Kalle, 2016). Its ecological validity is also higher because this method creates a more natural setting by letting participants find the words on instinct. However, the results can also be controlled, which makes the method suitable for word recognition research. On the other hand, a disadvantage of this method is that the detection value only measures whether a word has been found, but not the reaction time. It is, therefore, less precise. Another disadvantage of this method is the inability to control the responses of the participants to the test environment. Through the online medium, more participants can be approached. However, it is also more challenging to communicate with the participants to ensure that all instructions are understood correctly.

So far, this method has only been used in monolingual word recognition research, but it can also possibly be used for other fields of research, such as bilingual word recognition. It is interesting to see whether the Word-Search Puzzle method provides the same results as previously used methods in this field of research or whether it will give new insights regarding bilingual word processing. The method is suitable to test words not in isolation, but in combination with other test material at the same time. This provides researchers with a

new tool for word recognition research where they can omit meaningful lexical context, which influences word processing on all levels, but still provide context for the participant. Due to the various findings on the effect of proficiency on word recognition, it is also interesting to see whether such an effect can be found using the WSP-method.

This new method is a promising tool to investigate bilingual word recognition. The method is still new, and therefore, this research can help support the method as a suitable, new way to test word recognition. It might also identify the shortcomings of this method regarding bilingual word recognition research. This results in the following research question.

2. Research question

This study focuses on one main research question and will be supported by several sub-questions. The study was centred around two factors: word type and proficiency. For word type, there were three conditions: Dutch words, English words, and cognates. An additional control variable was age-group. This resulted in the following main research question:

RQ: Is there an effect of subjects' **English proficiency** on word-detection of **different word-types** in the Word-Search Puzzle**?**

The first sub-question focused on the difference between the word group categories. As the literature on bilingual word recognition has reported a cognate effect, the first thing to investigate was whether this effect also occurred in the context of a Word-Search Puzzle.

SQ1: Is there an effect of **word type** on word detection in the Word-Search Puzzle?

As the L1 of the participants is Dutch, it was expected that Dutch words and cognates would have a lower activation threshold compared to English words, because Dutch was the primary language used by the participants. Therefore, Dutch words and cognates were expected to be recognised more often than English words.

In addition to the differences between the number of words detected for each word-type, this study investigated whether L2 proficiency had an effect on the detection of both L2 non-cognates and cognates.

SQ2: Is there an effect of **English proficiency** on the number of **English words** detected?

SQ3: Is there an effect of **English proficiency** on the number of **Cognate words** detected?

It was expected that participants with a higher level of English proficiency would be better at detecting English and cognate words, because a higher proficiency has been shown to have a link with better word recognition in bilinguals (van Hell and Tanner, 2012). More balanced bilinguals have a more extensive vocabulary in their L2 and have had more exposure to it. However, not all studies support this claim. Therefore, a possible positive effect of proficiency was expected to be found but was not guaranteed.

To investigate whether the cognate effect occurs and to see whether proficiency influences this, the following research question has been provided to answer this.

SQ5: Does **English proficiency** affect the recognition of **cognates** compared to non-cognates?

It was expected that Dutch learners of English with a high proficiency would perform better at recognising both English and Dutch words and would detect more words in total as the cognate facilitation effect only works with speakers who are proficient enough in both languages.

3. Method

3.1. Participants

There were 50 participants in this study, acquired through two channels. Group one consisted of 13 participants that were high school students from a high school in the north-east of the Netherlands. All of them were native speakers of Dutch who were learners of English. They all had been learning English at school since the seventh grade of primary

school. They were all in their third year of secondary school. Their teacher has approached these participants. The other 37 participants, group two, were contacted through social media and varied in age between 17 and 62. They also were native speakers of Dutch. The English proficiency level of the participants ranged between a little knowledge to almost balanced bilingual. All participants participated willingly and anonymously.

