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Priming Dutch-English interlingual homographs

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Abstract

The present study investigated the processing of Dutch-English interlingual homographs in bilingual participants through a primed lexical decision task. While cognates are generally responded to faster than control words, interlingual homographs often show an inhibition effect. The degree of inhibition is influenced by the specific task demands. In the current study, interlingual homographs were primed with a word semantically related to either the English reading or the Dutch reading, or with a semantically unrelated prime. Matched English control words were also primed with a semantically related or semantically unrelated prime. The results of this experiment indicate that interlingual homographs were responded to significantly slower than matched control words. Reaction times were also slower for semantically unrelated pairs than for related pairs. There were no significant differences in reaction times found between interlingual homographs that were primed with a word related to the English reading and interlingual homographs that were primed with a word related to the Dutch reading.

The results are in line with the BIA+ model by Dijkstra & Van Heuven (2002) which predicts that a bilingual activates both languages simultaneously when performing a lexical decision task. In this case, the two different readings of an interlingual homograph will become active, causing participants to respond slower to interlingual homographs than to matched English control words.

Keywords: interlingual homographs, Dutch-English bilinguals, priming, lexical decision task, semantic relatedness

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Introduction

Dutch and English are two languages that are similar in many ways. They both use the Latin script and have similar orthographic rules. This results in the existence of many Dutch-English cognates (words that are orthographically the same or similar across two or more languages and have the same meaning) and interlingual homographs (words that are orthographically the same but are semantically unrelated), such as the word 'angel' which means 'sting' in Dutch. Cognates generally show a facilitation effect in lexical processing, meaning that they are processed faster than control words. Interlingual homographs (IHs) can show a facilitation effect, inhibition effect or no significant effect compared to control words, meaning that they can be processed faster than, slower than, or at a similar rate as control words depending on the context of the task. In this thesis I focus on the processing of Dutch-English IHs in native Dutch speakers who speak English as a second language. Models that predict how words are processed in bilinguals are discussed later in this thesis, along with studies that show evidence for the language selective access view or the language nonselective access view. A primed lexical decision task including IHs, matched control words and pseudowords was carried out to give more insight on bilingual lexical processing.

Literature review

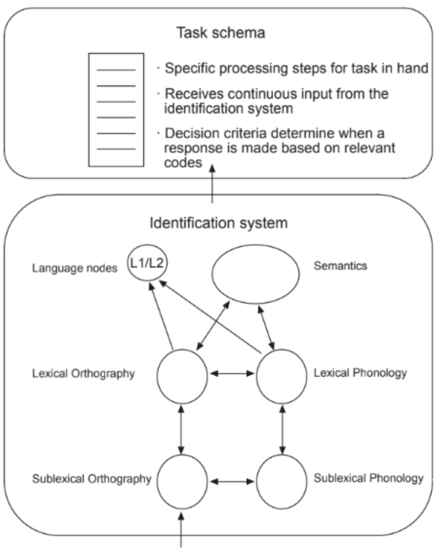
Models of bilingual lexical access

In the field of bilingualism, there has been a debate about whether lexical access in bilinguals is selective or nonselective. According to the language selective view, bilinguals activate one language at a time while according to the language nonselective view, bilinguals activate both languages simultaneously. There are studies that provide evidence for selective access, but the majority of experimental studies suggest that lexical access in nonselective. Based on the results of numerous studies, Dijkstra & Van Heuven (1998) (as cited in Dijkstra & Van

Heuven, 2002) created the Bilingual Interactive Activation (BIA) model, which predicts the activation of words based on orthographic representations. When reading a word, its neighbours will also get activated according to the BIA model. Neighbour words are words that are orthographically similar but differ in one letter. For example, when reading the word 'HOOD' in English, the English words 'FOOD' and 'HOLD' will get activated, as well as the Dutch words 'LOOD' and 'HOND' (Dijkstra et al., 2019). This BIA model does have some limitations, as Dijkstra & van Heuven (2002) explain. The model only considers orthographic representations of words, it does not consider phonological and semantic representations. In the later BIA+ model (see figure 1), Dijkstra & Van Heuven (2002) do consider phonological and semantic representations of words, and include an emphasis on the importance of non-linguistic context. Dijkstra & Van Heuven (2002) suggest that non-linguistic context, such as the instructions or task demands, can influence lexical processing significantly. The nature of a task can change the decision criteria of a participant, but cannot influence the activation of words in a bilingual itself. For example, whether a participant is asked to respond to just English words or asked to respond to both English and Dutch words affects the processing of IHs.

Figure 1

The BIA+ Model for Bilingual Word Recognition



Another model that builds on the BIA+ model is the Multilink model by Dijkstra et al. (2019). The Multilink model aims to extend the BIA+ model and predicts that orthographic representations which get activated based on the input in turn activate representations that are semantically related to the activated representations. For example, the word 'HOOD' activates its neighbour 'FOOD', which in turn activates the word 'HUNGRY'. Similarly, the word 'HOOD' will also activate the Dutch word 'VOEDSEL' (meaning 'food' in Dutch) according to the model. All in all, the Multilink model predicts that an input word activates similar orthographic representations, which then activates semantically or phonologically similar words. The BIA+ model and Multilink model both make predictions about bilingual lexical access, and subscribe to the language nonselective access view. The models are based on Dutch-English bilingualism.

Evidence from lexical decision tasks

Many studies on IH processing include lexical decision tasks. In these tasks, a participant is presented with a word, and asked to make a decision about whether the presented word is a real word or not by pressing a certain button or key. The stimuli often include IHs, matched control words and pseudowords. A pseudoword is a word that is not a real word in a certain language but does adhere to the language's orthographic rules, so it that could be a word. The reaction times (RTs) to the different words can then be analysed, which will provide information about how quickly words from different condition are processed. A few examples are the studies by Von Studniz & Green (2002), Dijkstra et al. (1998), De Groot et al. (2000), and Vanlangendonck et al. (2020). These studies researched IH processing in German-English bilinguals (Von Studniz & Green, 2002) and Dutch-English bilinguals (Dijkstra et al., 1998, De Groot et al. 2000, Vanlangendonck et al., 2020). In these four studies including language-specific lexical decision tasks, a group of participants was first presented with a 'pure' task including IHs, pseudowords and English control words. The control words were pure English words, so they were not orthographically the same as a German word (Von Studniz & Green, 2002) or a Dutch word (Dijkstra et al., 1998, De Groot et al., 2000, Vanlangendonck et al., 2020). The task of the participants was to decide whether a letter string on the screen was a real English word. The experimenters then carried out a follow-up task, a 'mixed' task which included, in addition to the previously mentioned conditions, pure control words in German or Dutch. Pure German or Dutch words required a 'no' response here. Dijkstra et al. (1998), De Groot et al. (2002) and Vanlangendonck et al. (2020) found no significant differences between IHs and English controls in the pure task but an inhibition effect for IHs in the mixed task, meaning that responses to IHs were significantly slower than responses to English control words. Dijkstra et al. (1998) also included a lexical decision task that was not language-specific, meaning that participants responded to both English words and Dutch words. In this case, IHs showed a facilitation effect meaning that they were responded to faster than English control words. Von Studniz & Green (2002) found an inhibition effect for IHs in the pure task, and an even greater inhibition effect in the mixed task. The results of these experiments show that the condition of the task influences the degree of facilitation or inhibition for IHs. They also all provide evidence for the language nonselective access view, because both of the participant's languages are active in the brain while performing the tasks.

