Testing the Revised Hierarchical Model: Do Dutch-English bilinguals show Word Association or Concept Mediation for L2 Verbs?

Name: Jonne Roelofs

Supervisor: dr. Sybrine Bultena

Bachelor Thesis Linguistics: English Language and Culture

Radboud University Nijmegen

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Abstract

Multiple studies have tested the predictions of the Revised Hierarchical Model regarding bilingual word processing and meaning access. However, previous research has mostly used noun translations as stimulus items. The present study contributes to the field of research by adding a study to the word class of verbs in combination with forward translation. 32 Dutch-English bilinguals performed a translation recognition task that included different categories of stimuli. The English target items were word sets that were either form-related or semantically related to the preceding Dutch prime word. Sensitivity to either one of those categories would suggest the appearance of word association (form-related words appeal to lexical connections in the mental lexicon) or concept mediation (semantically related words appeal to conceptual connections in the mental lexicon). The results showed that more-proficient bilinguals were affected by semantically related words. Therefore, it can be concluded that concept mediation is present for more proficient bilinguals in a forward verb translation task. This is in line with the hypothesis of the Revised Hierarchical Model, that states that a shift from word association to concept mediation takes place when a bilingual becomes more proficient in their second language.

Keywords: Revised Hierarchical Model, bilingualism, word association, concept mediation, translation recognition task, forward translation

Name: Roelofs
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1. Introduction

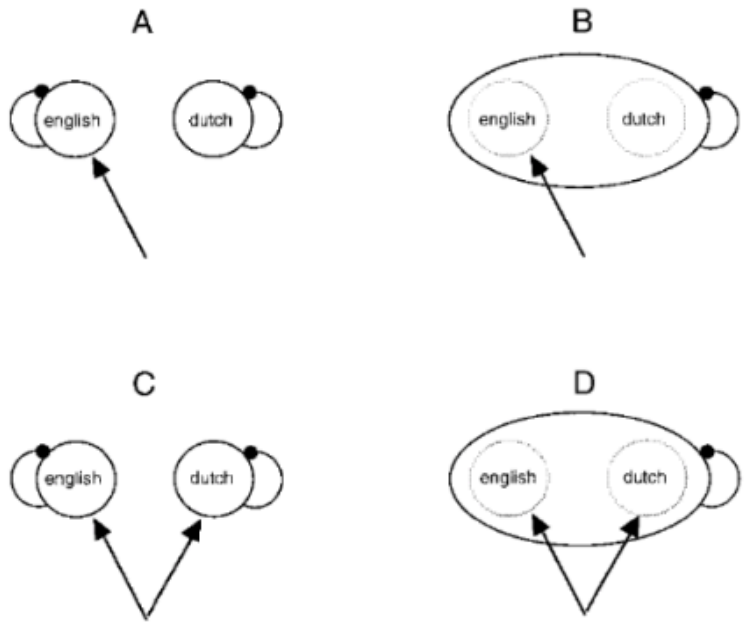
Humans have an estimated capacity to know over 50,000 words, which indicates that the mental lexicon must be a systematic arrangement of words and concepts. Despite the enormous number of words, humans are able to identify a word within 200 milliseconds from its onset (Aitchison, 2012). The large capacity of words and the rate in which these words can be located suggest that the mental lexicon is a coherent, intricate, and organised system. Building a model of the mental lexicon has been a difficult task, since limited tools are available to amplify the organisation of the mental lexicon. However, research that has been conducted on this subject (e.g. by Aitchison, 2012) shows that the mental lexicon is a mixed system in which multiple processes co-occur, such as word production and word comprehension. These processes are linked and interacting with each other, as well as other aspects that activate in and around the mental lexicon, such as phonology, syntax, and semantics (Aitchison, 2012).

But what happens in the mental lexicon when words are processed in the second language? Due to the complexity of the mental lexicon, there are several hypotheses for bilingual word recognition and processing. All differ in the way in which they look upon two aspects: the way in which the languages are accessed and how the lexicon is structured. Language access concerns the way in which the two languages are activated when a specific language is processed. This can either occur selectively (activation is restricted to the target language) or non-selectively (co-activation of both languages). The second aspect, regarding the structure of the lexicon, is mostly divided into two camps: one that states that two languages are stored in two separate mental lexica, and one that assumes that two languages

are stored into one shared mental lexicon (Van Heuven, Dijkstra, & Grainger, 1998).

Figure 1

Four Hypotheses of Bilingual Word Recognition and Processing
(adopted from Van Heuven et al., 1998)



Van Heuven et al. (1998) recognise four different hypotheses based on these two issues, as can be seen in Figure 1. Hypothesis A assumes that there are two independent lexica and that language access is selective. When talking in one language, only the lexicon of that language is activated. Hypothesis B argues that there is one integrated lexicon for both languages, but that language access still happens selectively. Hypothesis C states that there are two independent lexica and that the first language and the second language are simultaneously activated. However, the words of both languages do not influence each other in this process. Hypothesis D argues that both languages are stored in one integrated lexicon and that language access happens non-selectively. According to this hypothesis, the languages influence each other and are activated simultaneously during the process of word recognition (Van Heuven et al., 1998). Several studies have found evidence for the latter hypothesis,

which is nowadays widely accepted to be correct (e.g. Van Heuven et al., 1998; Duyck, Van Assche, Dreighe, & Hartsuiker, 2007; Grainger, Midgley, & Holcomb, 2010).

A part of what happens when words are processed in the second language can be explained according to the 'non-selective access, integrated lexicon' principle. However, this still does not fully explain what exactly happens in the mental lexicon when words are processed in the second language. There are questions that still need to be answered, mainly concerning the process of bilingual word processing and meaning access. For example, to what extent is the translation of a target word directly accessible and how do form and meaning representations of a word relate to this process? Next to that, it is interesting to examine whether and how the proficiency of the bilingual, the translation order, and/or the specific word class of target words influence this process.

The present study will examine these questions by incorporating a theoretical framework, called the Revised Hierarchical Model, that tries to describe how the form and meaning representations of the first language and the second language mental lexicon are connected to each other. The model provides an overview of aspects of the bilingual mental lexicon, such as word activation, processing and meaning access. The generalisability of its predictions regarding these aspects is tested to contribute to the field of research. A forward translation recognition task to the word class of verbs with Dutch-English bilinguals is used in order to do so. The present study proceeds on previous research with the following research question: To what extent does a translation recognition task using forward translation in combination with the word class of verbs for Dutch-English bilinguals contribute to the generalisability of the Revised Hierarchical Model?

2. Previous Research

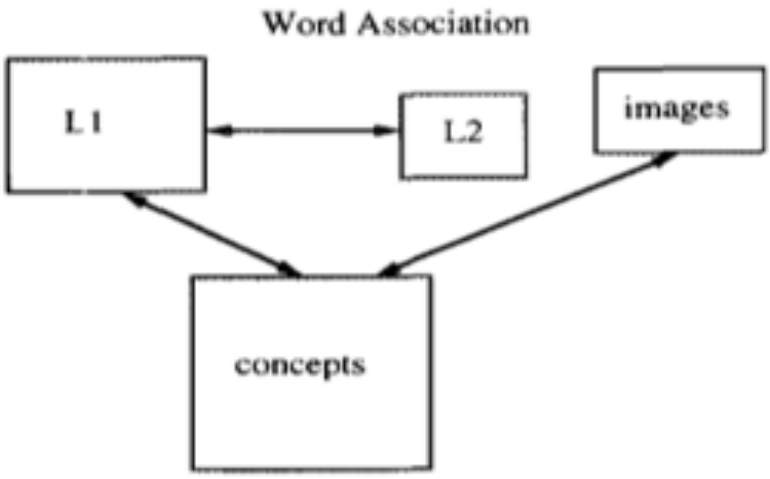
2.1 Early Hierarchical Models

Two early theories that provided fundamental arguments for word processing and meaning access in the bilingual mental lexicon are the Word Association Model and the Concept Mediation Model (Potter, So, Von Eckardt, & Feldman, 1984). The Word Association Model is seen as the first step to lexical development and the Concept Mediation Model is assumed to be valid for higher levels of proficiency.

The Word Association Model (WAM) is visualised in Figure 2. The boxes represent several aspects of the bilingual mental lexicon: the first language (L1) lexicon and the second language (L2) lexicon are represented by the L1-box and the L2-box. The concepts-box represents the conceptual storage. The arrow between the boxes represent mental links, which connect the L1-lexicon, the L2-lexicon, and the conceptual storage. The WAM assumes that there is a direct link between the L1-lexicon and the L2-lexicon in both translation directions. Next to that, the absence of an arrow between the L2-box and the concept-box implies that there is an indirect link between the L2-lexicon and the conceptual storage.

Figure 2

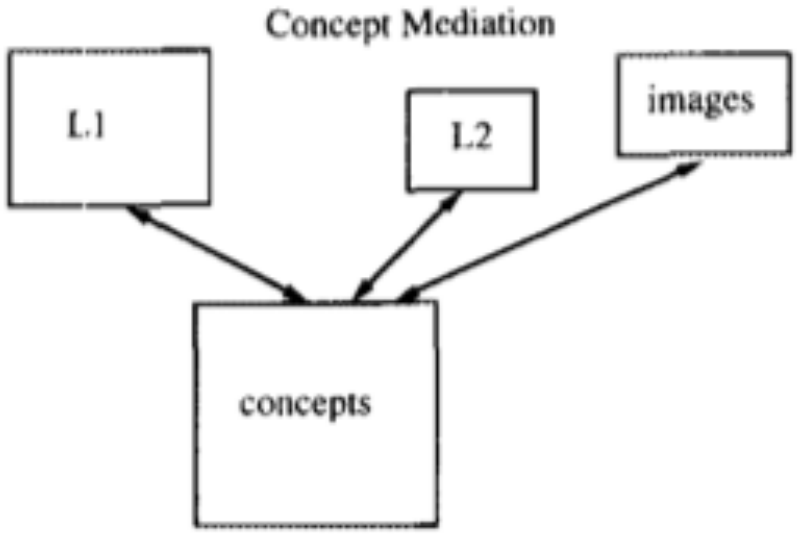
Word Association Model (Adapted from Kroll & Stewart, 1994)



Even though the lexicon of the L1 and L2 share one conceptual storage, the L2-lexicon does not have a direct link connected to it. Therefore, the WAM argued that L2-learners access L2 word meaning through the L1 translation. The reliance on the L1 translation is called word association. According to the WAM, translation happens from the L1-word directly to the L2, whilst picture naming happens from the image via concepts and L1 to the L2. Therefore, it was hypothesised that translation takes less time than picture naming because the process of translation requires less steps than picture naming (Potter et al., 1984).

Figure 3

Concept Mediation Model (Adapted from Kroll & Stewart, 1994)



The Concept Mediation Model (CMM) (Figure 3) assumes that there is an indirect link between the L1-lexicon and the L2-lexicon and a direct link between L2-lexicon and the conceptual storage. Translation of L1 and L2 words therefore happens via the conceptual storage. There is no reliance on the L1-lexicon for meaning access of L2 words. This is called concept mediation. The CMM argued that both translation from L1 to L2 and picture naming happen from the L1-word or the image via the concept to the L2. Following this, it was hypothesised that translation would take similar time compared to picture naming because the processes require an equal number of steps (Potter et al., 1984).

Potter et al. (1984) argued that a transition from word association to concept mediation takes place when the proficiency of the bilingual increases, caused by an increase of strength of the conceptual connection between the L2-lexicon and the conceptual storage. They tested their assumptions by conducting two experiments. The first experiment included 24 high-proficient Chinese-English bilinguals. The materials of the experiment consisted of objects names in Chinese and English. Some of the items included an object drawing as well. All objects belonged to superordinate categories such as animals or clothing. The items were presented to the participants and some of them had to name or translate the items and others had to match the items to their superordinate category. The results showed that the concept of an object is accessed as fast from the picture as from the written L1 word. This finding was in line with the hypothesis of the CMM, that argued that translation and picture naming take similar time. There was no evidence of word association found for the high-proficient bilinguals. This is also in line with the prediction that high-proficient bilinguals have shifted from word association to concept mediation (Potter et al., 1984).