3.2 Materials

The Word-Search Puzzle method requires around 20 to 30 words to be added to the puzzle. An even distribution was chosen between cognate words and non-cognate words, which resulted in ten cognates, ten Dutch non-cognates, and ten English non-cognates (Appendix 3). These words were selected using three databases. The databases showcased the frequencies of the most used words in their respectful language. The database used to choose the English words was the COCA corpus (Davies, 2011), and the Dutch words were selected using the PAROLE-Corpus 2004 (INT, 1999) and the SoNaR Corpus (Nederlanse Taalunie, 2015). The word used in the Word-Search Puzzle were compared to the corresponding translation of the other corpus. A non-cognate word was selected when its frequency and the translation's frequency was at a similar level, and the words differed in morphological structure. The words varied in length and syllabic structure to create a representable mix of existing words. The words were placed in the Word-Search Puzzle in a distribution where no clusters of words of the same word-type were created. All words were at least four letters long and were presented horizontally, from left to right. The rest of the puzzle was filled with random letters and syllables that resembled the lexicon of the two languages but did not form any new words. Two versions of the Word-Search Puzzle were used to control for placement biases (Appendix 1 & 2).

To estimate a participant's proficiency level in English, participants had to assign a grade to their English capabilities compared to others of the same age. This method of

determining the L2 proficiency of participants was chosen due to it being a short task. Self-assessment has been found to give accurate representations of participants' skills (Ross, 2006). Preferably a language placement test was used. However, to gather as many participants possible, an extended placement test was omitted, as this decreased the chance of finding enough participants.

Other details that were collected were the age of the participants, their gender, mother tongue, and, for the high school students, educational level.

3.3 Procedure

The participants were tested through an online task on a computer. Their teacher provided this task for group one. Group two was approached through social media and was sent the link to the study by the researcher. All communication with the participants was in Dutch. Participants had to read the instructions before starting the task, so they would be prepared and knew what was expected of them. The instructions for group two were presented in a Google Forms document, in which they had to fill in an estimation of their English level and a made-up name to connect the results from the form to the word puzzle. All participants had to access the website created for the Word-Search Puzzle method and received a few more instructions about the content of the task.

The website consists of six parts. Part one provided more instructions; part two asked for three details: age, gender, and mother tongue. Part three provided an example puzzle in which the participants could practice by selecting three given words "klap", "klaploper" and "schroeven". After they had practised enough, they were able to proceed to part four. Part four was the actual task, where the participants had three minutes to find as many Dutch and English words possible in the Word-Search Puzzle. This time limit was used because it provided participants enough time to find multiple words, but it was restrictive enough so that they were not able to look for every item. Part five consisted of a remarks box in which

participants had to write down their English estimation grade again and their made-up name. Part six was a confirmation that the test was submitted correctly.

3.4 Analyses

The data of both groups of participants were combined, and this created a data file with 50 participants. The number of words that the participants had selected was noted down, and the total for each word category: English, Dutch, and Cognate, was calculated. For each research question, the appropriate statistical test was performed.

4. Results

4.1 Comparison of Word-Search Puzzle versions

To see whether both versions of the test could be used together, the mean number of words found in each category: English, Dutch, Cognate and in the total number of words found between the two versions were compared using an independent samples t-test. Neither the English word group ($t(48) = -0.81$, $p = .42$), the Dutch word group ($t(21.470) = 0.48$, $p = .63$), nor the Cognate group ($t(48) = -1.02$, $p = .32$) resulted in significant differences between the two versions. Therefore, all data could be combined and used further in the analysis.

4.2 The effect of word types

The data of the two versions of the test were joined together. This resulted in the following means and standard deviations for each language category (table 1).

Table 1: The mean and standard deviation of the total number of words found for the categories: English, Dutch, and Cognates

	English	Dutch	Cognates	Total
Number of words found (n = 50)	3.8 (2.9)	5.4 (2.2)	5.5 (2.0)	14.7 (5.3)

Before including proficiency as a factor, the three groups were compared to see whether there are any differences between them. The three word-type groups were compared using a one-way ANOVA. This resulted in a significant difference between the three different word-types ($F(2, 147) = 9.59$, $p < .001$). A Tukey HSD Post-hoc test was conducted to differentiate which word-types cause this significant difference. This resulted in no significant difference between the Dutch and Cognate word-type categories ($p = .98$) but did result in a significant difference between the English word group and the Dutch word group ($p < .001$), as well as a significant difference with the Cognate group ($p < .001$).