A slightly different study by Haigh & Jared (2007) shows more support for the language nonselective access view in French-English bilinguals. The participants performed an English lexical decision task that included English words, French-English interlingual homophones (e.g. SUE sounds similar to the word 'sous' in French, SANK sounds similar to the word 'cinq' in French), and nonsense words. The results of the first experiment suggest that bilinguals responded significantly faster to interlingual homophones than to control words. In the second experiment, the nonsense words were replaced with pseudohomophones which were pseudowords that sound like real English words when they are pronounced (e.g.

BRANE sounds like the real English word ‘brain’, FLOAR sounds like the real English word ‘floor’). This made sure that participants’ lexical decisions could not be based on phonology anymore. As a result, the facilitation effect of the interlingual homophones in the first experiment turned into an inhibition effect. This study too provides support for the language nonselective view, as both languages are activated simultaneously in the bilingual’s brain.

Most of the results of studies on this topic, such as the ones discussed previously, suggest support for the language nonselective access. There are however studies that contradict this view and suggest support for a language selective view, such as the study by Rodríguez-Fornells et al. (2002). The study looked at event-related brain potentials (ERPs) in Catalan-Spanish bilinguals while doing a language specific lexical decision task with a mixed stimuli list. Participants were asked to respond to a Spanish word by pressing a button, and to not respond to either a Catalan word or a pseudoword. ERP effects were nearly identical for Catalan and pseudowords and there were no significant differences in RTs. This suggests that participants were able to block the language they were not supposed to respond to very well, and responded to words in the nontarget language and pseudowords similarly. A control experiment was then conducted in which participants were asked to respond to Catalan words, and to not respond to a Spanish word or a pseudoword. The results of this experiment were similar, as there were no significant differences in responses to Spanish words and pseudowords. The results of this study contradict the predictions of the BIA+ model and the language non-selective access view because participants blocked words in the nontarget language and only activated words in the target language.

Different task types and nonselective access

There are a number of other tasks that are performed in order to explore language selective or nonselective access. Next to the lexical decision task, De Groot et al. (2000) also performed a translation task, in which a pair of words was shown and participants were asked to judge whether or not the two words were a translation of one another. Half of the pairs required a 'no' response and half of the pairs required a 'yes' response, which were the translation pairs. Half of the translation pairs included a Dutch-English IH and its English translation of the Dutch reading, e.g. GLAD – SLIPPERY ('glad' is the Dutch translation of the word 'slippery') or Dutch translation of the English reading, e.g. GLAD – BLIJ ('blij' is the Dutch translation of the word 'glad'). The other translation pairs consisted of control words. In the pairs requiring a 'no' response, half of the pairs were IHs again and the other half were control words. These words were not translations of each other and did not have any similarity either. The results of this experiment show an inhibition effect for IHs. Pairs with an IH were responded to more slowly than control pairs indicating that the non-target reading of the IH is also activated. The degree of inhibition was influenced by the frequency of the readings of the IHs. Inhibition was stronger when the non-target reading of the IH was more frequent than the target reading of the IH. The degree of inhibition was also influenced by the position of the IH. For half of the participants, the IH was the first word of the pair (GLAD – SLIPPERY) and for the other half the IH was the second half of the pair (SLIPPERY – GLAD). The inhibition effect of IHs was stronger when the IH was presented second. When the word 'slippery' is presented first, the word 'glad' is already activated but when the word 'glad' is presented first, both possible translations of the word will be activated.

A similar experiment was conducted by Hoshino & Thierry (2012) in which Spanish-English bilinguals and English monolinguals were presented with a pair of words. Instead of translation pairs, the pairs in this experiment were semantically related. There were three conditions: a pair of words that is related when considering the English reading (APPLE – PIE), a pair of words that is related when considering the Spanish reading (TOE – PIE) – 'pie' means 'foot' in Spanish – or an unrelated pair of words (FLOOR – PIE or BED – PIE). While the monolingual participants exhibited semantic priming effects only for primes related to the English reading, bilingual participants exhibited semantic priming effect for primes related to both the English reading and the Spanish reading, meaning that pairs including an IH and a related word were responded to faster than pairs including an IH and an unrelated word.

The role of frequency and phonology in lexical decision tasks

There are a multitude of factors that can influence RTs to IHs in lexical decision tasks. Dijkstra et al. (1999) explored the role of phonology in the processing of IH. Participants of the first experiment were presented with target words which consisted of IHs, cognates and control words and asked to respond as soon as they saw an English word. The IHs and cognates used in this experiment had varying degrees of orthographic (O), semantic (S), and phonological (P) overlap between the Dutch and the English reading. The six conditions were: SOP (e.g. hotel), SO (e.g. fruit), SP (e.g. clock/klok), OP (e.g. pet), and O (e.g. stage). The results of this experiment suggest a facilitation effect for semantic and orthographic overlap but an inhibition effect for phonological overlap. In the second experiment, pseudowords were added to the stimulus list. The results of this experiment are similar, showing faster RTs for target items with semantic and orthographic overlap but slower RTs for target items with phonological overlap.

Another study by Dijkstra et al. (2000) emphasises the significance of word frequency in lexical decision tasks. In this experiment, the stimulus list consisted of IHs, English control words and Dutch control words. There were three groups of IHs: words with a high frequency English meaning and a low frequency Dutch meaning (HFE-LFD), words with a low frequency English meaning and a high frequency Dutch meaning (LFE-HFD), and words with a low frequency English and a low frequency Dutch meaning (LFE-LDS). The study included three similar tasks. In the first one, the task was to press one button if the target word was an English word and another one if the target word was a Dutch word. Participants were informed of the presence of IHs and instructed to choose the language that came to mind first. In this experiment, participants generally reacted to the reading of the IH with the highest frequency. The second task was to press a button in response to an English word and do nothing in response to a Dutch word and the third task was to press a button in response to a Dutch words and do nothing in response to an English word. In all three experiments, participants reacted more slowly and made more errors in response to IHs than in response to control words.

