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Tip-of-the-tongue states in Norwegian-English bilinguals:

Investigating word-finding difficulties and its connection to bilingual profile

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Acknowledgements

Thank you, family and friends for supporting me on this journey. A special thanks to Siri, my sister, who has been an inspiration to me. You have been of great help, and I could not have done this without you.

Thank you to Susanne, Malin and Linda for keeping my spirits up!

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Introduction

In many places all around the world the use of two or more languages is widespread and bilingualism and multilingualism is deemed to be the norm rather than the exception. How do we acquire multiple languages? How does language processing differ between bilinguals and monolinguals? How does bilingualism shape the mind? The phenomenon of bilingualism raises countless questions and has fascinated researchers for decades. The main focus in research has been on how the two language systems are represented in the bilingual mind and if they are connected. The present study will focus on bilingual speech production and specifically lexical access failures.

Have you ever been engaged in a conversation with someone else (or yourself for that matter) and found that you've had difficulties retrieving a word you know very well? Sometimes you are able to access partial phonological information like initial letter ("I know it starts with a /t/"), or number of syllables, and at times you are unable to retrieve it without some assistance from the one you are conversing with. This sensation is called a "tip of the tongue" (TOT) state, and it occurs when a speaker is unable to produce a word combined with the feeling of being imminently close to lexical retrieval. This occurs frequently for both monolinguals and bilinguals; however, research has found that bilinguals are more likely to fall into a TOTs state when speaking in their second language (L2), and when they are speaking in their dominant language (L1) they tend to experience more TOTs than monolinguals (Ecke, 2004).

In this study we aimed to examine the occurrence of induced TOTs in Norwegian-English bilinguals using a lexical retrieval task in order to investigate the roots of lexical retrieval failures in bilingual word production. There are two main theoretical hypotheses that aim to explain the occurrence of the "tip-of-the-tongue" state. The weaker-links/frequency-lag account suggests that bilinguals are disadvantaged relative to monolinguals on tasks that require lexical retrieval because of their divided frequency of use between two different languages (Gollan, Montoya, Cera, & Sandoval, 2008). According to Michael and Gollan (2005), words of lower frequency (words that are used less in everyday language) are more susceptible to the failure of lexical retrieval relative to high frequency words. The alternative explanation is the cross-language interference hypothesis (Green, 1998; Kroll, Bobb, & Wodniecka, 2006), which suggests that lexical candidates from both languages compete for selection even when the speaker intends to speak in one language.

Bilinguals differ from each other in many ways: Age of acquisition, how they acquired their languages, proficiency, and language use are all variables that may influence lexical processing and thus produce conflicting findings in experimental research. Therefore, as part of our study, we have included bilingual profile as an independent variable. By doing this we will be able to investigate what factors are related to the number of TOTs in both languages of a bilingual. We will then connect these findings to the main theories explaining the bilingual disadvantage.

The structure of this paper will be as follows. The first section will serve as insight into the bilingual disadvantage. Then, the key models of bilingualism will be described with an emphasis on bilingual speech production. Next follows a section on how bilinguals differ and how a bilingual exerts language control. Following this is a section on word translation, comprehension and dual-language activation. A comprehensive overview of previous research on the bilingual disadvantage in word finding ensues to better understand the present study. A brief overview of the primary differences between English and Norwegian will be given, as well as further discussion on the importance of bilingual profiling. Finally, the present study will be explained and connected to the main theories and previous research.

The bilingual disadvantage

Aside from the many advantages that transpire from being a bilingual – such as being able to communicate with people from cultures different to one's own and opening up new social, and career opportunities, evidence from behavioral studies comparing bilinguals and monolinguals furthermore demonstrate advantages in cognitive control (Carlson & Meltzoff, 2008; Prior & Gollan, 2011). These behavioral studies have been accompanied by a range of linguistic tasks that, in addition, reveal the negative aspect to bilingualism. What is evident from these studies is that bilinguals are disadvantaged when it comes to measurements of vocabulary size (Bialystok, Luk & Craik, 2008; Thomas-Sunesson et al. 2016; Friesen, Luo, Luk & Bialystok, 2015). Bilinguals generally name fewer items when compared to monolinguals in naming tests and demonstrate longer naming latencies in picture naming tasks (Gollan Fennema-Notestine, Montoya & Jernigan, 2007; Ivanova & Costa, 2008). Bilinguals also produce fewer items on verbal fluency tasks, in which participants are asked to generate as many words as possible from a given category (Bialystok, Luk, & Craik, 2008). Research has also found that when reading or listening in one language, a bilingual's second language is also activated (Dijkstra and Van Heuven, 2002; Jared & Kroll, 2001). This phenomenon has been labelled dual-language activation. Translation equivalents that share both form, meaning, and phonology are called cognates. An extensive body of research has evidenced that lexical decision (Van Hell

& Dijkstra, 2002; Lemhöfer & Dijkstra, 2004) and picture naming (Costa, Caramazza & Sebastián-Gálles, 2000) in both L2 and L1 is faster for cognates than for matched controlled words. Sunderman and Kroll (2006) investigated lexical processing in two groups of English-Spanish bilinguals (one less proficient and the other more proficient in Spanish), in which the participants did a translation recognition task. The participants were asked to decide whether presented word-pairs (one Spanish and one English) were translation equivalents or not. For each word-pair, there were six distractor words, one form related to the first item (an English word with lexical similarity to the Spanish word), one form related to the second item (a lexical neighbor in English), and one meaning related. The participants were told to answer as fast and accurately as possible. By measuring the time it took for the participants to reject the pairs as translation equivalents, Sunderman and Kroll found that both words that were similar in form and meaning influenced performance (2006). In other words, because of dual-language activation, the bilinguals were slower to reject words that were similar in either form or meaning. Additionally, the findings by Sunderman and Kroll (2006) indicate that cognates may cause latencies due to increased competition.