4.3 The effect of proficiency level

Table 2. The mean and standard deviation of the number of words found for each category for all proficiency levels

	Proficiency score						
	3 N=5	4 N=3	5 N=11	6 N=8	7 N=15	8 N=6	9 N=2
English words	3.6 (2.5)	2.7 (2.5)	3.6 (2.4)	3.4 (2.5)	4.3 (1.8)	4.0 (1.1)	5.5 (2.1)
Dutch words	2.4 (2.9)	5.7 (3.2)	5.7 (1.9)	5.9 (1.7)	6.1 (1.2)	4.0 (2.3)	7.0 (2.8)
Cognate words	4.0 (1.6)	6.0 (3.5)	5.1 (2.0)	6.0 (2.1)	5.8 (1.4)	5.2 (1.7)	6.5 (4.9)
Total number of words	10.0 (6.2)	14.3 (9.1)	14.5 (5.4)	15.3 (5.5)	16.2 (3.4)	13.2 (3.7)	19.0 (9.9)

The main research question is to find out whether proficiency plays a role in the detection of words in both the L2 and cognates, in a bilingual context without added lexical meaning. The means and standard deviations of each proficiency score combined with the number of words found in each word category can be found in table 2. No participants used a score of 1, 2, or 10 to indicate their English proficiency, and therefore, these scores are not mentioned in the table. A Spearman's rank-order correlation was run to determine the

relationship between the participants' English proficiency and the scores on the word-types: English words and cognates. There were no positive correlations found between either English proficiency and the mean number of English words found ($r_s(48) = .20$, $p = .16$), or English proficiency and the detection of cognates($r_s(48) = .18$, $p = .20$).

5. Discussion & Conclusion

5.1 Differences between word groups

It was expected that more Dutch words and cognates would be detected than English words. This was proven to be true, as the results show that there is a significant difference between the number of Dutch and cognate words found compared to English words. This implies that, even though all participants possessed some English vocabulary, the Dutch mental lexicon might have a lower activation threshold and is therefore recognised more easily. For all categories, some words were recognised more often than other words (Appendix 3). The lower activation threshold of the Dutch vocabulary indicates that non-balanced bilingual speakers will recognise the language they are most fluent in first or more easily. Due to the significant difference between the detection of cognates and English words, it can be said that a cognate facilitation effect was present. However, the presence of Dutch makes it difficult to draw this conclusion because there was no difference between the detection of Dutch words and cognates. Cognates could have been perceived as Dutch words only, and as a result, have a detection rate that was similar to the non-cognate Dutch words.

5.2 Proficiency effects

It was expected that L2 proficiency would affect word recognition. Surprisingly, this study did not find such results. No correlation was found between English proficiency and English word detection, and proficiency did not have an effect on the detection of cognates either.

A possible explanation for the absence of evidence for an effect of proficiency can be the presence of outliers, thus participants who detected many words, but were overcritical of their English abilities.

Moreover, our results might be explained by other factors weighing in more heavily than L2 proficiency, such as intelligence level, years of exposure to English, or experience with word puzzles.

5.3 Limitations

The size of the participant group is large enough to conduct this study. However, it would be encouraged to conduct this study with more participants as people can fill it in on the computer, and the reach can be much larger. A larger dataset can give more accuracy to the results.

This study might yield different results if the number of words in the Word-Search Puzzle was increased or decreased. This can be a direction for further research into improving this method. Other factors that can be changed and cause a different result might be the time limit or scoring method. All words were used in determining whether there were any differences between the word-types. However, it would be possible only to consider the first ten detected words because this would show the words that were detected the fastest.

Another significant factor that could have contributed to the results is the method of determining the L2 proficiency of participants. The chosen method might have been too limited to reflect real L2 proficiency. Therefore, it may have created too much noise in the data and caused an unreliable proficiency score. As a consequence, the correlation between the detection value and proficiency might be skewed.