Interlingual homographs in sentence contexts

Many studies on IH processing focus on IHs presented in isolation. There are however numerous studies where IHs are presented in a sentence context. Those studies give more insight into how IHs are processed in a context that biases the target reading, biases the nontarget reading or is semantically unbiased. Titone et al. (2011) studied the processing of French-English IHs and cognates in bilinguals. The participants were native English speakers and with French as their second language. The study builds on Libben & Titone (2009), which tested native French speakers with English as their second language. The earlier 2009 study tested IH reading in the participants' second language and the later 2011 study tested IH reading in the participants' first language. The two studies were eye-tracking experiments with similar methodologies. In both experiments, participants were presented with English sentences that included a French-English cognate, IH or matched control word. These words were presented in a sentence that either semantically biased the target word ('*Since they really liked to gossip, they had an extended* ***chat*** *that lasted all night*') or was semantically unbiased ('*Since they liked each other, they had an extended* ***chat*** *that lasted all night*'). 'Chat' means 'cat' in French, so this is an example of an IH in the two different contexts. The results of both studies show that reading times were longer for sentences with IHs than for sentences with matched control words. Fixations were also shorter for semantically biased sentenced compared to unbiased sentences. This suggests that after reading the word ‘gossip’, it was easier for the participants to activate the English meaning of ‘chat’ that is semantically related to the word ‘gossip’ than to activate the French meaning of the word ‘chat’. The results of these experiments support the language nonselective access view. Libben & Titone (2009) suggests that a participant’s L1 influences reading in their L2, and Titone et al. (2011) suggests that a participant’s L2 influences reading in their L1.

Most studies on lexical processing explore two languages using Latin script. Jouravlev & Jared (2014) studied the processing of IHs in Russian-English bilinguals and therefore study bilingual lexical processing in two languages that use different scripts. Regardless, there are a few letters that are used in both English and Russian, such as M, K, O, P, and T. Participants were presented with a sentence in English including an IH, where the Russian reading of the word is expected in the sentence context. For example, ‘*THEY WENT TO THE MEDITERRANEAN* ***MOPE*** *FOR FISHING’*, where ‘MOPE’ means ‘sea’ in Russian. For every IH, two English words were selected, a match and a mismatch. In the ‘match’ condition, the English translation of the Russian word was used in a sentence like ‘*THE DIVERS EXPLORED THE WILDLIFE IN THE DEEP* **SEA** *FOR SCIENTIFIC PURPOSES*’. In the ‘mismatch’ condition, an unrelated English word was used in a sentence like ‘*MANY FISH LIVING IN THE OPEN* ***MACE*** *ARE ENDANGERED*’. The ERP results show no significant difference in participants between the IH and the match word, but a significant difference between the IH and the mismatch word. These results suggest that the bilinguals were able to activate the Russian meaning of the IH despite the English sentence context, and therefore support the language nonselective view.

In an eye-tracking experiment by Hoversten & Traxler (2016) Spanish-English bilingual participants and English monolinguals read a sentence including a Spanish-English IH. In half of the sentences, the English meaning of the IH was the appropriate one, as in

'*While eating dessert, the diner crushed his* ***pie*** *accidentally with his elbow*'. In the other half, the Spanish meaning was the appropriate one, as in '*While carrying bricks, the mason crushed his* ***pie*** *accidentally with the load*'. 'Pie' means 'foot' in Spanish, which makes the former sentence a congruent sentence and the latter an incongruent one. The results of this eye-tracking experiment show that there were no significant differences of gaze duration on the IH, but bilingual participants did spend more time in the post-target region – the two words after the IH – in incongruent sentences than in congruent sentences. However, it was easier for bilingual participants to adapt to the incongruent sentences compared to the monolingual participants as the latter group did not know the Spanish meaning of the IHs. This suggests that initially the sentence context of the incongruent sentences did not lead to early activation of the Spanish meaning of the homographs in the bilingual participants but participants were able to adapt later on in the experiment. This finding supports the Zooming-in hypothesis by Elston-Güttler et al. (2005) which predicts that participants adapt to a certain language as a result of the language context. In this case, participants were presented with a sentence in English where one would expect an English word so it took more time for them to process the Spanish meaning of that word. The bilingual participants did adapt to the conditions of the experiment and the gaze duration in the post-target region decreased later on in the experiment. The fact that the bilingual participants did manage to adapt to the incongruent sentences supports the language non-selective hypothesis.

Priming interlingual homographs

Many studies have found that when a target word is preceded by a semantically related word, the target word is responded to faster than when a target word is preceded by an unrelated word (e.g. Meyer & Schvanevelt, 1971). For example, the word 'butter' is responded to faster when it is preceded with the word 'butter' than when it is primed with the word 'nurse'. This priming effect has also been studied in experiments with IHs. In a primed lexical decision task, a prime word is presented briefly before the target word appears. Elson-Güttler et al. (2005), for example, studied IH priming in German-English bilinguals. The study builds on an earlier study by Elston-Güttler & Kotz (2005), which found that the word 'poison' is primed by the word 'gift' which means 'poison' in German (Elston-Güttler & Kotz, 2005, as cited in Elston-Güttler et al., 2005). Elston-Güttler et al. (2005) aims to explore whether this priming effect is also present when the prime is a sentence that ends in an IH. The participants were split into two groups. One of the groups viewed a film narrated in German before the lexical decision task, and the other group viewed the same film narrated in English. Participants were then presented with a sentence that either ended in an IH like '*The woman gave her friend a pretty* GIFT' or ended in a control prime word. Then the target word, in this case 'POISON' was presented. A priming effect of IHs was only found in the group that watched the German film, and only in the first half of the experiment. These results suggest that exposure to a language might influence lexical processing, but this result may wear off after a certain amount of time when a participant is exposed to the other language. Elston-Güttler et al. (2005) attempt to explain this with the Zooming-in hypothesis. They suggest that since the participant is getting used to doing the experiment in English, they can successfully focus on that language without the inhibition from having the German language activated. The results of the first half of the experiment support the BIA+ model.

There are also a number of priming experiments with single words as primes performed by Dutch-English bilinguals (De Bruijn et al., 2001, Kerkhofs et al., 2006). In the experiment by De Bruijn et al. (2001), Dutch-English bilinguals participated in a lexical decision task. In this task, two items were presented simultaneously, followed by a third item. First, a language prime and an IH appeared on the screen, for example HOUSE – ANGEL in the English language prime condition or ZAAK – ANGEL in the Dutch language prime condition. Then, a semantically related word or semantically unrelated word appeared in the screen next to the two words, for example ZAAK – ANGEL – HEAVEN in the related condition or ZAAK – ANGEL – BUSH in the unrelated condition. Filler triplets containing Dutch and English words in any position were added to the stimuli list along with triplets containing one or two pseudowords. Participants were asked to press a button if the presented letter strings were words in English or Dutch, and do nothing if they were not. The results show that participants' RTs were faster to triplets that included a semantically related pair than to semantically unrelated triplets. There was no significant effect of language prime in this task. Kerkhofs et al. (2006) also studied semantic priming of IHs in Dutch-English bilinguals. In this lexical decision task, IHs were presented twice, once with a semantically related prime (HEAVEN – ANGEL) and once with an unrelated prime (LAUNCH – ANGEL). The task was to press a button when presented with an English target word and do nothing when presented with a pseudoword. Again, the results of this study show faster RTs to IHs with a related prime. The frequency of the Dutch meaning of the IH compared to the English meaning influenced the RTs as well.