As previously mentioned, bilinguals are more susceptible to fall into the TOTs state which occurs when a speaker is unable to produce a word combined with the feeling of being imminently close to lexical retrieval. The speaker will on occasion be able to access partial lexical information of the intended word, such as word class, initial or final letter, and the number of syllables. According to Brown and McNeill (1966), this type of speech error phenomenon is quite common and presents itself for monolinguals fairly often in natural settings and about 10-20 % of attempts of retrieving low frequency target words in an experiment setting. Previous research comparing monolinguals and bilinguals have found that bilinguals experience more TOTs when compared to monolinguals (Gollan & Acenas, 2004) and occurs increasingly in older age (Burke, Mackay, Worthley, & Wade 1991).

Two explanations have been posed to explain the bilingual disadvantage: the cross-language interference account (Abutalebi & Green, 2007; Green 1998; Kroll & Gollan, 2014), and the frequency-lag account (weaker links) (Gollan et al., 2005, 2008). The cross-language interference account suggests that a bilingual's nontarget language competes against the target language in production. The frequency-lag account suggests that bilinguals are disadvantaged compared to monolinguals on tasks that require lexical retrieval because of their divided frequency of use between two different languages (Gollan, Montoya, Cera, & Sandoval, 2008). According to Michael and Gollan (2005), words of lower frequency are more susceptible to the failure of lexical retrieval relative to high frequency words. A bilingual's natural use of two languages results in less use of each language, which becomes evident when comparing bilinguals and monolinguals of each language.

In the following section I will discuss the theoretical models that aim to explain lexical selection in bilingual speech production and comprehension, as well as the theories that describe how the two languages of a bilingual are represented. In doing so, I will link the theories to either of the above-mentioned explanations for the bilingual disadvantage. As will become apparent, the dividing lines between the two are not clear-cut and some models lend themselves to both accounts.

Models of language processing

Before exploring the theories that explain bilingual language processing, it will be helpful to look at a speech production model in the monolingual domain, as most bilingual word production models posit similar processing stages.

An influential model was proposed by Levelt (2001), which has a serial two-system architecture, in which production occurs in two stages (as seen in figure 1). The first stage is called lexical selection, where the appropriate concept is chosen from the mental lexicon. Within lexical selection there are three stages, the first being "perspective taking," where the focus is on activating the most appropriate concept among related concepts that are coactivated. Thus, in a situation where the speaker is shown a picture of a horse and asked to name it, concepts like *horse*, *stallion*, and *animal* are all activated at the same time. Each active concept will then spread activation to corresponding lexical items (lemmas) in the speaker's mental lexicon, and the target lemma will be selected after competition. Following the lemma selection, the form encoding system is triggered, where the phonological codes (/h, ɔ, r, s/) are activated and placed together as phonological segments. These segments then form syllables incrementally, and are input to the final phonetic encoding step, creating the "articulatory score". The articulators then interpret this "score" and overt speech is produced (Levelt, 2001).

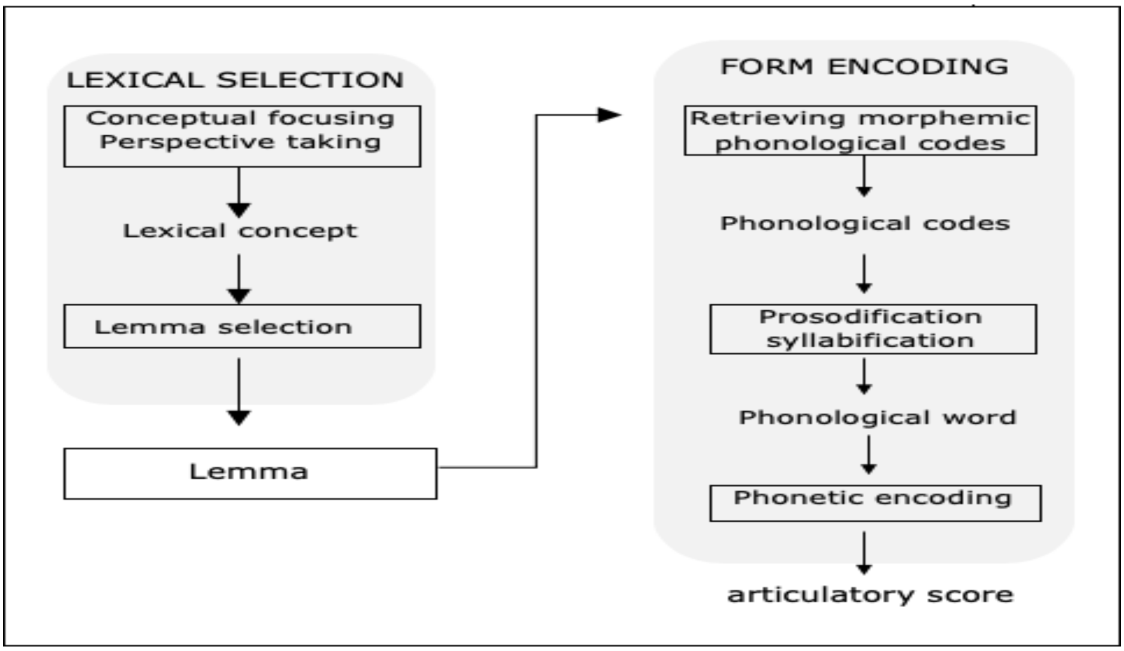

Figure 1: Architecture of spoken word production model (adapted from Levelt, 2001)