The second experiment consisted of 28 less-proficient English-French bilinguals. The experiment was similar to the first experiment, only these items were in English or French instead of Chinese. Participants had to respond to the items in both translation directions. The results showed that the participants named pictures in L2 faster than they translated an L1 word to the L2 equivalent. Next to that, they were significantly faster in naming words in the L1 than naming pictures in the L1. These results indicate that less-proficient bilinguals translate from their L1-lexicon via the conceptual storage to their L2-lexicon. These results are not in line with the predictions of the WAM, that argued for a direct connection between the L1-lexicon and the L2-lexicon. The WAM also predicted that less-proficient bilinguals have faster reaction times to an L1 word than to a picture, which was not found in the results either. Therefore, the experiment was not able to provide enough evidence to support the

WAM. Consequently, Potter et al. (1984) anticipated that the predictions of the CMM are also applicable to less-proficient bilinguals, because the results suggested that they did not access L2 word meaning via the L1-lexicon, but directly from the L2-lexicon to the concept storage (Potter et al., 1984).

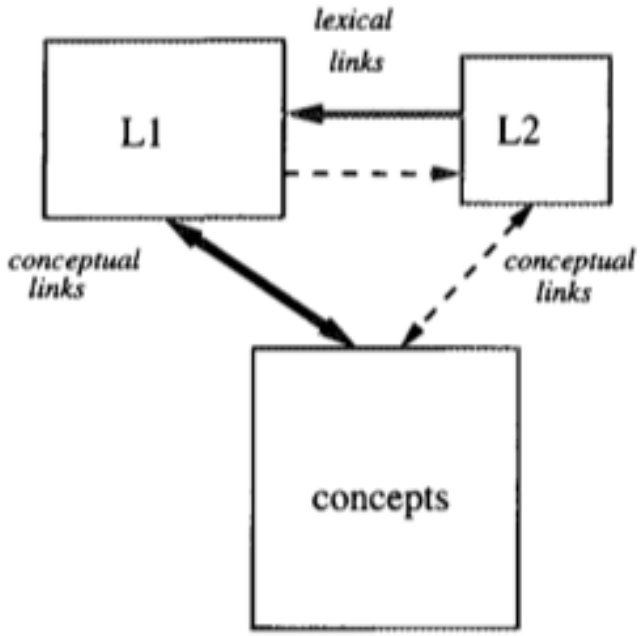
However, research from Kroll and Curley (1988) and Chen and Leung (1989) did show evidence in favour of the WAM. Both studies included participants that were even at an earlier stage of acquiring their L2 than the participants of Potter et al. (1984) were. Both studies showed that, at very early stages of acquiring their L2, participants did access L2 word meaning via the translation of the L1-equivalent, which is in line the predictions of the WAM. Therefore, enough evidence in favour was found to support its predictions for less-proficient bilinguals (Kroll & Curley, 1988; Chen & Leung, 1989).

2.2 The Revised Hierarchical Model

Kroll and Stewart (1994) have combined and revised the WAM and the CMM and put forward the Revised Hierarchical Model (RHM). The RHM is a combination of aforementioned models that also includes predictions regarding the proficiency of the bilingual and the difference between translation directions. It structures three main aspects of the mental lexicon: The L1, the L2, and their conceptual storage (see Figure 4). Form representations of words are assumed to be independent for both languages whilst meaning representations of words are presumed to be integrated for both languages.

Figure 4

The Revised Hierarchical Model (Adapted from Kroll & Stewart, 1994)



2.2.1 Translation Direction

The RHM describes an asymmetry between the two translation directions that can be explained by a difference in strength of the lexical and conceptual links that are visualised in Figure 4. The continuous line from the L2-box to the L1-box represents a strong connection from the lexicon of the L2 to the lexicon of the L1 (backward direction). A reason to account for this could be that new L2 words are often acquired via rote learning, a repetitional technique in which the new L2 word and the L1 translation are repeated until memorised. The new L2 word is thus acquired in backward direction, which is why the link from the L2 lexicon to the L1 lexicon is strong (Kroll & Stewart, 1994). This argument also accounts for why the connection from the L1-lexicon to the L2-lexicon (forward direction) is weaker, represented by the dashed line from the L1-box to the L2-box in Figure 4. The lexical links in forward direction are not as trained as the ones in backward direction, causing forward translation to take additional time.

The influence from the conceptual storage also contributes to the translation asymmetry. When a word is read in the L1, it automatically causes an interference from semantics because the word and its meaning are familiar. Contrary, when a new word is read in the L2, it does not automatically cause an interference with the conceptual storage because the word and its meaning are less or not familiar. Therefore, it is argued that forward translation is influenced by semantics in any case. According to Kroll and Stewart (1994), this so-called concept mediation does not affect backward translation.

Kroll and Stewart (1994) tested these assumptions with a translation recognition task in forward and backward direction. 24 Dutch-English low- and high-proficient bilinguals showed shorter reaction times in the backward translation task compared to the forward translation task. Next to that, they conducted a picture-naming and translation task with semantically categorised words and with randomised words. If forward translation requires additional time because of concept mediation, it should be influenced by the semantically categorised words. If backward translation is faster because it only requires lexical links (i.e. no concept mediation), it should not be influenced by semantically categorised words. The results showed that the semantically categorised words only affected the translation process in forward direction and showed no effect for backward translation. This suggested that backward translation can be done without interference with the conceptual storage whereas forward translation cannot. Forward translation thus shows to have concept mediation, whereas backward translation does not (Kroll & Stewart, 1994).

However, other studies claimed the opposite by showing similar reaction times for forward translation and backward translation. De Groot and Poot (1997) indicated that backward translation appears to have concept mediation as well and argued that concept mediation is a general process for language translation in both directions. Similarly, La Heij, Kerling, and Van Der Velden (1996) found signs of concept mediation for both translation

directions. Possibly, the experimental task could account for the difference in results between De Groot and Poot (1997) or La Heij et al. (1996) and Kroll and Stewart (1994). The translation recognition task used by Kroll and Stewart (1994) presented single words without context, whilst La Heij et al. (1996) included the context of a picture before translating. Possibly, the presence of context causes the translation asymmetry to disappear, as Kroll later suggested in another study (Kroll & Tokowicz, 2001).

2.2.2 Proficiency Effect

The RHM also takes the proficiency of the bilingual into account. As can be seen in Figure 4, the connection between the L1-lexicon and the conceptual storage is strong, whilst the connection between the L2-lexicon and the conceptual storage is weak. Following Potter et al. (1984), Kroll and Stewart (1994) argue that the increase of L2-proficiency causes an increase in strength of the conceptual links. This causes a developmental shift from word association to concept mediation.

Early in the process of learning the L2, the meaning of L2 words is accessed through the equivalent L1-word. As mentioned before, this so-called word association can be explained by the fact that the connection between the L1-lexicon and the concept storage is stronger than the connection between the L2-lexicon and the concept storage. The strong lexical link between the L2-lexicon and the L1-lexicon causes low-proficient bilinguals to have a reliance on the L1 equivalent rather than the conceptual storage when accessing L2-word meaning. When the bilingual is more proficient in their L2, the conceptual links from the L2-lexicon to the conceptual storage have increased in strength. This increase causes an interference from semantics (concept mediation) because high-proficient bilinguals have access to a direct route between the L2-lexicon and the corresponding representation of the concept (Kroll & Stewart, 1994).

This developmental shift from word association to concept mediation shows how the presented language is processed, but what does this look like in practice? When a word has to be translated, the meaning of that word has to be activated as well. When a high-proficient bilingual is asked to perform a translation recognition task, as in the experiment of Kroll and Stewart (1994), they see a number of words of which they have to determine whether it is the correct translation or not. Due to the increase in strength of the conceptual links, a high-proficient bilingual directly appeals to the meaning of the words because the process of perceiving several words causes them to think about whether the meaning of the word they see on the screen matches the meaning of the word they have to translate. Contrary to that, weak conceptual links but strong lexical links causes a low-proficient bilingual to translate the word to their L1 and to access meaning via that L1-equivalent.

The shift from word association to concept mediation has been studied by Talamas, Kroll, and Dufour (1999). In line with Kroll and Stewart (1994) they predicted that low-proficient bilinguals have more reliance on word form whereas high-proficient bilinguals have more reliance on word meaning. They tested 39 Spanish-English bilinguals, divided in two proficiency groups (low-proficient and high-proficient). They performed a translation recognition task in which the participants had to judge if the second word they saw on the screen was the correct or incorrect translation of the first word they saw on the screen. The task included of 64 translation sets, consisting of a prime word (in either English or Spanish), a correct translation, and four types of incorrect translations. The incorrect translations were either form related to the correct translation (e.g. *soap-jamón* (ham) instead of *jabón* (soap)), semantically related to the correct translation (e.g. *soap-baña* (bathe) instead of *jabón*), or unrelated to the correct translation (e.g. *soap-cerca* (nearby) or *soap-limón* (lemon) instead of *jabón*). The word frequencies of the words in the translation sets were not significantly different compared to each other. This is important because a difference in word frequency

could influence the results (more frequent words are generally read faster than less frequent words). The results of the experiment show that low-proficient bilinguals have a significantly longer reaction time on form-related word sets than on semantically related word sets. This shows that they are more affected by form relatedness and less sensitive to semantic relatedness. The high-proficient bilinguals show the opposite result: they have more conflict processing word pairs that contain semantically related translations and are less affected by word pairs that contain form-related translations. This is evidence for the gradual shift from a dependence on word form to a dependence on word meaning that goes hand in hand with the increase of proficiency in the second language. The more L2-proficient, the greater the dependence on word meaning (Talamas et al., 1999). The results are in line with the prediction of the RHM that a developmental shift takes place from word association to concept mediation (Kroll & Stewart, 1994).

Aforementioned prediction has also been tested by Ferré, Sánchez-Casas, and Guasch (2006). High- and low-proficient Spanish-Catalan bilinguals performed a translation recognition task of similar design as Talamas et al. (1999). The results of their experiment showed that the semantic interference was significantly larger for the high-proficient bilinguals in comparison to the low-proficient bilinguals. In addition to that, the low-proficient bilinguals showed a significant interference effect for form-related words. This also indicates the gradual shift from word association to concept mediation that goes hand in hand with the increase of proficiency in the second language. Again, these results were in line with the predictions of the RHM (Ferré et al., 2006; Kroll & Stewart, 1994).

Kelder (2018) also tested the predictions of the RHM, including the word classes nouns and verbs. The results are partially in line with the predictions of the RHM, showing that high-proficient bilinguals have a strong conceptual connection between the L2 lexicon and the conceptual storage for both word classes. However, the results that regarded low-

proficient bilinguals were not in line with the predictions of the RHM because there was no significant difference between the form interference and the semantic interference on both word classes. Several possible explanations can account for this. The proficiency of the low-proficient participant group could still have been too high to find an evident effect of word association, which was the case for Potter et al. (1984). Following this, it was suggested that the low-proficient participant group had possibly already started acquiring stronger conceptual links (Kelder, 2018).

2.2.3 Word Class of Verbs

It is interesting to examine in what way the type of word class influences the translation processes as proposed by the Revised Hierarchical Model. Kroll and Stewart (1994) only tested their predictions of the RHM with stimuli that consisted of the word class of nouns. However, nouns differ linguistically from verbs, causing word processing to be different for these word classes (Bultena et al., 2013).

First of all, verbs are more complicated than nouns due to the large information load they can take (e.g. tense, number, argument). Second of all, nouns differ from verbs in the sense that their meaning is stricter than the meaning of verbs (Gentner, 1981). For example, the meaning of the noun *carrot* is very concrete. The representation of the concept of *carrot* is likely to be very similar – if not the same – for everyone. A noun such as *carrot* thus has one fixed interpretation. Contrasting, the meaning of a verb such as *to care* is far more abstract: everyone is familiar with the meaning, but the representation of the concept could differ between people. Gentner (1981) argued that the abstractness of verbs causes verb processing to be a more complex task than noun processing.

Van Hell and De Groot (1998) have also argued that concept representations of nouns are less complex than concept representations of verbs. The results of their experiment

showed that the way in which concepts are represented in the bilingual mental lexicon depends on the word class: nouns share larger parts of the representation than verbs do. The shared representation of nouns facilitates word processing. Verbs, on the other hand, take additional processing time because they share less parts of the representation than nouns. This contributes to the complexity of verb processing (Van Hell & De Groot, 1998).