The present study

The present study aims build on previous studies in the area of bilingual lexical processing. More specifically, the processing of IHs with different prime words. Previous research has shown that IHs can show a facilitation effect, an inhibition effect or no significant effect depending on several factors like language context and primes. In general, a facilitation effect is shown when an IH is primed by a semantically related prime (De Bruijn et al., 2001, Kerkhofs et al., 2006). Like the BIA+ model and Multilink model predict, language access is nonselective so words that are semantically or orthographically related are activated when presented with a target word, regardless of which language the word belongs to. So, while various studies have shown faster RTs when an IH is primed with a word semantically related to the English reading of the word, no experiments – to my knowledge – have primed an IH with a prime related to the non-target reading of the IH. The present study aims to explore how second language speakers of English process IHs when they are primed with a word related to the Dutch reading of the IH. The study will explore whether a prime related to the Dutch reading will activate the Dutch reading of the word over the English reading, causing inhibition when deciding whether the word is a real English word. The results of this experiment will shed some light on second language processing and lexical activation in bilinguals.

In the present study, participants perform a lexical decision task. The target words are either pure English words, IHs or pseudowords. The critical targets – the IHs – are be primed with an English word that is either semantically related to the English reading of the word (e.g. heaven – ANGEL), a word that is semantically related to the Dutch reading of the word (e.g. bee – ANGEL) or semantically unrelated to the target word (e.g. human – DROP). Participants will perform a language-specific lexical decision task in which they are asked to decide whether the target word presented is an English word or not. Participants are asked to press one button when the target word is a real English word, and press another when the target word is not a real English word. Since the words 'angel' and 'heaven' are semantically related, a facilitation effect is expected in this condition compared to the unrelated condition. In the condition that includes primes related to the nontarget reading, the prime 'bee' may activate the Dutch meaning of the word 'angel' which might slow down the participants' processing of these IHs causing an inhibition effect. In this condition, it might take longer for the participants to decide that the word 'angel' is an English word as well. The results of this study will broaden our understanding of lexical processing in bilinguals and might show evidence for the language selective or language nonselective view. Therefore the research questions of this proposal are:

1. *To what extent is there an inhibition effect for interlingual homographs compared to matched control words in a language-specific lexical decision task?*
2. *To what extent is there a priming effect for interlingual homographs when they are primed with a word related to the English reading and with a prime related to the Dutch reading?*

Regarding word types, the following hypotheses have been formulated:

H_0: *There will be no significant differences between RTs to IHs compared to matched control words.*

H_1: *There will be an inhibition effect for IHs compared to matched control words.*

Regarding priming, the following hypotheses have been formulated:

H_0: *There will be no significant priming effects for IHs.*

H_1: *There will be a facilitation effect of primes related to the English reading.*

H_2: *There will be an inhibition effect of primes related to the Dutch meaning.*

I expect to find an inhibition effect for IHs compared to control words, based on results by Von Studniz & Green, 2002, De Groot et al., 2000, Dijkstra et al., 1998, Vanlangendonck et al., 2020. For control words, I expect to find shorter RTs when they are primed with a semantically related prime compared to when they are primed with an unrelated prime. I also expect shorter RTs for IHs that are primed with a prime related to the English meaning compared to IHs primed with an unrelated prime. Previous research has suggested that target words are processed quicker when they are primed with a semantically related word (Meyer & Schvaneveldt, 1971, De Bruijn et al., 2001, Kerkhofs et al., 2006). Although there are no studies yet on priming IHs with words semantically related to the nontarget reading, I expect to find an inhibition effect for IHs primed with a prime related to the Dutch meaning compared to IHs primed with a prime related to the English meaning. Several studies (Von

Studniz & Green, 2002, De Groot et al., 2000, Dijkstra et al., 1998, Vanlangendonck et al., 2020) have found that IHs show a greater inhibition effect when pure control words in the nontarget language are added to the stimulus list. This suggests that when there is context related to the participants' native language, and not just English language context, the participant's native language is more likely to be activated, resulting in an increased inhibition effect. To add to that, experiments that studied IHs in a sentence context have found that it is more difficult for bilinguals to process IHs when the context is biased towards the nontarget reading of the IH compared to when the context biases the target reading of the IH (Hoversten & Traxler, 2016). Titone et al. (2011) suggest that it is easier to process IHs when the sentence context biases the target reading of the IH compared to when the sentence context is unbiased.

Method

Participants

Twelve students from the Radboud University Nijmegen took part in the experiment (1 male, 11 female). Participants were between 20 and 24 years old (mean: 21.6). All participants had Dutch as their native language had at least 9 years of experience with learning English (mean: 14.3 years). Participants were asked to self-rate their English proficiency on a scale of 1 to 10, 1 being very low and 10 being very high. Answers ranged from 7 to 10 (mean: 8.3). 10 participants studied or had studied English Language and Culture, 2 participants did not.

Materials

The lexical decision task was built in ROLEG (roleg.nl, n.d.), a platform/software by the Radboud University created for linguistic experiments. Templates provided by the ROLEG support team were used to create the lexical decision task. The lexical decision task contained 240 word pairs in total. Each pair consisted of a prime followed by a target word, which required a response. The targets consisted of 120 pseudowords, 60 IHs, and 60 pure English control words (see appendix). 30 of the control words were primed with a semantically related prime, and 30 control words were primed with a semantically unrelated prime. 15 IHs were primed with a word semantically related to the English meaning of the IHs, 15 IHs were primed with a word semantically related to the Dutch meaning of the IH, and 30 IHs were primed with a semantically unrelated prime (see table 1). All words used were either nouns, verbs or adjectives. Pseudowords were created using UniPseudo (Lexique.org, n.d.).

Table 1

Overview of Experimental Conditions

Prime word	**Target word**	**Example pair**	**Number of trials**
Semantically related to the English reading	Interlingual homograph	clean – MOP	15
Semantically related to the Dutch reading	Interlingual homograph	pie – ROOM (room means 'cream' in Dutch)	15
Semantically unrelated	Interlingual homograph	eat – BRIEF	30
Semantically related	English control word	skull – BONE	30
Semantically unrelated	English control word	meat – TWIST	30
Random word	Pseudoword	laugh – FREP	120

Length

All words and pseudowords consisted of 3-6 letters. Table 2 shows the mean lengths of the targets and primes for all conditions.