Levelt's speech production model is a discreet model, which means that phonological encoding only begins after a lexical node has been selected for production and that the previously activated, but not selected, lexical representations do not activate their corresponding phonological segments. A cascaded model, on the other hand, assume similar activation flow in all levels. In other words, any activated lexical representation will send activation down to its corresponding phonological properties, which in extension would imply that both languages are activated down to the phonological level.

Bilingual word production

A bilingual has a potentially more complex job to perform in speech production than the average monolingual, due to the finding that both languages of a bilingual are constantly active, even when context only requires the use of one language. Costa (2005) evaluated the various views concerning bilingual speech production; how activation flows in the selection processes and whether these are restricted to one of the two languages of a bilingual. Models of speech production primarily have a top-down structure, and similar to monolingual speech production, Costa assumes three levels of representation. The first is the semantic level, where the speaker decides what concept he or she wants to convey. The second level is the lexical level with words and their grammatical properties. The third and last level is where the words are coded for phonology. According to Costa (2001), researchers have previously been unanimous to the idea that language is specified at the conceptual system, so that the activation flow towards the lexical level would be restricted to the words belonging to the target language. However, later models have postulated the idea that activation flows from the conceptual level to lexical candidates from both languages (e.g., Costa, Miozzo, & Caramazza, 1999; Gollan & Acenas, 2004), thereby insisting that language is non-specific at the lexical level as well. The selection of the lexical nodes is followed by the activation of the phonological segments belonging to that node.

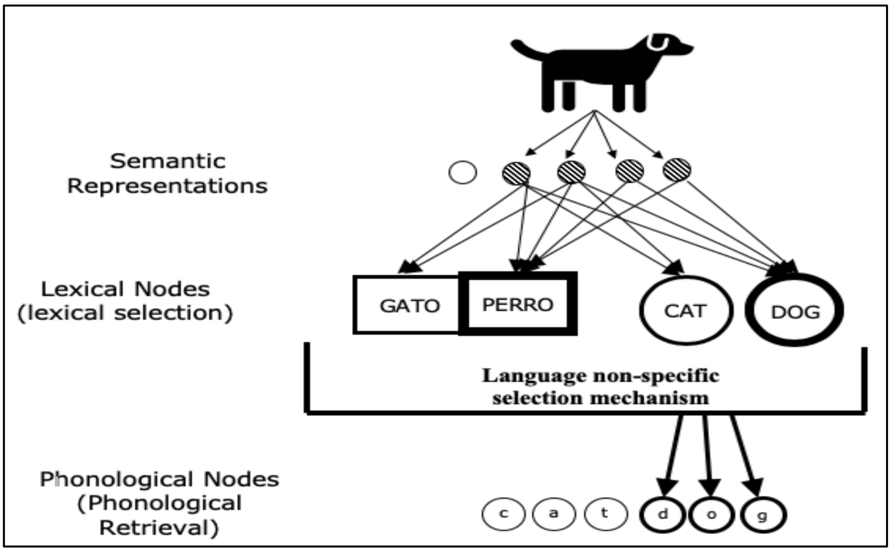

Figure 2: Architecture of the bilingual word production system (adapted from Costa, 2005)

According to Costa there are contrasting views concerning language specificity on the phonological level as well. Discrete models of speech production hold that the selection of the language nodes will filter out unwanted activation and consequently hold off activation from spreading to the phonological level, essentially similar to that of phonological encoding for monolingual speakers (Costa, 2005). Costa does, however, make it clear that the issue of activation flow from the lexical nodes to their corresponding phonological representations is debatable. Based on previous research, Costa argues that the conceptual system will activate both languages of a bilingual at the same time, and that the lexical system is language non-selective.

Inhibitory control in language production and comprehension

Following the notion of non-selective language activation there must be a mechanism to modify the competition that arises in lexical selection and controls performance. One such mechanism is described in the Inhibitory Control (IC) model, proposed by Green (1998) (as seen in figure

5). The model explains in detail how the cognitive system deals with the increased competition in bilingual lexical selection (Kroll & Tokowicz 2005).