2.3 The Present Study

Previous studies (e.g. Kroll & Stewart, 1994; Talamas et al., 1999; Ferré et al., 2006; Kelder, 2018) have put forward results that are in line with the prediction of the RHM that a developmental shift from word association to concept mediation takes place with the increase of L2-proficiency. The present study expands on previous research by altering the conditions of the experiment, using a forward translation recognition task with verbs, in order to examine if the RHM could be generalised further. To examine this, the present study proposes the following research question: To what extent does a translation recognition task using forward translation in combination with the word class of verbs for Dutch-English bilinguals contribute to the generalisability of the Revised Hierarchical Model?

3. Hypotheses

If less-proficient bilinguals have word association as suggested, they should be more sensitive to features on the lexical level than to features on the semantical level because the lexical link between the L2 lexicon and the L1 lexicon is strong. The RHM argued that a developmental shift takes place from word association to concept mediation when the proficiency in the L2 increases. If more-proficient bilinguals have concept mediation as suggested, they should be more sensitive to features on the semantical level than to features on the lexical level because the conceptual link between the L2 lexicon and the conceptual

storage has increased in strength. The shift from word association to concept mediation should therefore be visible in the reliance on either word form (for less-proficient bilinguals) or word meaning (for more-proficient bilinguals). According to this, two main hypotheses are put forward:

Hypothesis 1: *If there is a shift from word association to concept mediation, it should be visible as follows:*

(1.1) The reaction time of less-proficient bilinguals on form-related words is a) longer than on semantically related words and b) longer than the reaction time of more-proficient bilinguals on form-related words.

(1.2) The reaction time of more-proficient bilinguals on semantically related words is a) longer than on form-related words and b) longer than the reaction time of less-proficient bilinguals on semantically related words.

Hypothesis 2: *If less-proficient bilinguals are more affected by form similarities, they should have a lower accuracy score on form-related words than on semantically related words. If more-proficient bilinguals are more affected by semantic similarities, they should have a lower accuracy on semantically related words than on form-related words.*

As suggested by several studies (e.g. Kroll & Stewart, 1994; Talamas et al., 1999), concept mediation appears in forward translation. However, other research (e.g. De Groot & Poot, 1997; La Heij et al., 1996) argued for concept mediation to be a more general process, appearing both translation directions. Taking this into account, some sign of concept mediation should be present for less-proficient bilinguals as well. More-proficient bilinguals

should, however, show more signs of concept mediation because they acquired stronger conceptual links between the L2 lexicon and the conceptual storage.

When a less-proficient bilingual is asked to perform a translation recognition task, they see a word set of which they have to determine whether the second word is the correct translation of the first word or not. Strong lexical links from the L2-lexicon to the L1-lexicon cause a less-proficient bilingual to access L2-word meaning via the translation of the L1-equivalent. This so-called word association results in a larger sensitivity to word form. This form interference should be visible in the way that less-proficient bilinguals should have longer reaction times on form-related words than on semantically related words. Also, their reaction times on form-related words should be longer than the reaction times of more-proficient bilinguals on form-related words. It is predicted that proficiency and reaction time on form-related words are negatively correlated for less-proficient bilinguals: the lower the proficiency, the higher the reaction times on form-related words. Next to that, the accuracy of less-proficient bilinguals should be lower on form-related words than on semantically related words. If they have more difficulty processing form-related words, they are predicted to make more mistakes because they are distracted by form similarities. It is thus predicted that proficiency and accuracy are positively correlated for less-proficient bilinguals: the lower the proficiency, the lower the accuracy scores on form-related words.

A more-proficient bilingual is predicted to perform differently from a less-proficient bilingual on a translation recognition task. The conceptual links between the L2-lexicon and the conceptual storage have increased in strength in the mental lexicon of a more-proficient bilingual, which causes them to directly appeal to semantics. Rather than translating the L2 word to the L1-equivalent, they perceive the L2 word and consider whether the meaning of that word matches the meaning of the L1 word. This so-called concept mediation causes a sensitivity to word meaning. This semantic interference should be visible in the way that the

reaction times of more-proficient bilinguals are longer on semantically related words than on form-related words. Also, their reaction times on semantically related words should be longer than the reaction times of less-proficient bilinguals on semantically related words. It is predicted that proficiency and reaction time on semantically related words are positively correlated for more-proficient bilinguals: the higher the proficiency, the higher the reaction times on semantically related words. The accuracy should be lower on semantically related words than on form-related words. Sensitivity to semantical relatedness causes more distraction by semantic similarities. Therefore, more-proficient bilinguals are predicted to be less accurate on semantically related words. It is also predicted that proficiency and accuracy are negatively correlated for more-proficient bilinguals: the higher the proficiency, the lower the accuracy scores on semantically related words.

As the present study only includes the word class of verbs, it is predicted that the overall process of translation recognition is more difficult compared to a task that regards noun processing. This follows Gentner (1981), Van Hell and De Groot (1998), and Bultena et al. (2013), who argue that concept representations of verbs are more complex than concept representations of nouns. An explicit comparison between verb- and noun processing cannot be made as the present study only includes the word class of verbs. However, the complexity of verbs could influence the translation recognition process for both less- and more-proficient bilinguals. This could, for example, be visible in overall longer reaction times.

4. Methodology

The present experiment looked at both the form interference and semantic interference as proposed by the RHM. It studied the shift from word association and concept mediation by looking at form and/or meaning sensitivity of a group of Dutch-English bilinguals for the word class of verbs. The experiment consisted of a translation recognition task in forward

direction. During the task, two words were presented to the participants in sequence. Participants were asked to judge whether the English word they saw on the screen was a correct or incorrect translation of the preceding Dutch word they had seen on the screen. In order to establish the proficiency of the participants, the translation recognition task was preceded by a Lextale Test (Lexical Test for Advanced Learners of English), which is a short test for English Proficiency (Lemhöfer & Broersma, 2012).

4.1 Participants

A number of 34 Dutch-English bilinguals were asked to perform the experiment. They were all Dutch native speakers with English as their second language. Two participants were excluded from performing the experiment due to downloading problems of the OpenSesame program, resulting in a total of 32 participants. The remaining 32 participants (23 females and 9 males) were between the age of 17 to 26 (M = 22.38, SD = 2.12). The participants all attend or have attended to either a Dutch university (Radboud University Nijmegen) (28 of the participants) or Higher Professional Education (Hogeschool Arnhem Nijmegen) (4 of the participants).

4.2 Materials

The translation recognition task included Dutch prime words and English target words. All words belonged to the word class of verb. First, a list of Dutch prime words was drawn up with their corresponding English translation. The English verbs were gathered from the lexical database Celex (Max Planck Institute for Psycholinguistics, 2001) and were all of similar frequency. The correct English translations of the Dutch prime words (henceforth: correct translation) were the filler items. Second, three other categories of words were added: a category that consisted of incorrect translations of the Dutch prime words that are form-

related to the correct English translation (henceforth: form-related translation), a category that included incorrect translations of the Dutch prime words that are semantically related to the correct English translation (henceforth: semantically related translation), and a category that consisted of unrelated English translations of the Dutch prime words (henceforth: unrelated translation). The form-related and semantically related translations were the target items and the unrelated translations were the control items. See Table 1 for an example of the stimulus items for each condition.

Table 1

Example of word set

Condition	Example
Dutch prime word	*Vertragen*
Correct English translation	*To slow*
Form-related incorrect translation	*To slope*
Semantically related incorrect translation	*To speed*
Unrelated incorrect translation	*To doubt*

Words were considered form-related if at least the first three letters or the first syllable were identical to the first three letters or the first syllable of the correct translation. Ideally, the form overlap was as large as possible. Next to the orthographic overlap, the coinciding letters had to be phonologically similar as well.

The semantical relatedness was tested with Snaut, an empirical validation for semantic similarity (Mandera, Keuleers, & Brysbaert, 2017). Snaut scores word pairs on their semantic similarity according to a score between 0.00 (high semantic relatedness) and 1.00 (no semantic relatedness). First of all, the Snaut scores of form-related translations, semantically related translations, and unrelated translations were compared to the Snaut scores of the correct translations, the latter being the control category in this case. The comparison ensures that the semantically related translations were in fact more semantically

related to the control items than the form-related translations and unrelated translations. A one-way analysis of variance ANOVA was conducted to quantify the difference between the Snaut scores of the translation categories. The main effect of Category was found to be statistically significant (F (2,71) = 16.80, $p < .001$).

A Tukey post hoc test was conducted to compare the distance between the Snaut scores of the correct translations and form-related translations, the distance between the Snaut scores of the correct translations and the semantically related translations, and the distance between the Snaut scores of the correct translations and the unrelated translations. The test revealed that the relation between correct and semantically related translations (M = .67, SD = .13) was significantly lower than the relation between correct and form related translations (M = .78, SD = .12) and the relation between correct and unrelated translations (M = .86, SD = .09). This result indicates that the semantically related translations were indeed more semantically similar to the correct translations than the form related translations and the unrelated translations.

After gathering enough stimuli for the translation categories, several matching criteria were applied to the stimulus selection. All items were checked according to three criteria: word length (in number of letters), number of syllables, and frequency of use (according to a logarithmic scale of COBUILD) (Collins Birmingham University International Language Database, 1990). It was important to take these three criteria into account because if one or more would differ significantly between two categories, results might be influenced by those factors. For example, more frequent words are generally read faster than less frequent words and shorter words are generally read faster than longer words. A one-way analysis of variance ANOVA was conducted to compare these three criteria for all translation categories. There were no statistically significant differences between the translation categories in terms of word length (F (3,96) < 1), syllable number (F (3,96) < 1), and frequency (F (3,96) = 2.08,

$p = 0.107$). Therefore, it could be ruled out that those factors would influence the results.

An extra set of 25 Dutch prime words with corresponding correct English translations was added to the dataset to even the number of target items and filler items. These were not explicitly tested according to the exclusion criteria mentioned before because they were filler items. See Appendix A for the complete overview of the stimulus items.

The total set of stimulus items were used to create four versions of the translation recognition task. For every version, the Dutch prime word was linked to another category of English translation (either correct, form, semantic, or unrelated) to ensure that every word-combination was included to the test set. For example, version 1 included the combination *vertragen-slow* (correct translation), version 2 included the combination *vertraging-slope* (form-related translation), version 3 included the combination *vertragen-speed* (semantically related translation), and version 4 included the combination *vertragen-doubt* (unrelated translation).

4.3 Procedure

The experiment of the present study is based on the experiment from Kroll and Stewart (1994), Talamas et al. (1999), and Kelder (2018). The main experiment was a translation recognition task created with the program OpenSesame (Mathôt, Schreij, & Theeuwes, 2012). Due to the fact that the experiment measures reaction times in milliseconds, the original plan was to run the experiment on the same laptop (the personal laptop of the researcher) for every participant because the use of different computers/laptops could slightly influence accuracy of keyboard response. However, the corona pandemic caused an obstruction to the original plan of action. Instead, every participant performed the experiment on their own computer or laptop at home in order to follow the safety measures that were put up by the government. Therefore, participants were, by means of a text message, informed

about the general course of the experiment and that their data would be elicited in a completely anonymous way. Next to that, they were sent two PDF-files. The first PDF-file (see Appendix D) was a step-by-step explanation on how to use Lextale, which was the first part of the experiment. The second PDF-file (see Appendix E) was an elaborate step-by-step explanation on how to download OpenSesame and how to run the translation recognition task, which was the second part of the experiment.

The first part of the experiment was the same for every participant. The Lextale test presented a number of 60 English words and pseudowords (Lemhöfer & Broersma, 2012). By clicking on either 'yes' or 'no', participants had to decide whether the English word they saw on the screen was a real English word or not. This resulted in an English proficiency percentage that was sent to the researcher via e-mail.

The second part of the experiment differed slightly per participant. There were four versions of the translation recognition task and participants were randomly assigned to one of the four versions. The total of 32 participants ensured that each version was performed an equal amount of times. First, a Dutch word was presented to the participants, followed by an English word. Their task was to decide whether the second word they saw on the screen was the correct English translation of the first Dutch word or not. The keyboard responses were programmed as follows: the 'C' was programmed as 'correct' and the 'N' was programmed as 'incorrect'. In order to familiarise the participants with the translation recognition task and these keyboard responses, five additional practise sets were presented at the beginning of the task. Before and after the practise set, the instruction of the task and an overview of the keyboard responses were visible on the screen. After practising and reading the instructions, participants could manually click 'start the experiment'. The actual experiment consisted of two blocks of 18 word pairs (a total of 36 word pairs). The two blocks were separated from each other by means of a small pause, in which the participant could once again manually

choose to proceed.