Table 2

Mean Length and Standard Deviation of Targets and Primes for all Conditions

Condition	**Length target**	**Length prime**	
IH + related	3.833 (0.747)	English-related prime: 4.767 (0.8858)	Dutch-related prime: 4.433 (0.935
IH + unrelated	4.000 (0.743)	4.433 (0.774)	
Control + related	4.433 (0.971	4.267 (0.828)	
Control + unrelated	4.733 (0.944)	4.533 (0.900)	
Pseudowords	4.517 (1.021	5.075 (0.811)	

The difference between length of the prime related to the English meaning and the prime related to the Dutch meaning is not significant ($t(29)= 1.23$, $p=.231$) to minimize the possibility of a difference in length of the primes influencing the RTs to the pairs in the IH + related condition.

Frequency

All words had a logarithmic frequency of >1.5 in both Dutch and English in to ensure that all words used were frequent words and to maximize the chances that participants know the meaning of all English words. A study by Dijkstra et al. (2000) suggests that a difference in frequency between the English reading and Dutch reading of an IH can influence RTs, so in order to minimize the influence from frequency on RTs, the logarithmic frequency of the English and Dutch reading of the IHs were matched along with the logarithmic frequency of their primes (see table 3). The logarithmic frequency of the primes in the IH + related condition were also matched. The SUBTLEX-NL (crr.ugent.be, n.d.) and SUBTLEX-US (ugent.be, n.d.) databases were used to judge the frequency of the words.

Table 3

Mean Logarithmic Frequency and Standard Deviation for the Primes and Targets in the IH + Related Condition

Word	**Logarithmic frequency**
English related prime	3.655 (0.647)
Dutch related prime	3.349 (0.589)
English reading IH	3.141 (0.839)
Dutch reading IH	2.947 (0.090)

The difference in frequency between the English reading of the IH and the Dutch reading of the IH is not significant ($t(59)= 1.34$, $p=.184$). The difference in frequency between the primes related to the English meaning and the primes related to the Dutch meaning of the IH is not significant either ($t(29)= 2.02$, $p=.053$).

Semantic relatedness

To judge semantic relatedness between primes and targets, the tool SNAUT (crr.ugent.be, n.d.) was used. Similarity ratings are based on how often words co-occur in a large corpora of text. Using SNAUT, the cosine distance between each word pair was calculated. A number near 0 means that a pair is closely related in meaning, and a number near 1 means that a number is not related. The related pairs all had a cosine distance of <0.8 and the unrelated primes all had a cosine distance of >0.8 (see table 4).

Table 4

Mean Semantic Distance and Standard Deviation for all Conditions

Condition	**Semantic distance**
IH + related prime	0.594 (0.077)
IH + English prime	0.551 (0.102)
IH + Dutch prime	0.636 (0.096)
IH + unrelated prime	0.889 (0.057)
Control + related prime	0.563 (0.106)
Control + unrelated prime	0.885 (0.058)

There is a significant difference in semantic distance between the IH + related and IH + unrelated condition ($t(58)= 16.86$, $p<.001$). The difference in semantic distance between the control + related and the control + unrelated condition is also significant ($t(58)= 14.61$, $p<.001$). The semantic distance between the conditions IH + English prime and IH + Dutch prime is significant ($t(29)= -3.71$, $p<.001$). Ideally, the difference in semantic distance between these conditions would be not significant. In order to calculate the semantic distance for the IH + Dutch prime condition, I had to translate the English prime into Dutch because it was not possible to rate semantic distance between two languages. So, to calculate the distance between *pink* (the Dutch word for 'little finger') *nail*, I calculated the distance between *pink* and *nagel* in Dutch. As a result, similarity ratings in the IH + Dutch prime might be less reliable than similarity ratings in the other conditions where two English words could be compared without having to translate a word.

Procedure

Participants performed a language-specific lexical decision task on ROLEG. They could perform the experiment in their own laptop in a preferred location. First, the participants were informed of the general aim of the experiment, and were informed that information about their gender age, native language, experience learning English, English proficiency and education would be collected. The participants consented to take part in the experiment. Then, instructions for the experiment were given. Participants were informed that they were to complete an English lexical decision task in which they were to judge whether the second word of each pair is a real English word or not. The participants were asked to press the [C] key on their keyboard if the presented letter string is a real English word, and to press the [N] key if the presented letter string is not. Primes were shown in lower case letters for 200 ms on the middle of the screen. Then, the screen was blank for 200 ms. Finally, the target word appeared in upper case letters and was presented on the screen until a response was given. Participants completed five practice trials first, after which the instructions were repeated and the 240 experimental trials started.

Four versions of the experiment were made, all including the same targets. The 30 IHs that were presented with a semantically related prime had two possible primes each: one related to the Dutch meaning and one related to the English meaning. All participants saw every IH once, but half of the participants saw a particular IH with a prime semantically related to the Dutch meaning and half of the participants saw that same IH with a prime related to the English meaning. For example, the target ANGEL was primed with the word ‘bee’ in version 1 and 3, and primed with the word ‘heaven’ in version 2 and 4. The 240 experimental trials were divided over six blocks of 40 trials. The order in which those blocks were presented was different in all four versions of the experiment in order to minimize any influence of the order or position in which the word was presented.

Design and analysis

To analyse the results, mean RTs and accuracy scores were calculated for all conditions. First, a repeated measures ANOVA was carried out to analyse the significance between RTs to IHs and control words, and to analyse the significance between RTs to semantically related pairs and semantically unrelated pairs. Then, paired samples t-tests were carried out to further analyse the differences in RTs between experimental conditions. For accuracy scores, a repeated measures ANOVA was carried out first again, followed by paired samples t-tests to analyse the difference in accuracy scores between experimental conditions.

The analysis first focuses on the effects of word type and relatedness. RTs in the conditions including an IH are compared to RTs in the conditions including a control word. RTs in the conditions including a related prime are compared to RTs in the conditions including an unrelated prime. The IH + related condition includes both primes related to the Dutch meaning and primes related to the English meaning.

Results

Reaction time analysis

Incorrect responses were excluded from the analyses as well as responses of over 2000 ms. Mean RTs were calculated for all conditions (see table 5, figure 2, figure 3).