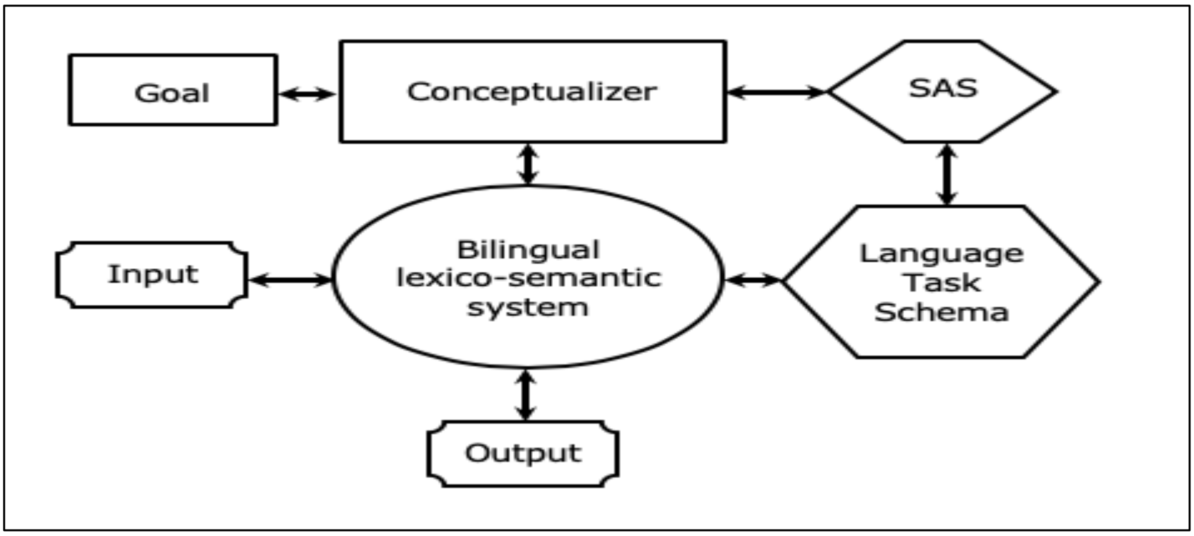

Figure 3: Architecture of the IC model (adapted from Green 1998)

The IC model deals with language production, in which conceptual representations are assumed to be formed at the onset of planning. According to Green (1998), each lexical representation is associated with a language tag, and lexical nodes can be suppressed if they are associated with the non-target language in a particular communicative context. The organization of the IC model is made up of several components, one being the conceptualizer, which builds conceptual representations, driven by a goal (speech, comprehension, or word-recognition). The conceptualizer activates the supervisory attentional system (SAS) and the lexico-semantic system simultaneously. The SAS controls the activation of the task schemas (similar to the task schemas in BIA), which establishes the demands for the task at hand. The fundamental function of the task schema is to trigger lemmas in the intended language of use and at the same time inhibit lemmas in the other language. The semantic system activates lexical nodes in both languages, and the nodes in the non-target language are then suppressed reactively. Inhibition is proportional to the level of activation of the lexical nodes in the non-target language – the more activation the unintended language receives the stronger inhibition is needed. In other words, the lexical candidates that are activated in L1, which is presumably more dominant and will forward more candidates, cause more competition and therefore require greater inhibitory processes. The model thus predicts that language switching costs will be greater when switching from L2 to L1 than the reverse. This prediction was supported by research on language switching (Meuter & Allport, 1999).

Costa and Santesteban (2004) investigated the language switching performance in two groups; L2 learners and highly proficient bilinguals. The aim was to replicate Meuter and Allport (1999), and to test whether proficiency in the participants' L2 would affect the pattern of switching performance (Costa & Santesteban, 2004). In experiment 1 the participants were considered to be L2 learners, with L1 being the dominant language. They were asked to name pictures as quickly as possible in the language indicated by the color of the pictures (red for L1 and blue for L2), thus making them switch between the two languages. The results replicated the asymmetrical switching cost found in Meuter and Allport (1999) – the switching cost was greater when switching into L1 than into L2. Following the hypothesis made by the IC model (Green, 1998), which predicts that switching from L2 to L1 creates a greater switch cost, they did a second experiment in which highly proficient bilinguals performed the same task, predicting the switching cost to be reduced (or possibly even eliminated). The results demonstrated that balanced bilinguals (in terms of language dominance), suffer the same switching costs in both languages, which might be considered a null result (results do not support the predictions). Costa and Santesteban did however attribute these results to inhibition: "[w]hen the difference in proficiency is small (highly proficient bilinguals), a similar degree of inhibition is applied to the two languages and symmetrical switching costs are observed." (2004, p. 498). These findings raise questions of how bilingual profile can affect language control.

Effects of individual differences on bilingual profile

Not only do bilinguals differ in terms of proficiency, but also in what contexts they use their two languages. Green and Abutalebi (2013) proposed the Adaptive Control Hypothesis as an extension of the IC model to explain the various control processes that are involved in language control in different bilingual speakers. In their attempt to describe the various interactional contexts, Green and Abutalebi also describe how bilinguals differ. An L2 learner is considered a bilingual and so are highly proficient bilinguals. This means that there are several groups of bilinguals, and they should be treated as such, at least in an experimental setting. The hypothesis suggests that there are three separate interactional contexts with distinct demands, to which the control processes have to adapt.

In a *single-language context,* each language of a bilingual is used in separate environments, such as using the L2 while at work and the L1 at home. Another example would be that of using one language at school or university, while sticking to the other language with family and friends. Switching between languages rarely happens in this context. In a *dual-*

language context, both languages are used but usually with different individuals. Language-switching may occur frequently in conversations in this context, but not within utterances. In a *dense code-switching context,* speakers alternate between the two languages within a conversation, as well as blending the languages, constructing hybrid utterances. The speakers in a dense code-switching context would also adapt words form one language to the context of the other (Green & Abutalebi, 2013).