All stimulus items appeared in white letters on a black background in 1024 px x 768 px resolution. The font of the letters was 'mono' and the size of the letters was 18 pts. Each version consisted of six form-related translations, six semantically related translations, six unrelated translations, and 18 correct translations. The order in which the word pairs were presented varied per version. During the main experiment, a black screen with a fixation dot appeared for a total duration of 1000 ms. After that, a black screen appeared for a total duration of 200 ms. Next, the Dutch prime word appeared on the screen for a total duration of 300 ms, followed by another black screen for a total duration of 200 ms. Last, the English test word appeared on the screen until the participant pressed one of the two possible keyboard responses. If the participant did not respond, the English test word would remain on the screen for a maximum of 3000 ms. This sequence was repeated 18 times before the break and 18 times after the break.

4.4 Design and Analysis

The present study used several variables in order to find an answer to the research question. The independent variables were word type (i.e. form-related, semantically related, or unrelated) and correct or incorrect answers on the translation recognition task. Next to that, proficiency was included as a continuous variable. The dependent variables were reaction time, proficiency score, and accuracy.

After collecting the data from every participant, the reaction times of the different categories were compared to each other. The reaction times on form-related translations and on semantically related translations (both experimental variables) were compared to the reaction times on unrelated translations (control items). These difference scores show the level of form interference and semantic interference, which were compared to each other.

This comparison contributes to the research question because according to the RHM, it is expected that more-proficient L2-speakers have longer reaction times on semantically related translations than on form-related translations. Next to that, the RHM expected that less-proficient L2-speakers have longer reaction times on form-related translations than on semantically related translations. By comparing the reaction times of the experimental variables to the control items, it became evident if participants show more signs of form interference (longer reaction time on form-related words) or semantic interference (longer reaction time on semantically related words).

By also comparing proficiency scores and reaction times, it would become even more evident whether the results would be in line with predictions of the RHM, because this comparison would give insight to the correlation between proficiency and reaction time on either form-related words or semantically related words.

A third comparison, between accuracy rates and the aforementioned difference scores, would also contribute to answering the research question. Following the RHM, less-proficient bilinguals have more difficulty processing form-related words. They are predicted to make more mistakes on form-related words because they are distracted by form similarities. The accuracy score of less-proficient bilinguals is therefore predicted to be lower on form-related words than on semantically related words. More-proficient bilinguals are more sensitive towards semantical relatedness, causing a larger distraction for semantic similarities. Therefore, they are predicted to make more mistakes on semantically related words which would cause the accuracy score for those words to be lower.

5. Results

The statistical package R showed that the proficiency of the participants was not normally distributed (See Appendix C). This resulted in the fact that no specific groups were formed according to proficiency level. Rather, proficiency level was included as a continuous variable to test possible correlations between proficiency and reaction times. Despite there being no clear participant group of less-proficient participants, the present study used the all more-proficient participant set to accurately test the predictions of the RHM regarding to high-proficient bilinguals.

After the translation recognition task, an accuracy score was measured from the data of each participant. Following Kelder (2018), a cut-off score of 70% accuracy was instituted. The data of participants scoring less than 70% would be removed from the dataset in order to ensure accurate data. However, all 32 participants managed to score accuracy levels higher than 70%, resulting in the fact that no data was removed from the dataset regarding accuracy scores.

The data of the experiment were analysed with the statistical package IBM SPSS. The data regarding the combination of the Dutch prime words and the correct English translations were filler items and these were removed before performing the analyses. The remaining data consisted of the reaction times on the form-related translations, the semantically related translations, and the unrelated translations. The reaction times analyses were only computed over the correct responses of the participants. The data of these three target items were also adjusted by removing missing values and outliers before running the statistical analyses to ensure that the data would be as representative as possible. There were eight missing values, caused by no response of the participant. The missing values made up 0.69% of the total dataset. Next to that, three boxplots (one for the reaction times on form-related translations, one for the reaction times on semantically related translations, and one for the reaction times

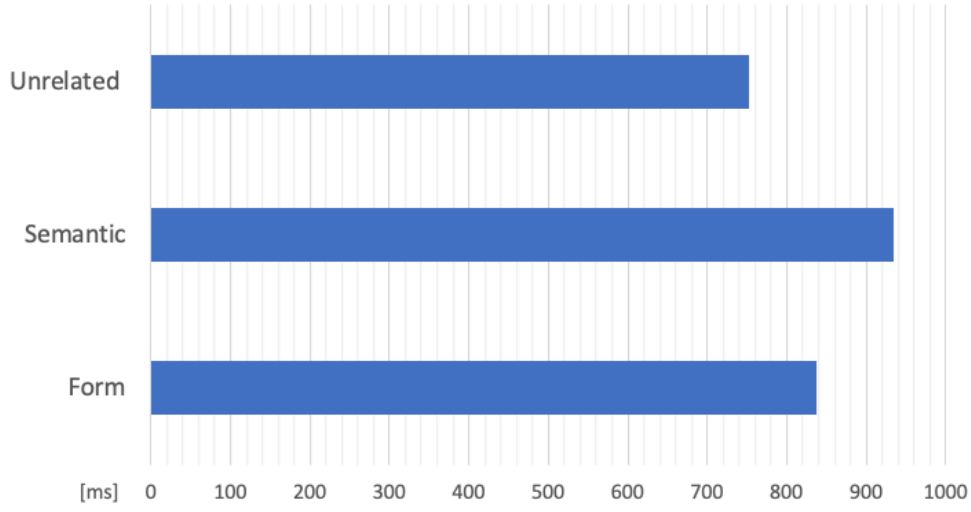
on unrelated translations) were created to identify any outliers (see Appendix B). The specific range of reaction times that were regarded as outliers differed per condition. According to the boxplot, the form-related translations with reaction times shorter than 439 ms and longer than 1556 ms were considered outliers. For the semantically related translations, reaction times shorter than 474 ms and longer than 1904 ms were considered outliers. For the unrelated translations, reaction times shorter than 469 ms and longer than 1292 were considered outliers. All outlier ranges were also calculated manually in the statistical package R in order to ensure the correctness. Afterwards, all outliers were removed from the dataset. The total percentage of deleted outliers was 5,41%.

5.1 Reaction Time Analysis

A mean reaction time was calculated per translation condition for every participant. These were used to calculate general averages on the reaction times for the three translation conditions in milliseconds: unrelated (M = 753), semantic (M = 934), and form (M = 838). An overview of these means can be seen in Figure 5, where the three bars visualise the three translation conditions.

Figure 5

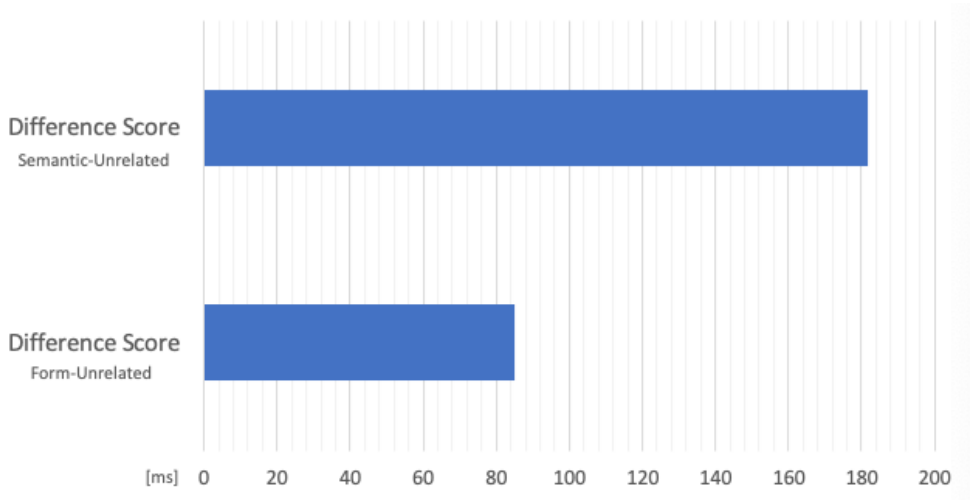
Mean reaction times [ms] for the three translation conditions



The mean reaction times of the three conditions were used to calculate two difference scores. The difference in which participants responded to the experimental items (form-related and semantically related) and to the control items (unrelated) gave insight in whether participants were affected by form similarities or semantic similarities. The difference scores therefore show is called the interference effect, visualised in Figure 6. As can be seen, the interference effect on the semantically related condition (181 ms) is higher than the interference effect on the form-related condition (85 ms).

Figure 6

Difference scores for reaction times on form-unrelated conditions and semantic-unrelated conditions show the Interference Effect [ms]



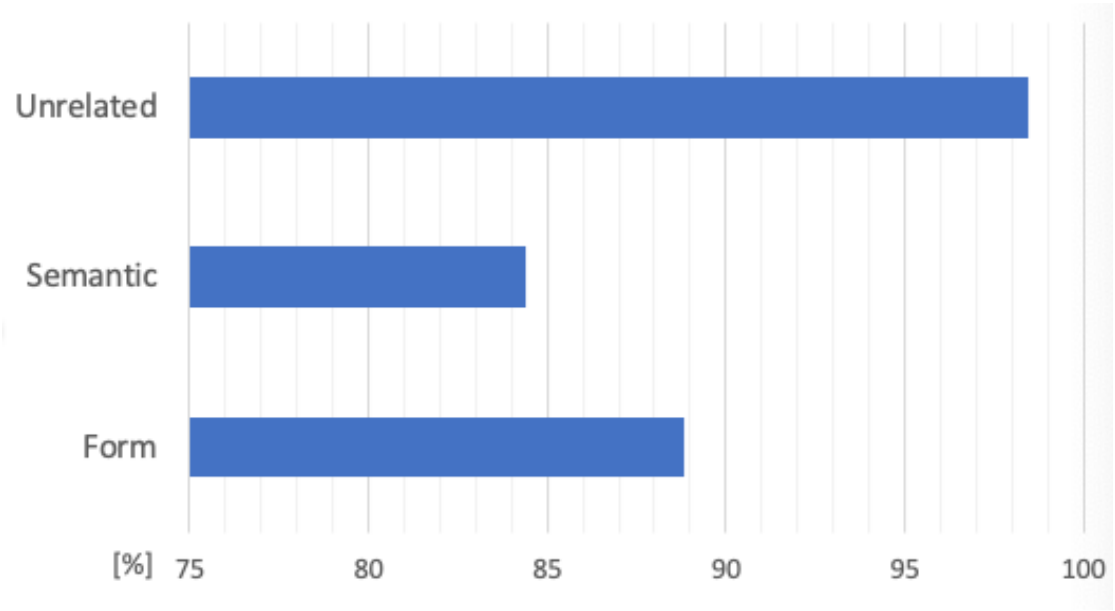
In order to calculate whether the interference effect of the semantically related condition was significantly different from the interference effect of the form-related condition, a paired-samples t-test was conducted. The test showed that there was a significant difference between the interference effect of the form-related condition and the interference effect of the semantically related condition (t (31) = 3.27, p = .003). The interference effect of the semantically related condition (M = 181ms, SD = 168) was significantly higher than the interference effect of the form-related condition (M = 85ms, SD = 112).

5.2 Accuracy Rates Analysis

Accuracy rates were also calculated for every participant per translation condition. The averages for the three translation conditions are visualised in Figure 7. The mean accuracy rate of the unrelated condition (98.43%) is higher than the accuracy rate of the semantically related condition (84.37%) and form-related condition (88.85%).

Figure 7

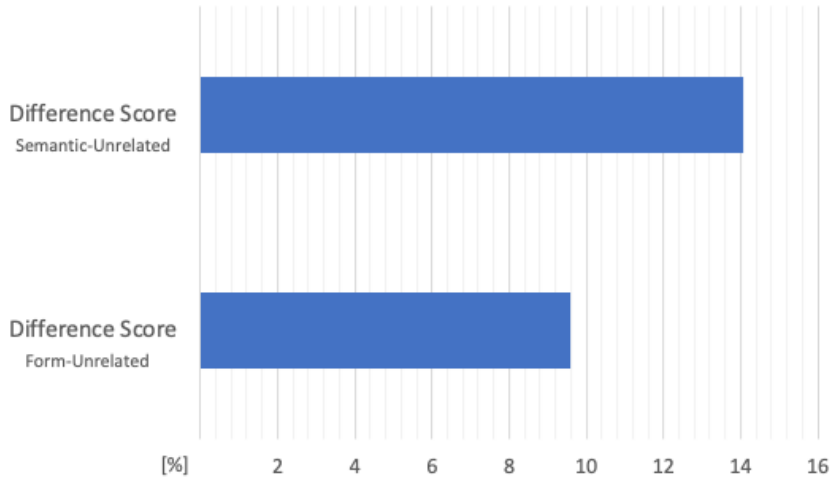
Accuracy Rates for the three translation conditions.