Table 5

Mean Reaction Times and Standard Deviations for all Conditions

Condition	Mean RT	SD
IH + related prime	727.82	100.70
IH + English related prime	703.66	103.60
IH + Dutch related prime	752.52	120.39
IH + unrelated prime	768.42	111.24
Control + related prime	654.31	106.30
Control + unrelated prime	713.54	107.88
Pseudowords	772.05	113.90

Figure 2

Mean Reaction Times and Standard Deviation for All conditions

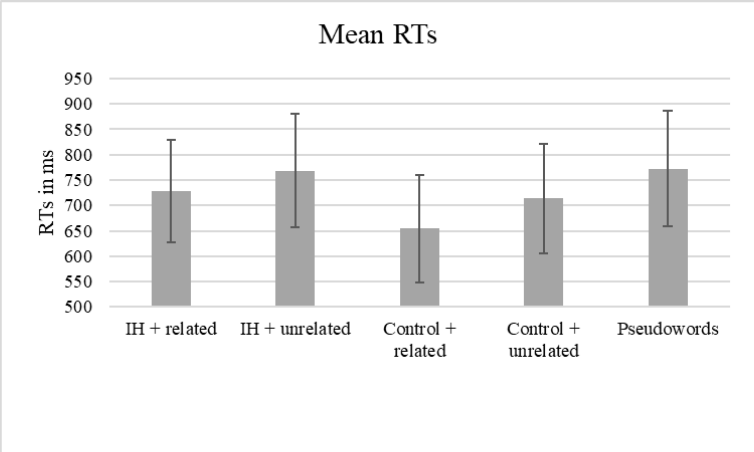
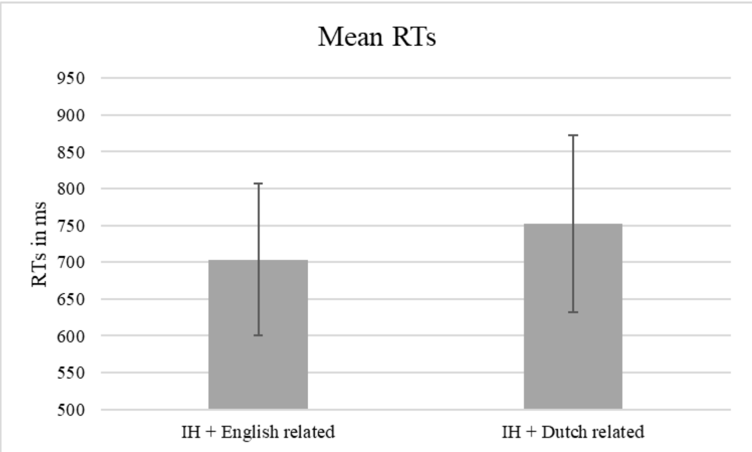


Figure 3

Mean Reaction Times and Standard Deviation for the IH + related conditions.



A main effect of word type was found (F(1,11)= 16.30, p=.002). A main effect of relatedness was also found. (F(1,11)= 12.63, p=.004). This means that control words were responded to significantly faster than IHs. Pairs in the related conditions were also responded to faster than words in the unrelated condition. The interaction effect between word type and relatedness was not significant (F(1,11)= 0.42, p=.528).

Zooming in, conditions were compared using paired samples t-tests. This showed that words in the control + related condition were responded to significantly faster than words in the IH + related condition (t(11)= 3.59, p=.004). Words in the control + unrelated condition were also responded to significantly faster than words in the IH + unrelated condition ($t(11)$= 2.47, p=.031). Also, words in the control + related condition were also responded to significantly faster than the control + unrelated condition ($t(11)$= -3.23, p=.008). There was no significant difference between RTs to the word in the IH + related and the IH + unrelated condition ($t(11)$= -1.88, p=.086) but there was a significant difference between words in the IH + English related condition compared to the IH + unrelated condition more specifically ($t(11)$= -3.53, p=.005). There was no significance in RTs between these conditions IH + English related and IH + Dutch related. ($t(11)$= -1.70, p=.116).

Error analysis

Next to the RTs, accuracy scores were also analysed for all conditions. Again, responses of over 2000 ms were excluded from analysis. Participants' responses were given either a 1 when the response was correct, or a 0 when the response was incorrect. The mean accuracy of the conditions were then calculated (see table 6, figure 4, figure 5). The closer a number is to 1, the more accurate the responses to that condition were.

Table 6

Mean Accuracy Scores and Standard Deviation for all Conditions

Condition	Mean	SD
IH + related prime	0.961	0.04
IH + English related prime	0.970	0.04
IH + Dutch related prime	0.949	0.06
IH + unrelated prime	0.946	0.04
Control + related prime	0.992	0.01
Control + unrelated prime	0.966	0.03
Pseudowords	0.953	0.02

Figure 4

Mean Accuracy scores and Standard Deviation for all Conditions

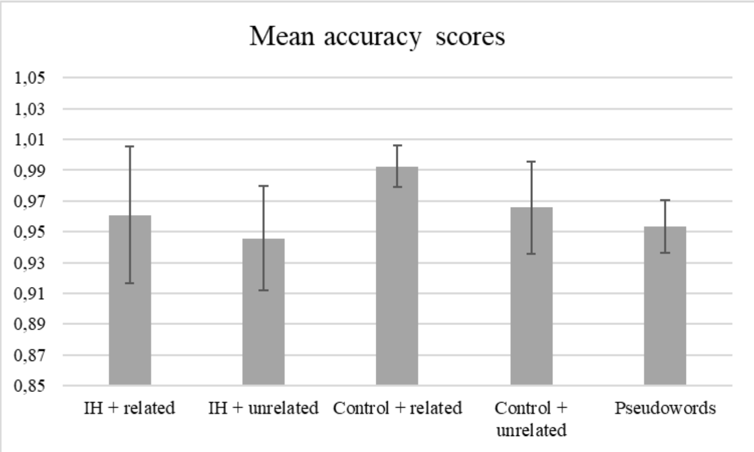
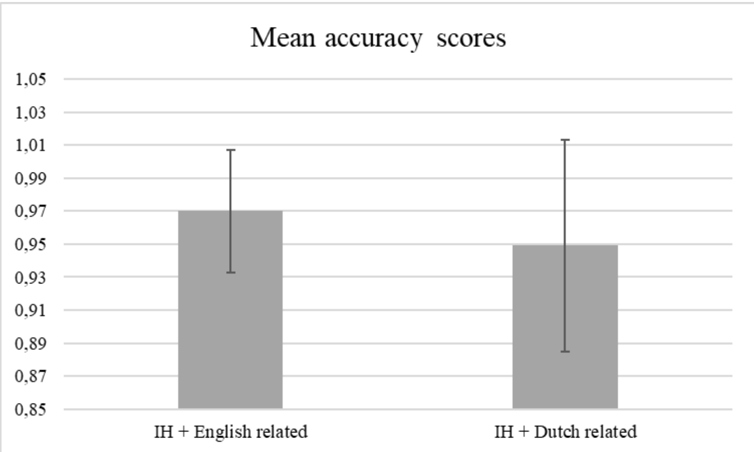


Table 5

Mean Accuracy scores and Standard Deviation for the IH + Related Conditions



A main effect of word type (*F*(1,11)= 7.67, *p*=.018) and a main effect of relatedness (*F*(1,11)= 6.75, *p*=.025) were found. Thus, there were higher error rates for IHs compared to control words, and higher error rates for unrelated conditions compared to related conditions. The interaction effect between word type and relatedness was not significant (*F*(1,11)= .41, *p*=.532).