The conceptual architecture of the model is made up of the interactional context, *the speech pipeline, control process, and meta-control processes* (as seen in figure 6). The speech pipeline is the conceptual representation of the linguistic sensorimotor that is incorporated in speech production and comprehension. These representations are presumably controlled by processes in working memory to establish the goal of communication. The meta-process sets the parameters of the control processes (Green &Abutalebi, 2013).

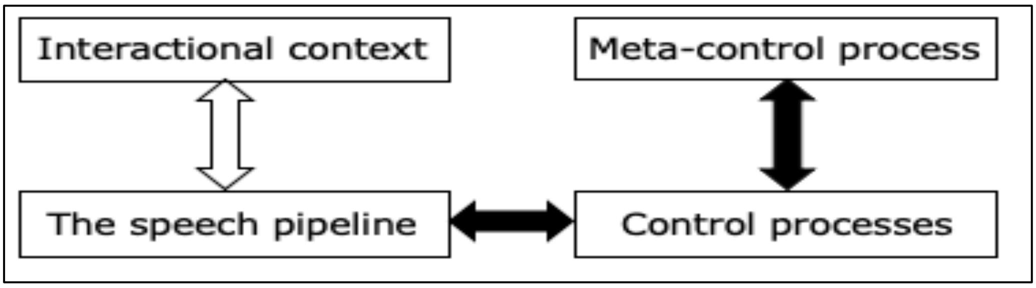

Figure 4: Architecture of the adaptive control hypothesis. Filled arrows represent internal control processes (adapted from Green & Abutalebi, 2013)

As previously mentioned, in Green's inhibitory control model (1998), selecting a language requires the activation of the task schema. In concern with the Adaptive Control hypothesis, Green and Abutalebi surmise that the task schemas are in a competitive relationship in single- and dual- language contexts, in contrast with the dense code-switching context, in which the task schemas are in a co-operative relationship. Green and Abutalebi propose a further breakdown of the control process, seeing as different control processes are being used in each interactional context. According to Green and Abutalebi there are eight control processes. The first control process is labelled *Goal maintenance* and refers to the task of establishing and maintaining the goal to speak in one language and not the other. Disturbances around a conversation, such as nearby speakers of the other language may trigger the other language to a certain extent, which creates the need for interference control to be able to maintain the goal of speaking the intended language. Green and Abutalebi have labeled two control processes: *Conflict monitoring,* which detects conflict, and *interferences suppression* inhibits disturbances. The fourth control process is labelled *salient cue detection,* which signifies cues such as a new speaker entering the conversation, which may require switching to L2. The fifth process is labelled *selective response inhibition,* which stops the speaker from speaking the current language and initiate the sixth process – *task disengagement.* Switching to the other language is the seventh process, labelled *task engagement*. The eighth and last process is labelled *opportunistic planning,* which involves adapting the words of one language to the syntactic frames of the other (Green & Abutalebi, 2013).

Green and Abutalebi assume that the above-mentioned interactional contexts affect the demands on the control processes in different ways. In the single-language context, the control processes are goal maintenance, control monitoring, and interference suppression. The dual-language context requires the same processes, as well as salient cue detection, selective response inhibition, task disengagement, and task engagement. Lastly, opportunistic planning is required in the dense code-switching context – meaning that they modify the words of one language to fit into the syntax of the other. Owing to the fact that speakers in the dual-language context exert more control processes, Green and Abutalebi predict that they will be more accomplished in inhibition, and thus perform better in tasks requiring it, compared to speakers in the other contexts mentioned above (Green & Abutalebi, 2013).

The theory of inhibitory control has been the most common component to explain the bilingual advantage in executive functioning: "inhibition based on the assumption that the nontarget language is suppressed to avoid interference" (Bialystok, 2015 p.118). The positive effects of bilingualism have been found in all stages across the lifespan (Bialystok, 2011), by comparing monolinguals and bilinguals on various tasks that measure different aspects of executive functioning. The explanation proposed for the enhanced executive control found in these studies is that bilinguals use this system to manage attention to jointly activated competing languages. Direct evidence comes from neuroimaging studies of executive control tasks, demonstrating that not only do bilinguals perform these executive control tasks more effectively than monolinguals but hey also recruit different brain networks in those performances (Luk, Anderson, Craik, Grady & Bialystok, 2010; Kałamała, Drożdżowicz, Szewczyk, Marzecová, and Wodniecka, 2017).

The adaptive control hypothesis does, as mentioned, predict that speakers in a dual-language context will be highly skilled in tasks that require inhibition. Prior and Gollan (2011) investigated the possibility that skilled language switchers would be better at other switching tasks compared to monolinguals. In their study, three groups, one monolingual and two bilingual ones completed several non-linguistic (cognitive) and linguistic tasks. In the cognitive task, the participants performed color and shape judgments on visual stimuli, in which they were asked to press buttons in response to shapes (circles and triangles) that were either red or green. The cue for color was a color gradient and the cue for shape was a series of small black shapes. In the language switching task the participants were asked to name digits out loud. When cued by the American flag they named the digits in English, the Mexican flag cued Spanish, and the Chinese flag cued Mandarin. The results demonstrated a smaller switching cost for the Spanish-English bilinguals, but not for the Mandarin-English bilinguals. Prior and Gollan attributed this finding to the fact that Spanish-English bilinguals reported switching languages more often in daily conversations, compared to the Mandarin-English bilinguals. Mandarin-English bilinguals also had lower fluency scores and self-rated their proficiency lower than the Spanish-English group. Prior and Gollan concluded that the advantages in executive control can differ across bilingual populations and therefore emphasize the importance of taking into consideration the varying proficiency levels and language use, and variables such as socio-economic status (2011, p. 689).