Initially, only high school students were supposed to participate. However, due to the coronavirus circumstances, it was not possible to meet the participants physically during one of their lessons. The test would have been conducted on paper or digitally with participants

and the researcher present during the data retrieval. This setup was created to allow the participants to ask questions and for the researcher to control whether the test was taken correctly. Unfortunately, this setup was not possible to achieve, and therefore, the participants from the high school were approached online through their teacher, to ensure the anonymity of the students. More than 70 students have been contacted this way. However, because the participants could not be obliged to contribute to this study, only 13 responded and participated. This caused too low a number of participants, and as a result, the research question had to be adjusted to be able to test other participants, the adult group, as well.

Another limitation of this study was caused as a result of time constraints. Unfortunately, there was not enough time to adjust the code of the test material website, and this caused a discrepancy between the task instructions provided and the input participants saw on their screen. This might have caused some confusion with the participants, and in further research, this should be avoided.

5.4 Future studies

A cognate effect was not found between the Dutch words and cognates, but there was a significant effect between the English words and cognates. To rule out the influence of Dutch on the recognition of the cognates, Dutch can be omitted from the Word-Search Puzzle. Only cognates and English words will remain, and a different outcome might appear. Another possible way to eliminate or change the influence of Dutch can be to ask participants only to spot English words. This study only used cognates as interlingual words. It would be interesting to investigate the effect of interlingual homographs or interlexical neighbours on word recognition using the present method.

Before future studies adopt the current study's way of testing, the limitations mentioned should be addressed and resolved first. Most of all, interference from Dutch should be avoided, and a reliable proficiency test should be used.

The Word-Search Puzzle method generated results regarding the cognate facilitation effect that seemed similar to Language Decision Tasks. As a result, the WSP-method can be considered as a method of testing word recognition in the future.

5.5 Conclusion

This study investigated the relation between bilingual word recognition in a meaningless lexical context and L2 proficiency level. Significant word recognition differences were found between the L1 and the L2, with the L1, Dutch, being recognised more often. More cognates were recognised than English words; therefore, a possible cognate facilitation effect was found between English and cognate words. However, due to the possible interference from Dutch, this cannot be stated with certainty. Proficiency did not appear to affect the recognition of either cognates or English words. This study used a new method for word recognition research. The method seems promising for future research because of the possible cognate facilitation effect. Nevertheless, there are problematic aspects, namely the inability to measure reaction time and unwanted priming effects.

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7. Appendix

Appendix 1. Word-Search Puzzle version 1

a	x	t	e	g	e	f	i	b	A	e	h	i	l	i	c	h	a	a	m	a
l	a	i	l	i	b	r	a	r	Y	b	u	b	s	t	a	d	p	a	l	o
r	v	r	o	u	w	c	o	v	A	e	x	p	e	r	i	e	n	c	e	v
p	s	y	r	o	h	w	a	t	e	r	v	r	e	t	s	i	n	h	i	e
o	w	n	e	r	g	a	m	r	o	m	i	m	o	m	e	n	t	v	r	o
w	a	g	y	c	e	n	d	f	o	o	r	l	o	g	o	a	l	t	r	e
a	e	e	u	w	n	i	t	o	c	e	s	u	w	e	e	k	a	l	l	t
k	a	a	r	b	o	r	u	f	u	r	e	m	o	n	e	y	t	e	r	k
a	s	c	h	o	o	l	u	n	d	e	s	o	r	m	a	l	a	r	m	p
b	e	e	l	o	d	e	c	i	s	i	o	n	m	a	g	n	i	n	g	o
i	v	e	r	h	a	a	l	b	e	r	z	a	v	e	r	t	o	o	f	s
t	r	e	j	e	a	r	t	h	i	g	s	o	n	o	m	p	e	e	y	k
f	u	n	t	e	r	i	g	h	o	s	p	r	o	d	u	c	t	a	p	t
o	n	t	w	i	k	k	e	l	i	n	g	t	i	y	c	h	i	l	d	o
g	e	l	u	r	r	g	e	n	d	a	b	b	e	l	o	b	l	o	e	m
d	a	r	o	p	e	n	i	n	g	s	t	r	a	t	e	e	m	p	j	e
g	u	i	z	e	r	d	i	g	e	d	i	s	t	a	n	c	e	r	a	f
o	p	e	o	p	l	e	s	t	j	o	s	t	d	o	e	f	r	u	i	t
o	c	k	s	e	r	u	n	t	i	c	k	e	t	u	i	h	a	u	t	u
e	x	t	o	n	n	e	d	o	l	c	u	s	t	v	o	i	c	e	t	o
t	r	u	m	o	p	r	e	s	t	a	u	r	a	n	t	y	o	u	g	h
t	s	p	a	n	n	i	n	g	s	p	e	x	t	p	a	a	r	d	u	l