Conditions were compared using paired samples t-tests again. Significant differences in accuracy scores were found between IH + related condition and the control + related condition (*t*(11)= -2.23, *p*=.047) and between the control + related condition and the control + unrelated condition (*t*(11)= 3.93, *p*=.002). There was no significant difference between the IH + unrelated condition and the control + unrelated condition (*t*(11)= -.71, *p*=.115) or the IH + related condition and the IH + unrelated condition (*t*(11)= .96, *p*=.360). Splitting the IH + related condition, no significant difference was found between accuracy scores of IH + English prime and IH + Dutch prime (*t*(11)= 1.38, *p*=.195).

Discussion

General discussion

In the present study, Dutch-English bilinguals performed a language-specific lexical decision task. Of the 240 pairs in total, 60 pairs contained an IH. 30 of the pairs were primed with a semantically unrelated prime. The 30 other primes containing an IH were primed with a semantically related prime, that related either to the English reading or the Dutch reading of the IH. First, I hypothesised that IHs would show an inhibition effect compared to control words. The results of the present study support this hypothesis meaning that IHs were responded to significantly slower than matched control words and more errors were made. Regarding priming, I hypothesised that targets primed with a semantically related prime would show a facilitation effect compared to target words with unrelated primes. The results show that targets in the control + related condition were responded to significantly faster than targets in the control + unrelated condition. Targets in the IH + English related condition were also responded to significantly faster than targets in the IH + unrelated condition.

Furthermore, I hypothesised that IHs that were primed with a word related to the Dutch meaning would show slower RTs than IHs that were primed with a word related to the English meaning. Targets with a prime related to the English meaning were reacted to 49 ms seconds faster on average compared to targets with a prime related to the Dutch meaning, although this difference was not significant so the results of the present study do not support this hypothesis. There was also no significant difference in accuracy scores between IHs primed with a word related to the English meaning and IHs primed with a word related to the Dutch meaning.

Relation to previous literature

The main effect of relatedness found in the present study is in line with previous literature (e.g. Meyer & Schvaneveldt, 1971) that suggests that targets are responded to faster when preceded by a semantically related prime. In the present study the difference in RTs between targets in the control + related and targets in the control + unrelated conditions was significant. The difference in accuracy scores between these two conditions was significant too. There was no significance difference in either RTs or accuracy scores between targets in the IH + related condition and the IH + unrelated condition but the difference in RTs between the IH + English related condition and the IH + unrelated was significant. This latter result is in line with previous research by De Bruijn et al. (2001) and Kerkhofs et al. (2006). These studies found a facilitation effect for IH that were primed with a semantically related word too.

Previous studies have found contradicting results regarding RTs of IHs compared to RTs of control words. Dijkstra et al. (1998), De Groot et al. (2000), and Vanlangendonck et al. (2020) showed no significant difference in RTs between IHs and control words in a pure English lexical decision task. When pure control words in Dutch (the participants' native language) were added to the stimulus list, IHs showed an inhibition effect. Since the present study found an inhibition effect for IHs compared to matched control words, the results are in line with the results from the literature. Von Studniz & Green (2002) did find an inhibition effect for IHs in a pure English lexical decision task. The inhibition effect increased when pure control words in German (the participants' native language) were added. The results of the present study are also in line with the results from this experiment. The present study was a pure English lexical decision task, as no pure Dutch control words were added. The previously mentioned studies were lexical decision tasks that did not include priming. In that aspect, the current primed lexical decision task differs from the previously mentioned studies by Dijkstra et al. (1998), De Groot et al. (2000), Vanlangendonck et al. (2020) and Von Studniz & Green (2002). Therefore, the present experiment with primes related to the Dutch meaning of half of the IHs provided some language context to the experiment that the studies without priming tasks did not have. The difference between the types of task might have influenced the difference in results between the present study and previous studies that did not find a significant difference in RTs between IHs and matched control words.

The non-significant difference in results between IHs primed by an English related or Dutch related prime can be supported by the Zooming-in hypothesis by Elston-Güttler et al. (2005) and the BIA+ model by Dijkstra & Van Heuven (2002). Elston-Güttler (2005) predict that participants of a study adapt to the language context of that study. For example in the present study, the entire experiment was conducted in English, which might mean that participants have adapted to this English-specific lexical decision task. The BIA+ model (Dijkstra & Van Heuven, 2002) also predicts that a participant's performance is affected by task demands. In the present study, participants' task was to decide whether or not a target word was a real English word. This might have made the participants able to focus more on the English language while performing the experiment.

Limitations

The present study has several limitations. The sample size for the current experiment was small, as only twelve students participated. More researched is needed with a larger sample size in order to be able to generalise the results. Furthermore, no significant difference was found between IHs that were primed with a word related to the English meaning, and IHs that were primed with a word related to the Dutch meaning. A possible explanation is that according to the tool SNAUT which was used to calculate the semantic distance between the primes and the targets, pairs in the IH + English related prime were significantly more related than pairs in the IH + Dutch related prime. For the latter condition, the Dutch related prime had to be translated into Dutch first, which might have made the calculated semantic distance for that condition less reliable. Another limitation is that phonological overlap was not taken into account while selecting the stimuli materials. Phonological overlap was discarded because this would have greatly decreased the amount of suitable IHs if word category, frequency and word length were into account. Future research should take phonological overlap into account since it is an important variable in lexical decision tasks including IHs according to Dijkstra & Van Heuven (1999).

Conclusion

Many studies on bilingual lexical processing support the nonselective language access view, meaning that bilinguals activate words from multiple languages simultaneously. The present study aims to contribute to the existing literature by investigating the processing of IHs when they are primed with a word related to the English meaning and when they are primed with a word related to the Dutch meaning. The results show no significant differences between the RTs and error accuracy between those two conditions. The present study did find that pure English control words were responded to more quickly than IHs. Besides, control words that were primed with a semantically related prime where responded to significantly more quickly than control words that were primed with a semantically unrelated prime. The significant difference in RTs and accuracy scores between IHs and control words suggests support for the language nonselective access view. The participants' L1 Dutch is activated too while reading an IH and causes inhibition. The results of the present study do not show evidence that an English prime word like 'bee' activates the Dutch reading of the word 'angel', since there were no significant differences in RTs between IHs primed with a word related to the English meaning or to the Dutch meaning although more research is needed in order to draw more generalisable conclusions.