In relation to our study, The IC-model is in accord with the cross-language interference account, seeing as competition is at the base of the model, yet the extension of it, the adaptive control hypothesis (Green & Abutalebi, 2013) also speaks for the frequency-lag account. The interactional contexts – *single-language, dual-language*, and *dense code-switching* – describe the individual differences between bilinguals in terms of how they use their two languages. Some bilinguals may use their two languages separately to a larger extent (single-language context), which may comply with frequency of use.

Word translation

The revised hierarchical model (RHM) is a model of bilingual lexical representation and is based on the assumption that a bilingual's two systems are represented separately but share conceptual representation. The relative strength of connections between words and concepts in the bilingual memory are, according to the model, asymmetric in the two languages (Kroll & Stewart, 1994). The assumptions pertaining to this asymmetry is that L1 words have a direct link to their meanings, while L2 words are accessed via their L1 equivalents (as seen in figure 7). This asymmetry reflects the outcome of late acquisition of L2 for bilinguals who already possess a fully developed lexicon for words in L1, yet it is assumed that the links between words and concepts in L2 will strengthen as proficiency increases, making it possible to process L2 words directly. Another consequence of this asymmetry was discovered by Kroll and

Stewart (1994), who found that semantic categorization of experimental stimuli led to co-activation of overlapping conceptual representations and consequently slowed processing from L1 to L2 due to the need for inhibition. Translating from L2 to L1 was found to be processed faster due to its direct lexical connections and was thus immune to semantic manipulation (Kroll & Stewart, 1994).

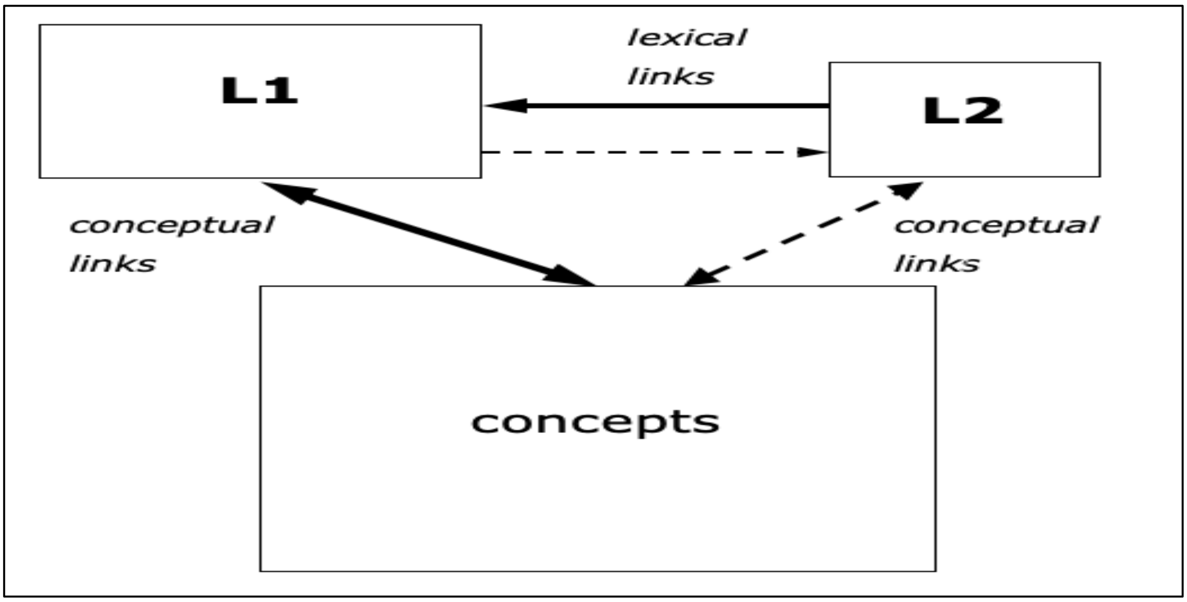

Figure 5: Architecture of RHM, adapted from Kroll & Stewart, 1994

Ibrahim, Cowell, and Varley (2017) proposed that the asymmetries found in Kroll and Stewart (1994) may, however, stem from differences in the frequency of word use across languages, rather than the strength of lexical links. They explored this hypothesis in three experiments. The first experiment was a “within-language synonym task” where they compared access to a high-frequency (HF) vs low-frequency (LF) words to examine the possible asymmetry between the two directions. Monolingual participants were presented with nouns of both low and high frequency and asked to produce a synonym to each word. The second experiment was done in a similar way, except the stimuli was blocked into one semantically related category and one form related category, to learn whether both semantics and form would interfere in retrieval of low-frequency synonyms. In the third experiment, the researchers examined whether two groups of Russian-English bilinguals’ performance on a translation task was modulated by their frequency of L2 use (English). In agreement with RHM, Ibrahim et al. (2017) predicted that the L1 dominant group would translate faster from L2 to L1, while the L2 dominant group were predicted to show the reverse effect; faster translation from L1 to L2.