Two difference scores were calculated according to the accuracy rates. Again, the two experimental conditions (form-related and semantically related) were compared to the control condition (unrelated). The difference scores show the interference effects for accuracy rates because they show if and how participants were affected their accuracy on form similarities or semantic similarities. Figure 8 shows that the interference effect on accuracy of the semantically related condition (14.06%) is higher than the interference effect on accuracy of the form-related condition (9.58%).

Figure 8

Difference scores for accuracy on form-unrelated conditions and semantic-unrelated conditions show the Interference Effect [%]



A paired-samples t-test showed that there was no significant difference between the interference effects for the accuracies of the form-related condition and the semantically related condition (t (31) = -1.02, p = .316). The interference effect of the semantically related condition (M = 14.06, SD = 19.45) was not significantly higher than the interference effect of the form-related condition (M = 9.58, SD = 18.83). This shows that participants overall are not more accurate in answering to the form-related words than to the semantically related words. For an overview of mean reaction times, accuracy scores, and the interference effects, see Table 2.

Table 2

Mean reaction times [ms] and mean accuracy rates [%] for the three translation conditions

Conditions	**Reaction Time**	**Accuracy Score**	**Interference Effect**	
			Reaction Time	Accuracy Score
Related				
Form	838	(88.85)	85	(9.58)
Semantic	934	(84.37)	181	(14.06)
Unrelated	753	(98.43)		

5.3 Proficiency Effect

REACTION TIME: It was interesting to find out if and how the proficiency of the participants had an effect on the reaction times of the translation conditions. This proficiency effect was calculated by means of two correlational analyses. The Lextale scores of participants were correlated with the two difference scores of the reaction times. The results of the first Pearson Correlation analysis showed that there was no significant correlation between the Lextale scores and the form interference in terms of reaction time, r (30) = -.264, p = .145. The results of the second Pearson Correlation analysis also showed no significant correlation between the Lextale scores and the semantic interference in terms of reaction time, r (30) = -.061, p = .738.

ACCURACY RATE: Next to that, it was investigated whether the proficiency of the participants had an effect on the accuracy rates of the translation conditions. This was also calculated by means of two correlational analyses. The Lextale scores of participants were correlated with the two difference scores of the accuracy rates. The results of the first Pearson Correlation analysis showed that there was no significant correlation between the Lextale scores and the form interference in terms of accuracy, r (30) = -.036, p = .844. The results of the second Pearson Correlation analysis also showed no significant correlation between the Lextale scores and the semantic interference in terms of accuracy, r (30) = -.159, p = .386.

6. Discussion

The present study examined to what extent a translation recognition task using forward translation in combination with the word class of verbs for Dutch-English bilinguals contributed to the generalisability of the Revised Hierarchical Model (RHM) by studying word association and concept mediation.

The RHM predicted that a developmental shift takes place from word association to

concept mediation that goes hand in hand with the increase of L2-proficiency. Early in the process of acquiring the L2, the lexical link between the L1-lexicon and the L2-lexicon is stronger and the conceptual link between the L2-lexicon and the conceptual storage is weak. Therefore, the meaning of L2 words are accessed through the translation of the equivalent L1 word. Later in the process of acquiring the L2, a strong conceptual link between the L2-lexicon and the conceptual storage is acquired. Now, meaning of L2 words are accessed directly from the conceptual storage, without interference from the L1-lexicon (Kroll & Stewart, 1994).

The present study tested whether this developmental shift is also present for verb translation in a forward translation recognition task. 32 Dutch-English bilinguals performed the task in which they had to decide whether the English verbs they saw on their screen were or were not the correct translations of the preceding Dutch verbs. The translation direction is particularly interesting because conceptual links are required for forward translation and not for backward translation, as suggested by several studies (e.g. Kroll & Stewart, 1994; Talamas et al., 1999). Sings of concept mediation should thus not only be present for more-proficient bilinguals, but for less-proficient bilinguals as well. The former should, however, show more concept mediation because they acquired stronger conceptual links between the L2 lexicon and the conceptual storage.

6.1 *Reaction Time and Proficiency Effect*

In order to investigate reaction times and proficiency effect, the following hypothesis was installed: *If there is a shift from word association to concept mediation, it should be visible as follows: (1.1) The reaction time of less-proficient bilinguals on form-related words is a) longer than on semantically related words and b) longer than the reaction time of more-proficient bilinguals on form-related words. (1.2) The reaction time of more-proficient*

bilinguals on semantically related words is a) longer than on form-related words and b) longer than the reaction time of less-proficient bilinguals on semantically related words. Following this, less-proficient participants had to show longer reaction times on form-related words compared to their reaction time on semantically related words, and more-proficient participants had to show longer reaction times on semantically related words compared to their reaction times on form-related words. In practise, participants were not divided into two proficiency groups because their proficiency scores were not normally distributed. All participants had a proficiency score of at least 75% (apart from four proficiency scores that were lower). Therefore, proficiency was included as a continuous variable.

The results of a reaction time analysis showed that the overall reaction times on semantically related translations were significantly higher than reaction times on form-related translations. This shows that the entire group of participants shows more sensitivity towards meaning compared to form, i.e. participants show more signs of concept mediation than word association. Due to the fact that the participant set almost entirely consisted of more-proficient bilinguals, this finding is completely in line with the predictions of the RHM.

In order to delve further into the proficiency effect, reaction times on form-related translations and semantically related translations were correlated with the Lextale proficiency scores. It was hypothesised that, for less-proficient bilinguals, the proficiency and the reaction times on form-related translations should be negatively correlated, because the lower the proficiency, the higher the reaction times on form-related words. It was also hypothesised that, for more-proficient bilinguals, there would be a positive correlation between the proficiency and the reaction times on semantically related translations, because the higher the proficiency, the higher the reaction times on semantically related words. However, no correlations were found at all. Several factors count account for this. The expected correlation for less-proficient bilinguals was not found because almost the entire participant set was

more-proficient. Accurately testing the predictions of the RHM regarding to less-proficient bilinguals was therefore unattainable. The expected correlation for more-proficient bilinguals was not found because there was no normal distribution of the proficiency scores. Having two clearly divided proficiency groups (low-proficient and high-proficient) would probably cause a clearer correlation between these factors.

6.2 Accuracy Scores and Proficiency Effect

In order to investigate accuracy rate and proficiency effect, the following hypothesis was installed: *If less-proficient bilinguals are more affected by form similarities, they should have a lower accuracy score on form-related words than on semantically related words. If more-proficient bilinguals are more affected by semantic similarities, they should have a lower accuracy on semantically related words than on form-related words.*

The participant set that almost entirely consisted of more-proficient bilinguals was expected to show an overall trend of lower accuracy scores on semantically related translations. However, the accuracy rate analysis showed no significant difference between the accuracy rates on form-related translations and semantically related translations. There was also no correlation found between accuracy rates and proficiency effect.

To account for these findings, the complete dataset was analysed again to check whether there were specific words that were often misjudged. If there were, these findings could be accounted for by a mismatch in some of the stimulus items. This was checked by examining the incorrect responses. There was a total of 62 incorrect responses, of which 13 could be left out because they were filler items. Of the remaining 49 items, 16 items were form-related translations (33%), 30 items were semantically related translations (61%), and 3 items were unrelated translations (6%). Mistakes that are made in the form-related category can possibly be explained by the fact that the target word is too similar in form to the correct

translation, for example *vleien – to flatten* (instead of *to flatter*), and *kronen – to crowd* (instead of *to crown*). Participants could have misread the target words as the correct translations. The mistakes that are made in the semantically related category can possibly be explained by the fact that the target word was too similar in meaning to the correct translation, for example *vleien – to adore* (instead of *to flatter*), and *bevelen – to instruct* (instead of *to command*). Participants could have judged the target words as the correct translation because their meaning was too similar to the meaning of the correct translation. It also became evident that aforementioned word set (DU: *vleien*, TRANS: *to flatter*, FORM: *to flatten*, SEM: *to adore*, UNR: *to cough*) was misjudged the most often (consisting of 24% of the total number mistakes). Possibly, a replacement of these mismatches would cause results that are more in line with the hypotheses.

6.3 *The Influence of Translation Direction and Word Class*

The present study expands on the research of Kroll and Stewart (1994), Talamas et al., (1999) and Kelder (2018). A forward translation recognition task was used, contrary to Kelder (2018) that incorporated a backward translation recognition task. The RHM proposed the notion of translation asymmetry, arguing that forward translation is more difficult than backward translation because it requires the use of conceptual links (Kroll & Stewart, 1994). However, despite the different translation direction, results from the present study and the study by Kelder (2018) are largely similar as both experiments found similar signs of concept mediation. This is in line with results of De Groot and Poot (1997) and La Heij et al. (1996), that argue for concept mediation to be a general process for language translation in both directions. Further research, including both translation directions, should be conducted to elaborate on the differences and similarities between translation directions.

The overall process of verb translation was predicted to be more difficult than noun

translation because concept representations of verbs are more complex than concept representations of nouns (Gentner, 1981; Van Hell & De Groot, 1998); Bultena et al., 2013). However, the specific influence that verbs have on the translation process was difficult to establish because the present study only used verbs as stimulus material. Therefore, an explicit comparison between reaction time and accuracy on verbs and nouns could not be made. Still, the results of present study with regard to concept mediation for more-proficient bilinguals are in line with other studies that have found this effect in a noun translation recognition task. However, deficient research that tested the RHM with a verb translation recognition task has been conducted to generalise the results of verbs compared to nouns. More research should be done in this specific setting to be able to elaborate on this.

6.4 *Limitations*

Several other factors could have influenced the results of the present study. Further research should anticipate on these factors in order to improve on the quality of the experiment. As mentioned briefly before, the proficiency scores of the participants were not normally distributed. As a result, almost all participants had higher-than-average Lextale scores, causing a participant set consisting almost entirely of more-proficient bilinguals. The prediction of the RHM that more-proficient bilinguals show concept mediation can be studied accurately with this set of participants, but it was not possible to accurately compare these results to the results of a less-proficient participant group. Therefore, the predictions of the RHM could not be examined entirely in this context. Further research should ensure two clearly divided proficiency groups in order to be able to investigate the predictions of the RHM in its entirety.

A second remark can be made about the setting of the actual experiment. Measures regarding the coronavirus pandemic made it impossible for the researcher to control the

specific setting in which the participants performed the experiment. The experiment was performed on 32 different computers and/or laptops, which could have influenced reaction times. Next to that, the researcher was not able to ensure that the participants were not distracted during performing the experiment, for example by placing them at a table facing a wall with a noise-cancelling headphone. Reaction times and accuracy scores could be slightly less reliable due to these factors.

7. Conclusion

The present study used the predictions of the Revised Hierarchical Model in order to test whether the predicted shift from word association to concept mediation could be further generalised for forward verb translation. The results of the translation recognition task showed that the interference effect of the semantically related condition was significantly higher than the interference effect of the form-related condition. This suggests that the more-proficient participant set had a larger sensitivity to word meaning than to word form. This suggests the presence of concept mediation for more-proficient bilinguals. However, there was no correlation between proficiency and reaction time, and no correlation between proficiency and accuracy score. There was also no clear less-proficient group to accurately test word association.

Therefore, the present study concludes that more-proficient bilinguals show concept mediation for forward verb translation. This is in line with part of the prediction of the Revised Hierarchical Model that argues for a developmental shift from word association to concept mediation that goes hand in hand with the increase of proficiency in the L2. However, further research should examine word association for less-proficient bilinguals in combination with forward verb translation to possibly expand the generalisation of the Revised Hierarchical Model.