Appendix 2. Word-Search Puzzle version 2

a	x	t	e	g	e	f	i	b	a	e	v	e	r	h	a	a	l	e	m	a
l	a	i	d	e	c	i	s	i	o	n	u	b	s	c	h	o	o	l	l	o
r	b	l	o	e	m	c	o	v	a	d	e	s	o	e	a	r	t	h	e	v
p	s	y	r	o	h	f	r	u	i	t	v	r	e	t	s	i	n	h	i	e
a	l	a	r	m	g	a	m	r	o	m	i	c	h	i	l	d	p	v	r	o
w	a	g	y	c	e	n	d	o	n	t	w	i	k	k	e	l	i	n	g	e
a	s	t	a	d	n	i	t	o	c	e	s	u	o	p	e	n	i	n	g	t
k	a	a	r	b	o	r	u	f	u	r	e	v	o	i	c	e	t	e	r	k
a	p	r	o	d	u	c	t	t	d	e	s	o	r	m	v	r	o	u	w	p
b	e	e	l	o	d	i	s	t	a	n	c	e	m	a	g	n	i	n	g	o
i	s	p	a	n	n	i	n	g	e	r	z	a	v	e	r	t	o	o	f	s
t	r	e	g	o	w	n	e	r	i	g	s	o	n	o	m	p	e	e	y	k
f	u	n	t	e	r	i	g	h	o	c	t	i	c	k	e	t	k	a	p	t

o	f	p	a	a	r	d	g	e	o	n	g	t	i	y	p	e	o	p	l	e
g	e	l	u	r	r	g	e	n	d	a	b	b	e	o	o	r	l	o	g	m
d	r	e	s	t	a	u	r	a	n	t	t	r	a	t	e	e	m	p	j	e
g	u	i	z	e	r	d	i	g	e	d	m	o	n	e	y	c	e	r	a	f
o	l	i	b	r	a	r	y	t	j	o	s	t	d	o	e	w	e	e	k	t
o	c	k	s	e	r	u	n	w	a	t	e	r	t	u	i	h	a	u	t	u
e	x	t	e	e	u	w	d	o	l	c	u	s	t	v	r	o	t	d	t	o
t	r	u	m	e	x	p	e	r	i	e	n	c	e	r	t	y	o	u	g	h
t	s	l	i	c	h	a	a	m	s	p	e	x	m	o	m	e	n	t	u	l

Appendix 3. Detection score for each word sorted by word-type

English		Dutch		Cognates	
People	0.54	Vrouw	0.52	School	0.88
Child	0.22	Lichaam	0.78	Product	0.76
Money	0.62	Verhaal	0.74	Week	0.52
Owner	0.28	Stad	0.36	Water	0.74
Distance	0.38	Oorlog	0.10	Restaurant	0.38
Earth	0.04	Paard	0.70	Opening	0.58
Library	0.30	Bloem	0.42	Ticket	0.26
Experience	0.64	Spanning	0.72	Alarm	0.34
Voice	0.62	Ontwikkeling	0.74	Fruit	0.32
Decision	0.20	Eeuw	0.30	Moment	0.68