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Appendix

Table 7

Full Stimulus List

Condition	Target	Prime version 1 + 3	Prime version 2 + 4
IH + related	angel	bee	heaven
IH + related	beer	claw	drink
IH + related	big	pork	size
IH + related	boom	forest	loud
IH + related	boot	sea	foot
IH + related	brand	smoke	logo
IH + related	glad	ice	happy
IH + related	kin	face	family
IH + related	kind	young	nice
IH + related	lid	join	jar
IH + related	long	organ	tall
IH + related	look	garlic	eye
IH + related	mop	funny	clean
IH + related	mug	bite	coffee
IH + related	pet	head	dog
IH + related	pink	color	nail
IH + related	put	place	deep
IH + related	room	space	pie
IH + related	rug	floor	body
IH + related	rust	stain	calm
IH + related	slim	thin	brain
IH + related	spin	turn	venom
IH + related	steel	metal	thief
IH + related	file	report	car
IH + related	trap	catch	climb
IH + related	vet	animal	butter
IH + related	wand	stick	paint
IH + related	want	wish	cold
IH + related	wet	water	rule
IH + related	wonder	think	magic
Condition	**Target**	**Prime**	
IH + unrelated	bad	tower	
IH + unrelated	bang	vague	
IH + unrelated	bid	boil	
IH + unrelated	blank	heavy	
IH + unrelated	breed	apple	
IH + unrelated	brief	eat	
IH + unrelated	drop	human	

IH + unrelated	stem	cozy
IH + unrelated	heel	talk
IH + unrelated	hoop	walk
IH + unrelated	last	lake
IH + unrelated	list	tea
IH + unrelated	lot	book
IH + unrelated	map	strong
IH + unrelated	mode	song
IH + unrelated	pad	red
IH + unrelated	peer	busy
IH + unrelated	pond	find
IH + unrelated	pool	make
IH + unrelated	ramp	house
IH + unrelated	slang	bike
IH + unrelated	slot	scream
IH + unrelated	spot	cheap
IH + unrelated	stage	blood
IH + unrelated	string	year
IH + unrelated	teen	chair
IH + unrelated	tree	build
IH + unrelated	vast	early
IH + unrelated	war	rich
IH + unrelated	wit	small
control + related	sour	sweet
control + related	listen	hear
control + related	bake	bread
control + related	pencil	draw
control + related	touch	feel
control + related	lion	cub
control + related	bone	skull
control + related	push	button
control + related	soil	earth
control + related	award	win
control + related	wife	marry
control + related	money	poor
control + related	grape	wine
control + related	actor	movie
control + related	top	roof
control + related	level	rank
control + related	sneeze	cough
control + related	blue	sky
control + related	hall	aisle
control + related	fix	heal
control + related	stone	rock
control + related	cow	farm
control + related	shower	rain

control + related	neck	throat
control + related	doll	toy
control + related	pot	stew
control + related	hot	sun
control + related	heart	love
control + related	bird	dove
control + related	guitar	piano
control + unrelated	ear	bath
control + unrelated	region	hair
control + unrelated	flight	tongue
control + unrelated	debt	road
control + unrelated	wood	neat
control + unrelated	disk	pretty
control + unrelated	tell	device
control + unrelated	twist	meat
control + unrelated	mind	snail
control + unrelated	pack	weak
control + unrelated	weigh	steep
control + unrelated	try	mud
control + unrelated	sound	finish
control + unrelated	sense	thumb
control + unrelated	round	queen
control + unrelated	square	news
control + unrelated	lame	topic
control + unrelated	hunger	idea
control + unrelated	afraid	method
control + unrelated	itch	search
control + unrelated	stove	rely
control + unrelated	area	true
control + unrelated	fancy	soup
control + unrelated	town	cheek
control + unrelated	sister	far
control + unrelated	church	mood
control + unrelated	energy	tale
control + unrelated	desk	army
control + unrelated	loss	same
control + unrelated	scene	tidy
pseudoword	alart	music
pseudoword	apa	angle
pseudoword	ase	own
pseudoword	bap	ready
pseudoword	barden	argue
pseudoword	beel	fact
pseudoword	blout	gold
pseudoword	boet	cabin
pseudoword	braw	whole

pseudoword	brelt	drive
pseudoword	brise	power
pseudoword	brite	green
pseudoword	broot	paper
pseudoword	buttel	candy
pseudoword	chined	board
pseudoword	corse	chest
pseudoword	cuffin	first
pseudoword	denion	able
pseudoword	dil	light
pseudoword	drint	sharp
pseudoword	drundy	table
pseudoword	dux	equal
pseudoword	frep	laugh
pseudoword	frolt	radio
pseudoword	gorve	store
pseudoword	gote	brown
pseudoword	grage	sugar
pseudoword	greel	story
pseudoword	grise	watch
pseudoword	gube	juice
pseudoword	hame	frame
pseudoword	harrel	guide
pseudoword	hed	train
pseudoword	heeks	new
pseudoword	hent	good
pseudoword	herge	plate
pseudoword	himp	dance
pseudoword	hished	dress
pseudoword	honder	knife
pseudoword	ilud	card
pseudoword	jook	mouth
pseudoword	jund	voice
pseudoword	kest	learn
pseudoword	kews	bell
pseudoword	knops	fair
pseudoword	lan	bead
pseudoword	leet	order
pseudoword	lenk	lean
pseudoword	lign	chat
pseudoword	lin	city
pseudoword	lod	crawl
pseudoword	lond	taste
pseudoword	lucket	edge
pseudoword	makel	mute
pseudoword	manter	quiet

pseudoword	marn	egg
pseudoword	midder	river
pseudoword	mig	duck
pseudoword	mon	smile
pseudoword	moups	cover
pseudoword	mut	dish
pseudoword	mester	dirt
pseudoword	natton	fold
pseudoword	noe	flow
pseudoword	norin	eight
pseudoword	olk	save
pseudoword	optive	cheese
pseudoword	pag	hotel
pseudoword	pam	crowd
pseudoword	pedden	trust
pseudoword	pell	rhythm
pseudoword	pocker	sudden
pseudoword	podley	country
pseudoword	porge	bottle
pseudoword	porst	dinner
pseudoword	potton	empty
pseudoword	prain	travel
pseudoword	rade	every
pseudoword	ralt	danger
pseudoword	rast	person
pseudoword	reng	begin
pseudoword	ret	circle
pseudoword	rint	fate
pseudoword	roled	orange
pseudoword	rone	fine
pseudoword	rost	reason
pseudoword	samp	people
pseudoword	sindy	flower
pseudoword	sog	street
pseudoword	sorbs	dream
pseudoword	spag	design
pseudoword	sping	pizza
pseudoword	spise	effort
pseudoword	stass	yellow
pseudoword	stasty	season
pseudoword	steef	cherry
pseudoword	strant	east
pseudoword	strel	future
pseudoword	struse	basic
pseudoword	tader	lesson
pseudoword	taven	vision

pseudoword	tenk	author
pseudoword	thrise	forget
pseudoword	thub	carpet
pseudoword	tir	girl
pseudoword	topsy	secret
pseudoword	tost	branch
pseudoword	tox	sailor
pseudoword	trang	gentle
pseudoword	trank	gain
pseudoword	treen	winner
pseudoword	vinus	master
pseudoword	wakel	strike
pseudoword	wamp	senior
pseudoword	wab	full
pseudoword	wasts	turtle
pseudoword	wem	zipper
pseudoword	wif	farmer
pseudoword	wog	middle
pseudoword	wouse	haunt