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Appendix

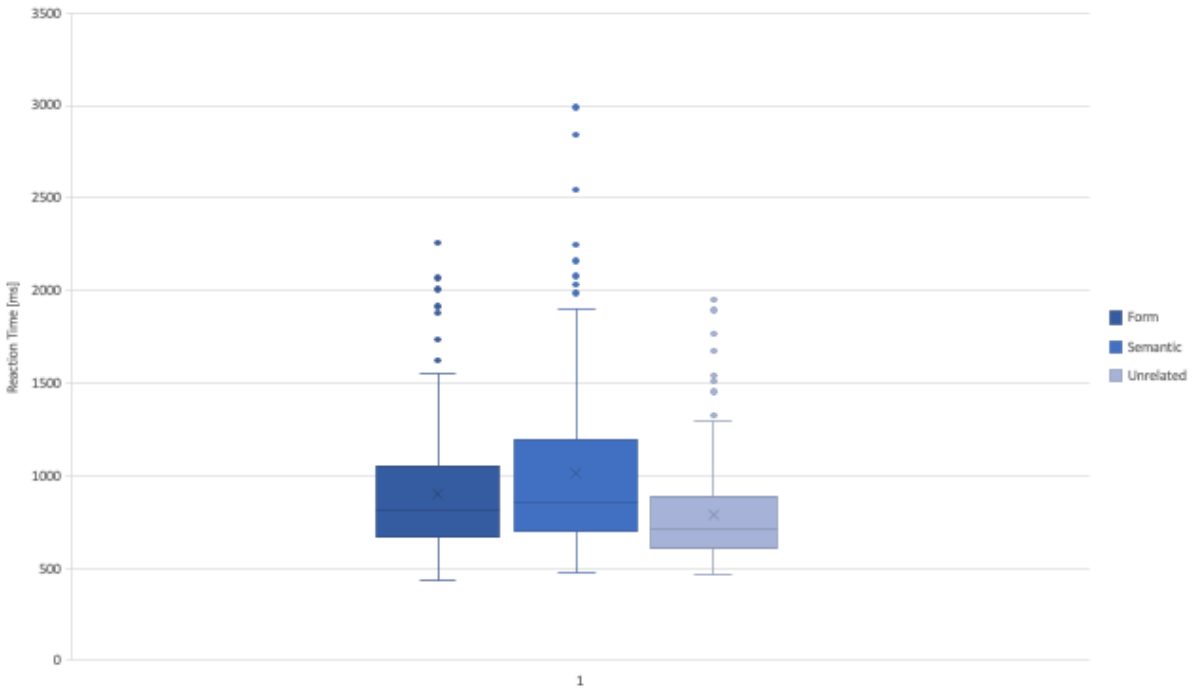
Appendix A) Complete overview of stimulus items

Verb	**Translation**	**Form**	**Semantic**	**Unrelated**
	Length | CobLog | Syllable	*Length | CobLog | Syllable*	*Length | CobLog| Syllable*	*Length | CobLog | Syllable*
Beschouwen	To regard	To regret	To think	To provide
	6 | 2.02 | 2	*6 | 1.20 | 2*	*5 | 3.30 | 1*	*7 | 2.42 | 2*
Betalen	To pay	To pace	To buy	To die
	3 | 2.54 | 1	*4 | 1.04 | 1*	*3 | 2.41 | 1*	*3 | 2.38 | 1*
Bevelen	To command	To commit	To instruct	To irritate
	7 | 1.45 | 2	*6 | 1.72 | 2*	*8 | 1.23 | 2*	*8 | 1.30 | 3*
Bevrijden	To free	To freeze	To desert	To shout
	4 | 1.30 | 1	*6 | 1.65 | 1*	*6 | 1.28 | 2*	*5 | 1.92 | 1*
Bidden	To pray	To prove	To beg	To type
	4 | 1.45 | 1	*5 | 2.17 | 1*	*3 | 1.48 | 1*	*4 | 1.23 | 1*
Bijwonen	To attend	To attach	To miss	To review
	6 | 1.88 | 2	*6 | 1.69 | 2*	*4 | 1.93 | 1*	*6 | 1.32 | 2*
Botsen	To crash	To crack	To shatter	To correct
	5 | 1.28 | 1	*5 | 1.28 | 1*	*7 | 1.30 | 2*	*7 | 1.28 | 2*
Kappen	To chop	To choke	To saw	To fund
	4 | 1.28 | 1	*5 | 1.15 | 1*	*3 | 1.04 | 1*	*4 | 1.11 | 1*
Kloppen	To knock	To knot	To ring	To flip
	5 | 1.72 | 1	*4 | 0.70 | 1*	*4 | 0.70 | 1*	*4 | 0.85 | 1*
Knipperen	To blink	To blind	To watch	To trade
	5 | 1.15 | 1	*5 | 0.95 | 1*	*5 | 2.40 | 1*	*5 | 1.30 |1*
Kronen	To crown	To crowd	To reign	To scent
	5 | 0.78 | 1	*5 | 0.90 | 1*	*5 | 0.85 | 1*	*5 | 0.70 | 1*
Lijden	To suffer	To suffice	To endure	To assault
	6 | 2.08 | 2	*7 | 0.70 | 2*	*6 | 1.28 \ 2*	*7 | 0.95 | 2*
Overwegen	To consider	To consult	To examine	To carry
	8 | 2.32 | 3	*7 | 1.49 | 2*	*7 | 1.89 | 3*	*5 | 2.49 | 2*
Regelen	To arrange	To arrest	To order	To burn
	7 | 1.94 | 2	*6 | 1.53 | 2*	*5 | 1.93 | 2*	*4 | 1.94 | 1*
Schoonmaken	To clean	To cleave	To wash	To slam
	5 | 1.78 | 1	*6 | 0.60 | 1*	*4 | 1.97 | 1*	*4 | 1.18 | 1*
Springen	To jump	To jumble	To dance	To rescue
	4 | 1.83 | 1	*6 | 0.48 | 2*	*5 | 1.82 | 1*	*6 | 1.26 | 2*
Spugen	To spit	To spill	To swallow	To object
	4 | 1.18 | 1	*5 | 1.26 | 1*	*7 | 1.52 | 2*	*6 | 1.38 | 2*
Uitbreiden	To extend	To extract	To stretch	To occupy

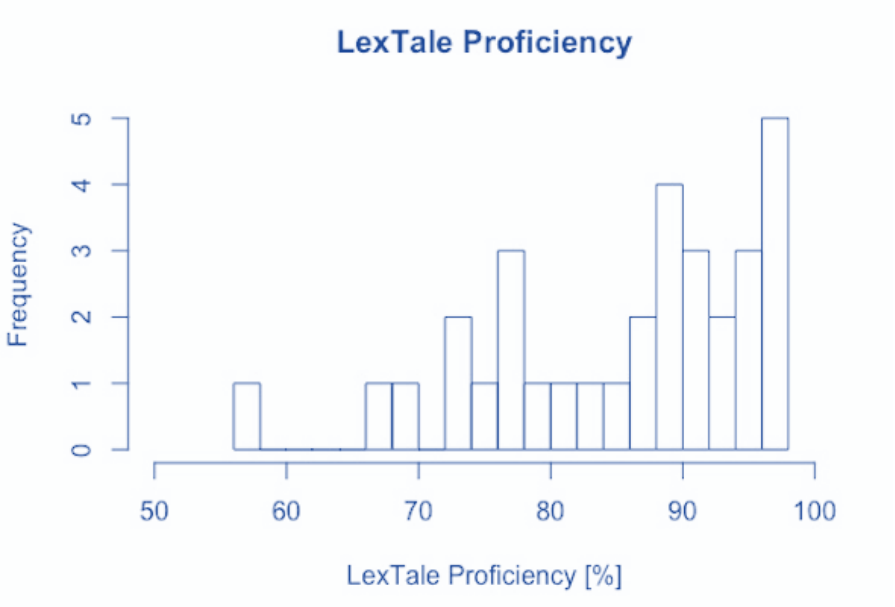
	6 | 1.87 | 2	*7 | 1.23 | 2*	*7 | 1.83 | 1*	*6 | 1.71 | 3*
Veranderen	To change	To charge	To decrease	To consume
	6 | 2.66 | 1	*6 | 1.65 | 1*	*8 | 1.15 | 2*	*7 | 1.38 | 2*
Vertragen	To slow	To slope	To speed	To doubt
	4 | 1.53 | 1	*5 | 0.90 | 1*	*5 | 1.23 | 1*	*5 | 1.53 | 1*
Verwarren	To confuse	To convey	To wonder	To require
	7 | 1.32 | 2	*6 | 1.36 | 2*	*6 | 2.24 | 2*	*7 | 2.28 | 3*
Verlopen	To expire	To expect	To refresh	To prick
	6 | 0.60 | 2	*6 | 2.45 | 2*	*7 | 0.70 | 2*	*5 | 0.70 | 1*
Vleien	To flatter	To flatten	To adore	To cough
	7 | 1.11 | 2	*7 | 0.95 | 2*	*5 | 1.08 | 2*	*5 | 1.08 | 1*
Vormen	To shape	To shave	To build	To marry
	5 | 1.23 | 1	*5 | 1.15 | 1*	*5 | 2.38 | 1*	*5 | 2.10 | 2*
Zetten	To put	To pull	To lay	To cry
	3 | 2.91 | 1	*4 | 2.27 | 1*	*3 | 2.08 | 1*	*3 | 2.08 | 1*

Aanraken	To touch
Begrijpen	To understand
Beloven	To promise
Bevelen	To ordain
Bezetten	To occupy
Drijven	To float
Durven	To dare
Gebruiken	To use
Genezen	To heal
Getuigen	To witness
Grappen	To joke
Krimpen	To shrink
Overdrijven	To exaggerate
Pijnigen	To hurt
Proeven	To taste
Roken	To smoke
Staken	To strike
Vegen	To sweep
Wrijven	To rub
Zoenen	To kiss

Appendix B) Boxplot of reaction times for the three translation conditions (form, semantic, unrelated) identifies outliers.



Appendix C) LexTale Proficiency of the participants



Appendix D) Step-by-step explanation on how to use Lextale

Hoe gebruik ik: LexTale

LexTale is een korte test die aan de hand van korte vragen een score geeft van jouw taalniveau. Om een accuraat beeld te krijgen van jouw niveau van Engels, vraag ik je om dit testje uit te voeren voordat je mijn hoofdexperiment uitvoerd. Onthoud hierbij dat het niet uitmaakt of jouw score 'hoog' of 'laag' is. Lees alle stappen goed door voordat je begint aan de LexTale test.

Stap 1……

Ga naar www.lextale.com tot je het volgende scherm ziet

Stap 2……

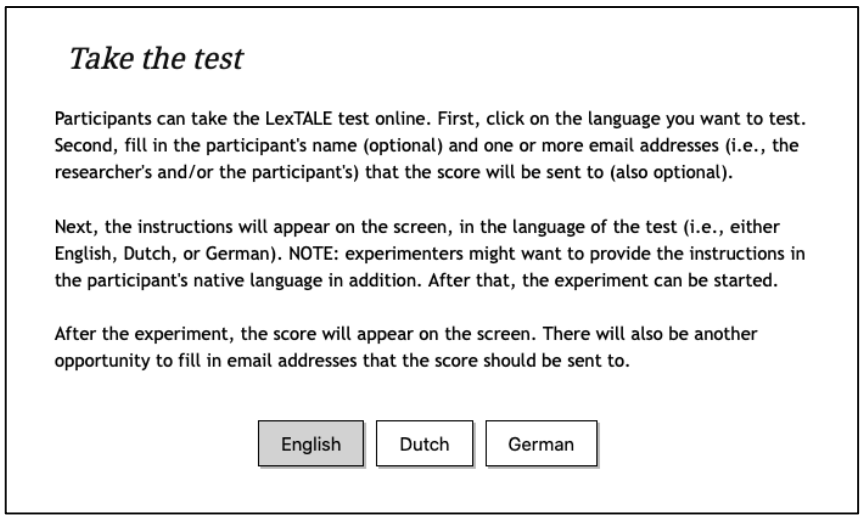
Klik op *Take the Test*, waarnaar je naar een nieuw scherm wordt geleid.

Stap 3……

Klik op *Start LexTALE*.

Stap 4

Vervolgens krijg je het volgende keuzescherm. Kies voor: *English*.