The results from Experiment 1 demonstrated a significant effect of word frequency, meaning that high frequency synonyms were accessed faster than low-frequency words, which according to Ibrahim et al. (2017) replicates that of the bilingual translation pattern found in Kroll and Stewart (1994). Another significant finding was that concrete items were processed faster than abstract items and even more so in the high- to low-frequency direction. The results from Experiment 2 (HF to LF direction) demonstrated that semantical categorization slowed conversion into LF words significantly compared to the randomized nouns, which again reproduce the findings of Kroll and Stewart (1994). Furthermore, Ibrahim et al. found that form blocking caused a more robust interference, indicating that the interference in Kroll and Stewart and the monolingual synonym task may not have been due to semantics alone, but an indication of LF words' sensitivity to various types of interference (2017, p. 53). The results from the LF to HF direction demonstrated no semantic interference. According to Ibrahim et al. (2017) these results are in line with the translation asymmetry predicted by the RHM. The blocking of form-related words generated interference effects in both directions of synonym production. The results from the third experiment were consistent with the predictions in RHM; Russian-dominant bilinguals translated faster into their L1, and Russian to English translations were more susceptible to semantic interference than the English to Russian translations. The English-dominant bilinguals translated equally fast in both directions but were affected by semantic interference in the English to Russian translations. These results also correspond with the frequency-lag account; HF words were accessed faster than LF words and may indicate that more frequent use of English modifies the translation asymmetry.

Dual language activation

One of the models that proposes non-selective language activation in bilinguals is the Bilingual Interactive Activation model (BIA). Initially put forth by Dijkstra and Van Heuven (2002), the BIA is first and foremost a model relating to word comprehension, with the purpose of explaining how bilinguals retrieve orthographical representations from their mental lexicon that correspond to a written word (Dijkstra and Van Heuven 2002, in Altarriba & Heredia, 2008, p.60). The BIA has a similar structure and parameter settings to that of McClelland and Rumelhart (1981), a model pertaining to monolingual visual perception.

The BIA (as seen in figure 3) assumes a bottom-up activation, which means that perception is initiated by presentation of stimuli, e.g. a written word. BIA is a computational network model, structured by four hierarchical levels (letter features, letters, words and language nodes), that interact and are activated in unison. When a string of letters is presented, features represented by the letters in the different positions are activated and in turn excite letters that contain similar features and simultaneously inhibit letters with contrasting features. The letters further excite words in both languages containing the letters in the correct position and inhibit the words with letters in the incorrect position.

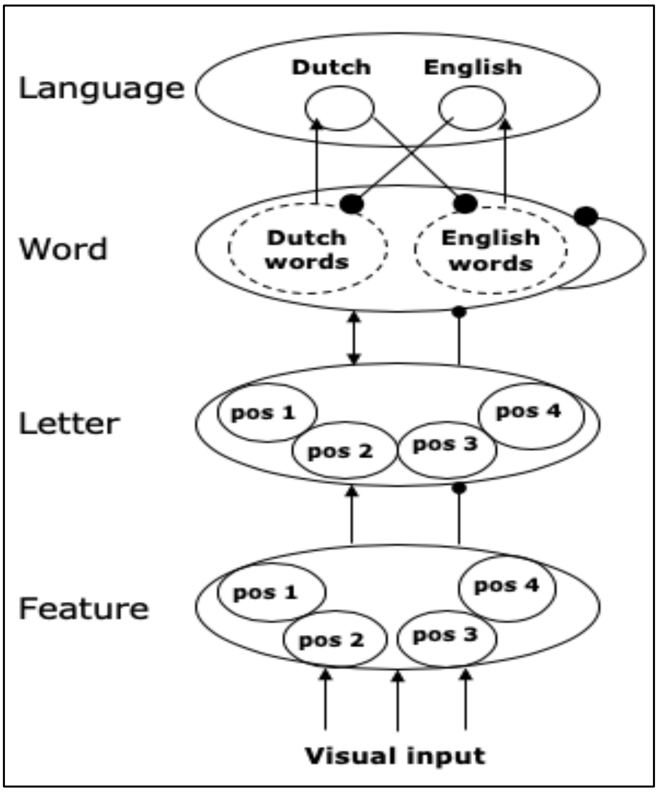

Figure 6: Architecture of the BIA model (adapted from Dijkstra & Van Heuven, 2002)

At the word level, the BIA assumes two integrated lexicons (one for each language), in which lexical access is parallel and non-selective. This essentially leads to competition for selection between the lexical alternatives from both languages, compared to a system with two separate lexicons, where competition effects are limited to only one language (Dijkstra & Van Heuven, 2002). When a word is presented, they activate language nodes, while simultaneously sending activation back to the letter level. The activated language nodes inhibit competing words from the other language lexicon and word recognition occurs when the level of activation of a word surpasses a recognition level, depending on such factors as how similar the words are across the two languages, word frequency (number of occurrences in a given corpus), recency of use, and L2 proficiency (Dijkstra, 2005).