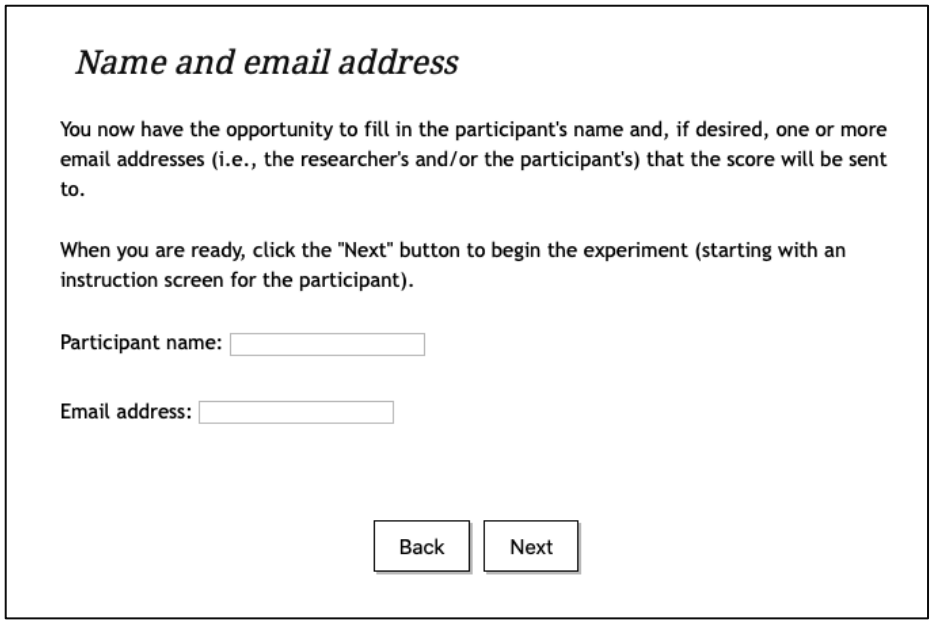


Stap 5

Let op! Bij *Participant Name* vul je je **NIET** eigen naam in. Hier vul je 'Participant' gevolgd door het nummer in wat je van de onderzoeker hebt ontvangen (dus geen willekeurig nummer). Bijvoorbeeld: Participant 0.

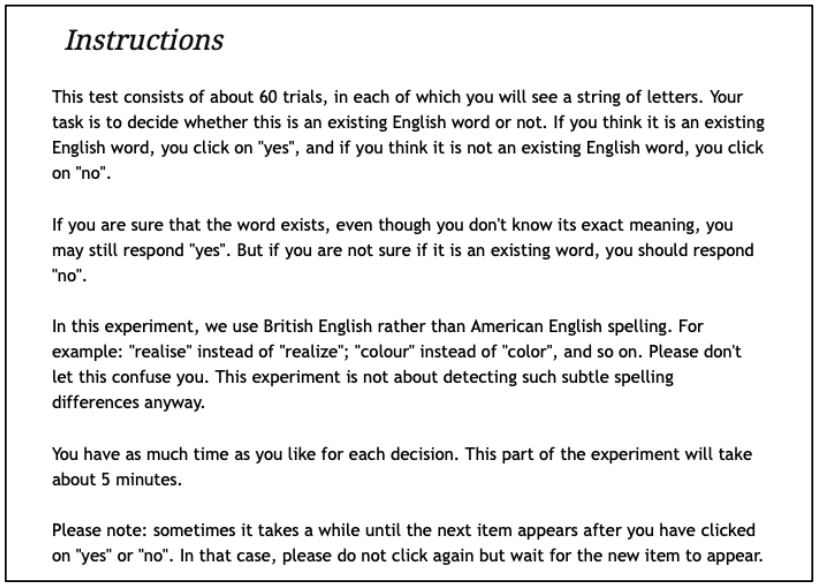
Bij *Email Address* vul je het volgende e-mailadres in:

Indien je zelf ook benieuwd bent naar het resultaat, kan je hierna ook je eigen e-mailadres invullen.



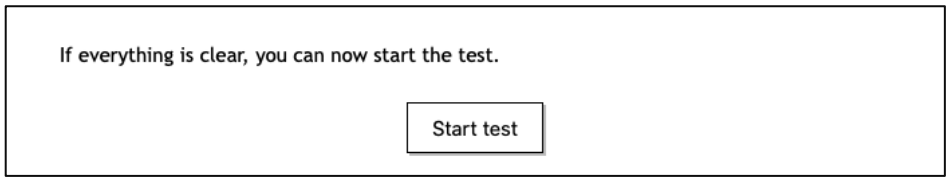
Stap 6……

Lees de volgende instructies goed door voordat je aan de test begint.



Stap 7……

Als je de instructies begrijpt, klik je op *Start Test*. De LexTale taak zal dan beginnen zoals voorgeschreven in de instructies.



Appendix E) Step-by-step explanation on how to download and use OpenSesame

Hoe gebruik ik: OpenSesame

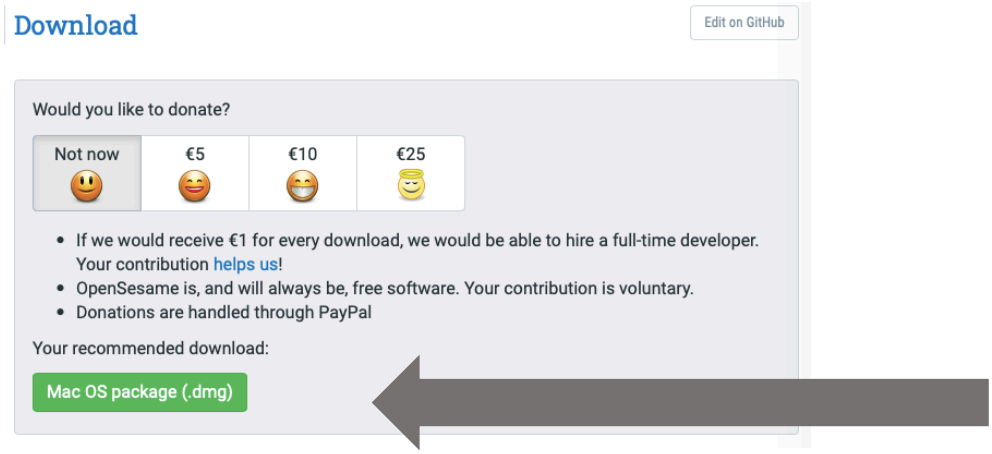
OpenSesame is een softwareprogramma waarmee het experiment wordt uitgevoerd. Het is de bedoeling dat je het programma gaat downloaden op je computer of laptop. Het downloaden van dit programma is (natuurlijk) legaal en kost geen geld. Na het uitvoeren van het experiment kan je het programma weer van je harde schijf verwijderen. Lees alle stappen goed door voordat je begint aan het experiment.

Stap 1……

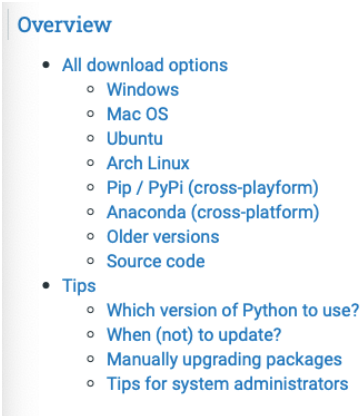
Om OpenSesame te downloaden ga je naar de volgende website:
https://osdoc.cogsci.nl/3.3/download/

Stap 2……

Onder de vraag *'Would you like to donate?'* staat een groene knop waar je het programma kan downloaden (de doneervraag kan je vanzelfsprekend negeren)

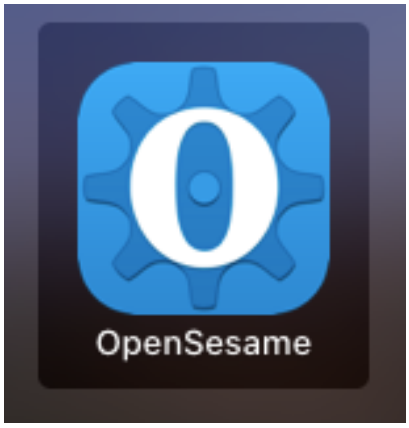


Komt *'Your recommended download'* niet overeen met jouw type computer/laptop? Scrol dan wat verder naar onder voor een overzicht van alle downloadopties:



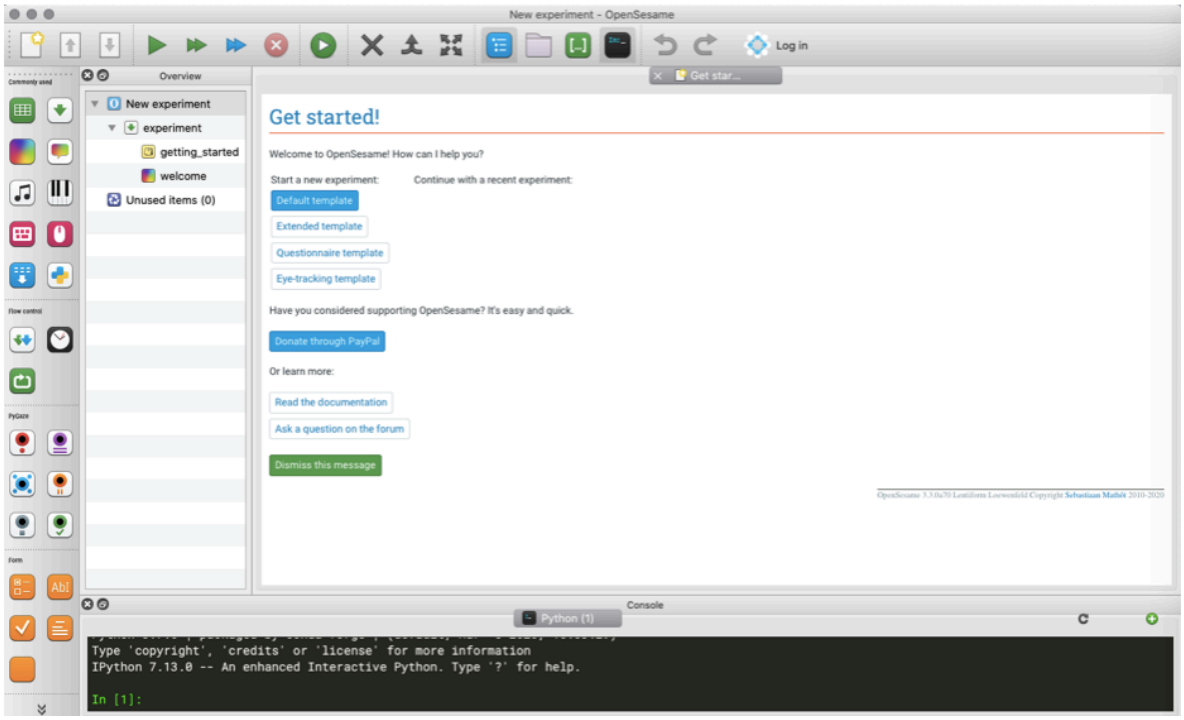
Stap 3

Kies de juiste versie (aan de hand van jouw computer of laptop) en download het programma. Zorg ervoor dat je het programma opslaat op een plek waar je het later terug kunt vinden. Het programma is te herkennen aan het volgende logo



Stap 4

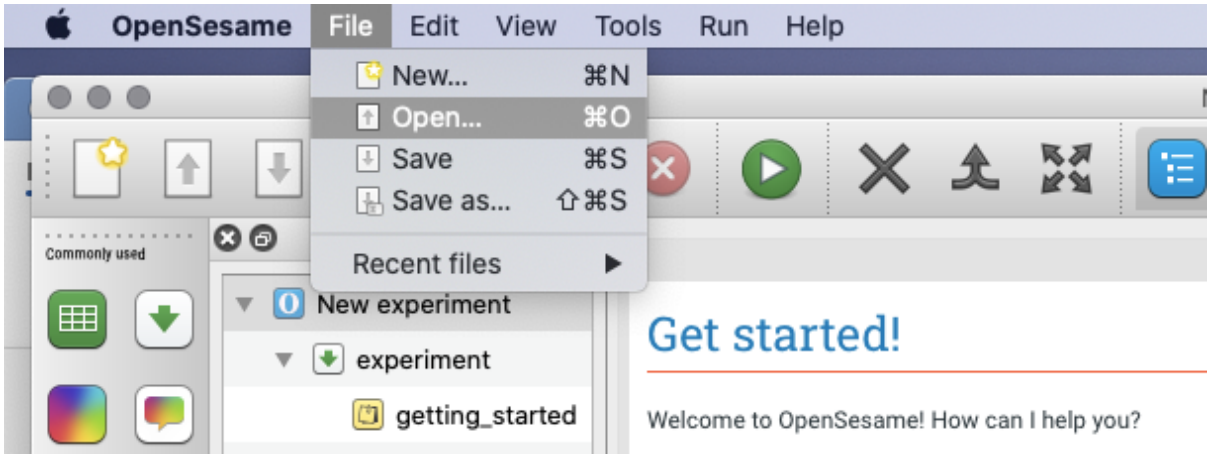
Open het programma door op het logo te klikken. Je krijgt dan het volgende scherm te zien:



Stap 5

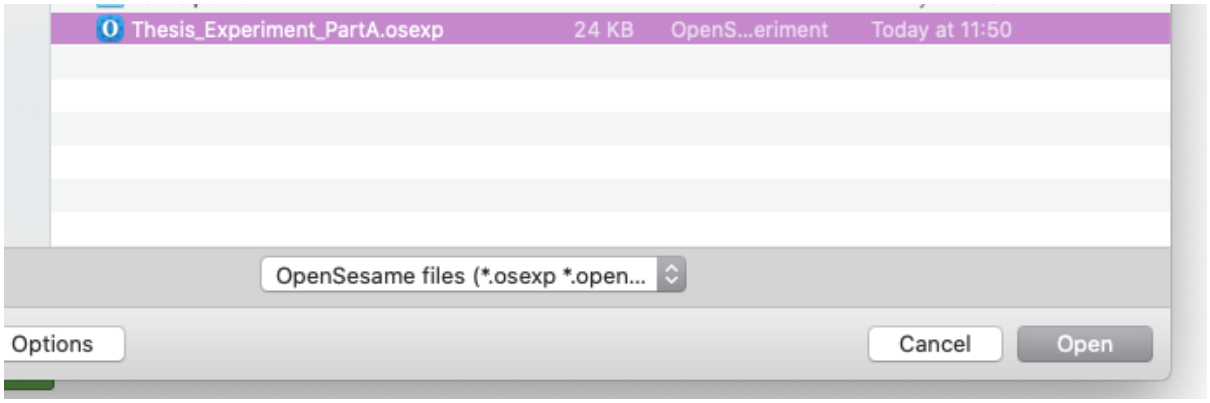
Van de onderzoeker heb je al eerder een OpenSesame-bestand ontvangen. Je zorgt er allereerst voor dat je deze opslaat op je computer of laptop, wederom op een plek waar je hem gemakkelijk terug kunt vinden. Het is nu de bedoeling dat je dit bestand in gaat lezen. Om dit te doen, klik je op de volgende knoppen: File, Open. Let op! Onderstaande afbeelding

is gemaakt op een MacBook. Het kan zijn dat het er bij jou, indien je een computer of laptop van Windows hebt, iets anders uitziet.



Nadat je op ‘Open’ hebt geklikt, krijg je een scherm waarin je het juiste bestand aan kunt klikken. Dit is het bestand wat je eerder van de onderzoeker hebt ontvangen, met één van de onderstaande namen:

- Thesis_Experiment_PartA
- Thesis_Experiment_PartB
- Thesis_Experiment_PartC
- Thesis_Experiment_PartD

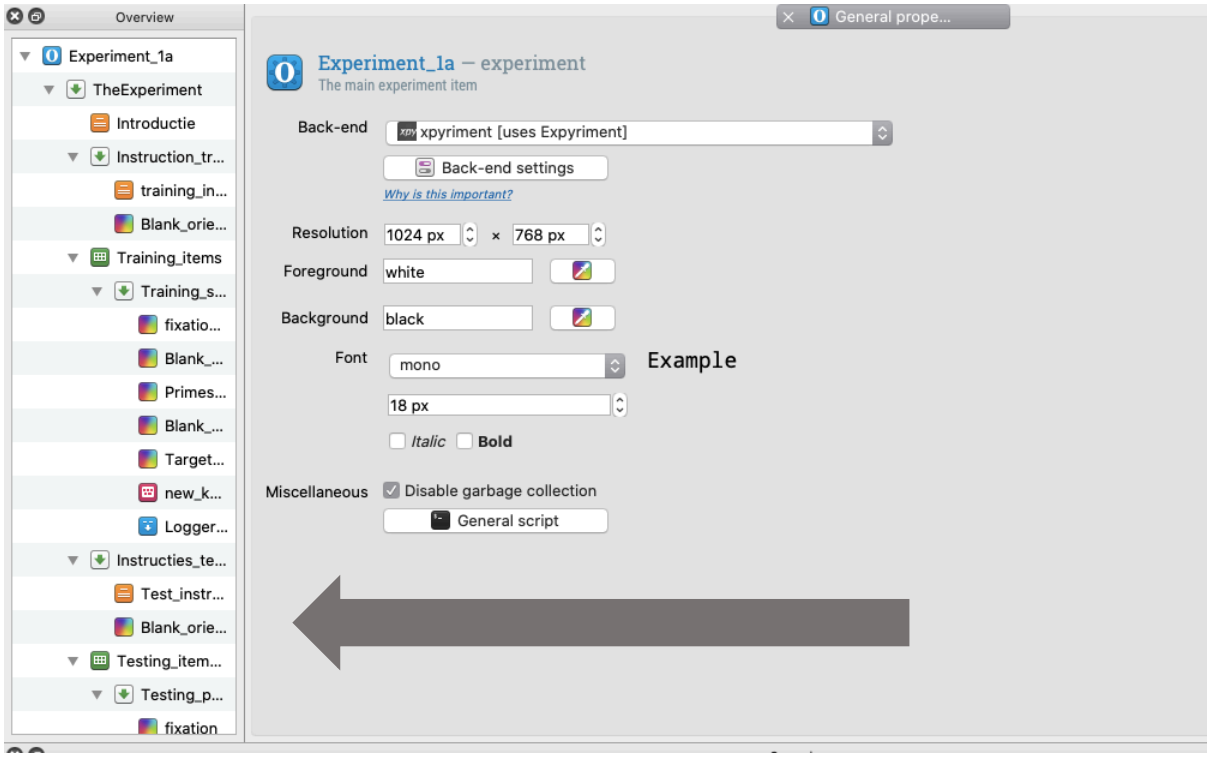


Selecteer het juiste bestand en klik op ‘Open’.

Stap 6……

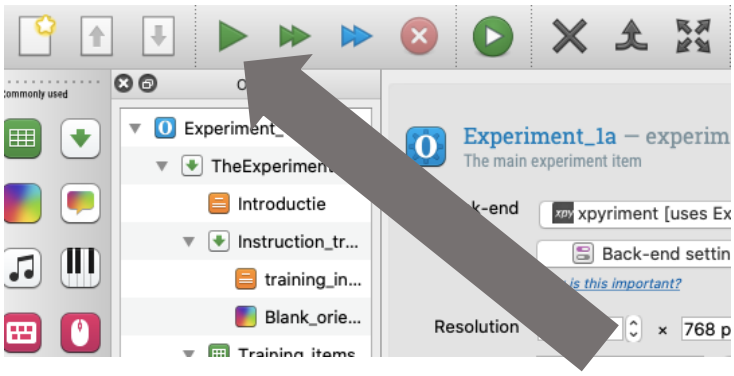
Het juiste bestand wordt nu ingeladen in OpenSesame. Als het goed is, veranderd de lay-out van de Overview van OpenSesame, en zie je allerlei icoontjes met bijbehorende namen aan de linkerkant van het scherm, zoals op onderstaande afbeelding.

LET OP! HET IS ENORM BELANGRIJK DAT JE **NIET** ZELFSTANDIG OP DEZE ONDERDELEN KLIKT. SCROL ER NIET DOORHEEN EN
BLIJF VAN DIT OVERVIEW AF.



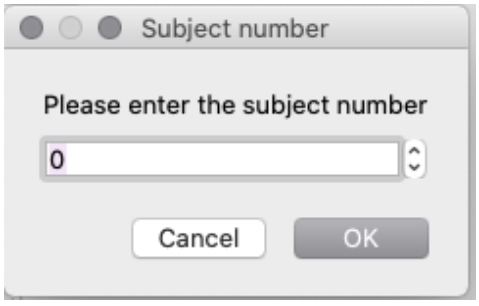
Stap 7……

Klik op de groene startbutton aan de bovenkant van het programmascherm.



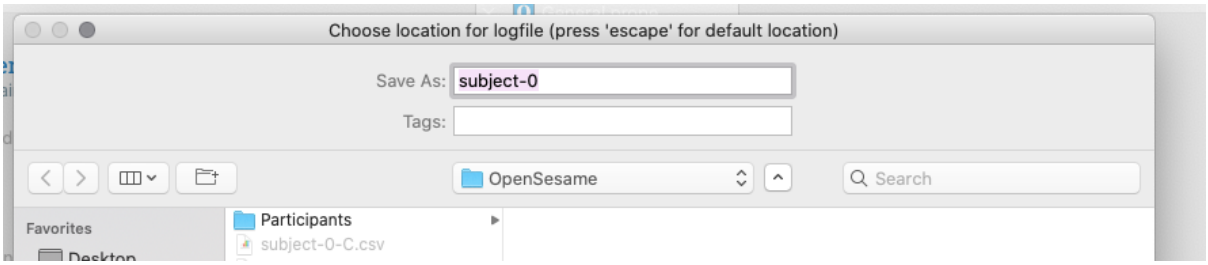
Je krijgt dan de volgende de vraag om een *subject number* in te vullen.

Let op! Vul NIET zelf een willekeurig nummer in. Van de onderzoeker heb je een nummer gekregen. Deze vul je hier in.



Stap 8

Vervolgens krijg je een scherm waar je aangeeft waar je de uiteindelijke output van het experiment opslaat. Let hierbij op het feit dat je de uiteindelijke output opslaat onder de volgende naam: subject-[jouwnummer]. Zorg er wederom voor dat je de output opslaat op een plek waar je het later makkelijk terug kunt vinden.

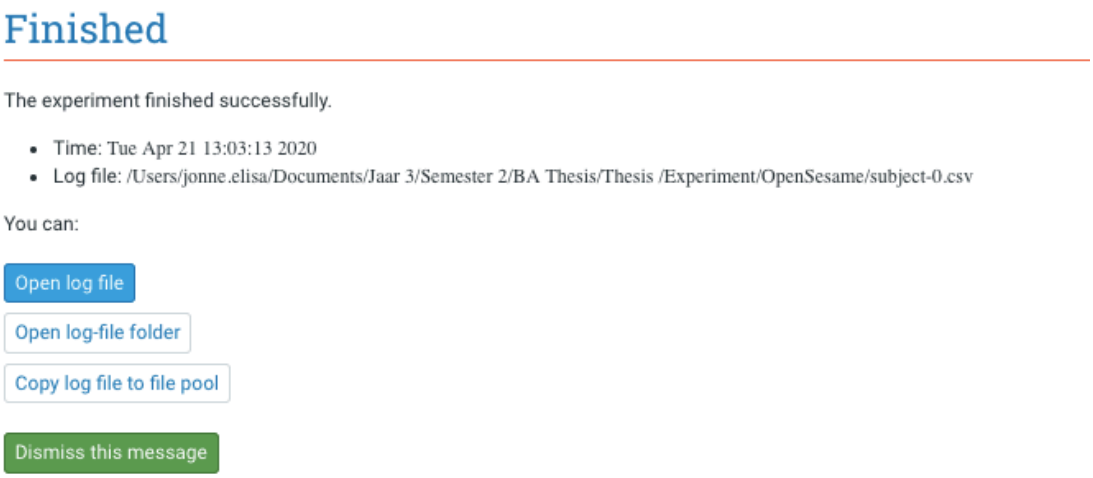


Stap 9

Zodra je op ‘Safe’ of ‘Opslaan’ hebt geklikt, begint OpenSesame met de voorbereidingen van het starten van het experiment. Dit kan een paar seconden tot een minuut duren, en het experiment start hierna automatisch. Wacht rustig tot het experiment wordt opgestart. Volg daarna de instructies op het scherm.

Stap 10

Wanneer het experiment is afgelopen sluit het zich automatisch af en kom je terug naar het beginscherm van OpenSesame. Je ziet dan het volgende scherm voor je



Klik op de knop ‘Open log-file folder’ zodat je kunt zien waar jouw output is opgeslagen. Het bestand met jouw output stuur je terug naar de onderzoeker. Dit mag via whatsapp of via de e-mail.

Heel erg bedankt voor het deelnemen aan het experiment!