The BIA was later extended and renamed BIA+ by Dijkstra and Van Heuven (2002) and incorporates semantic and phonological representations as part of the word recognition process (as seen in figure 4) This means that orthographic inputs activate associated phonological and semantic representations, as well as associated language nodes, which act as a marker in specifying a words' language membership (Van Heuven & Coderre, 2015). According to Dijkstra and Van Heuven (2002) it is the input word's likeness to the internal lexical representations that determines the level of activation, rather than what language it belongs to. The BIA+ also includes a task schema with the ability to influence output following lexical access, to control for non-linguistic factors, such as task demands, participant expectations, and instructions. The task schema continuously interprets input from the word recognition process in order to produce contextually correct output (Libben, Goral & Libben, 2017, p. 110).

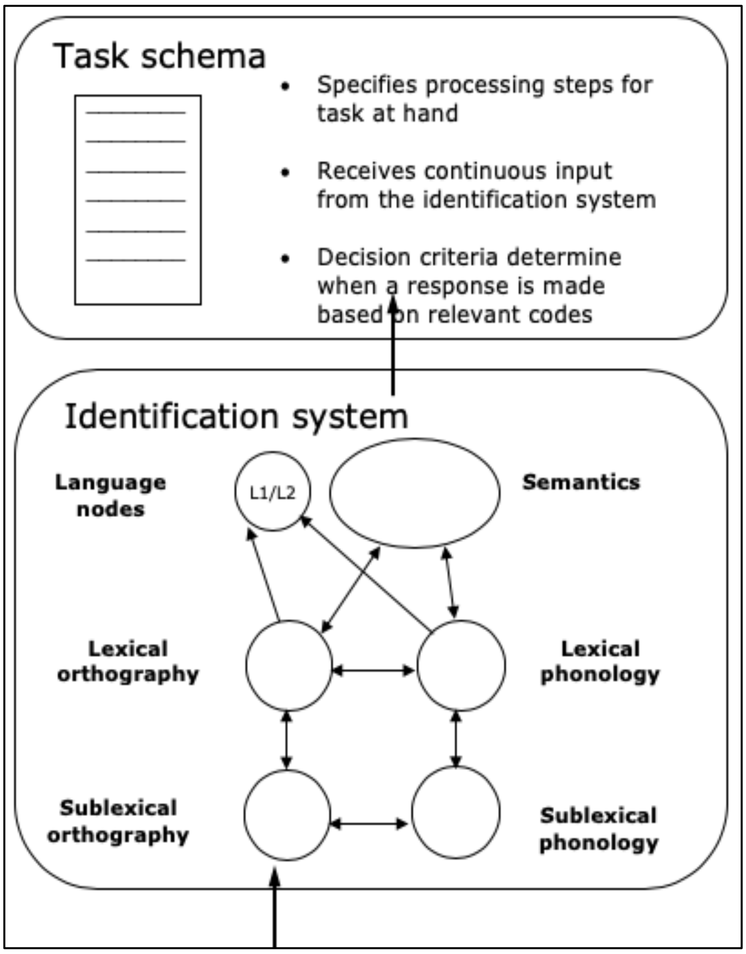

Figure 7: Architecture of the BIA+ (adapted from Dijkstra & Van Heuven, 2002)

If lexical access is non-selective across languages, as predicted by the BIA+, the consequences of cross-language activity should influence performance. Dijkstra and Lemhöfer (2004) provided evidence of such cross-language activity by investigating Dutch-English bilinguals' performance on lexical decision tasks. The participants were aurally or visually presented with a range of words and non-words and asked to indicate whether the presented items were words or not, with the press of a button. In the generalized lexical decision tasks, the participants were presented with words from both languages, as well as non-words that comply with the phonotactic rules of both languages. Dijkstra and Lemhöfer (2004), predicted that the participants would recognize cognates faster, thus facilitating the word-retrieval process.

The results suggest that cross-linguistic orthographic and semantic overlap in the test items led to facilitation as predicted. In the generalized lexical decision tasks, response times were faster for cognates and more accurate than the English and Dutch control words. They suggested that cognates were processed faster due to the shared semantic representation, which feeds back to the orthographic representations, and in that way strengthens both activations. The evidence provided by Dijkstra and Lemhöfer (2004), supports the BIA model, specifically by demonstrating that cognates facilitate processing.

The above-mentioned models each give possible descriptions for speech production, word recognition- and translation. To be able to account for all of these components of language processing, Dijkstra et al. (2018) proposed a computational model that combines several characteristics of BIA+ and RHM. Multilink can be used to simulate both monolingual and bilingual processing of words of varying length, frequency, and cross-linguistic similarity, such as cognates and interlingual homographs. The model can simulate processing of tasks such as lexical decision, orthographic and semantic priming, word naming, and production of word translation. Multilink can also account for varying L2 proficiency due to its ability to fine-tune lexicon and parameter settings.

The architecture of Multilink (as seen in figure 8) is structured in six layers; input, orthography, language, semantics, phonology and output. The model is interactional, which means that activation flows in both directions. Written input will activate various lexical-orthographic representations, which in turn activate their semantic and phonological counterparts, as well as associated language membership representations (Dijkstra et al., 2018). Similar to BIA+ and RHM, Multilink assumes that lexical retrieval is a nonselective process. The bilingual lexicon is integrated, meaning that there is just one pool of words from the two (or more) languages. The activation of competitors from one or two languages depends on their orthographical overlap with the input word. Activated words that receive no further input will eventually decline towards its resting level of activation. Each word's resting level activation depends on its frequency.

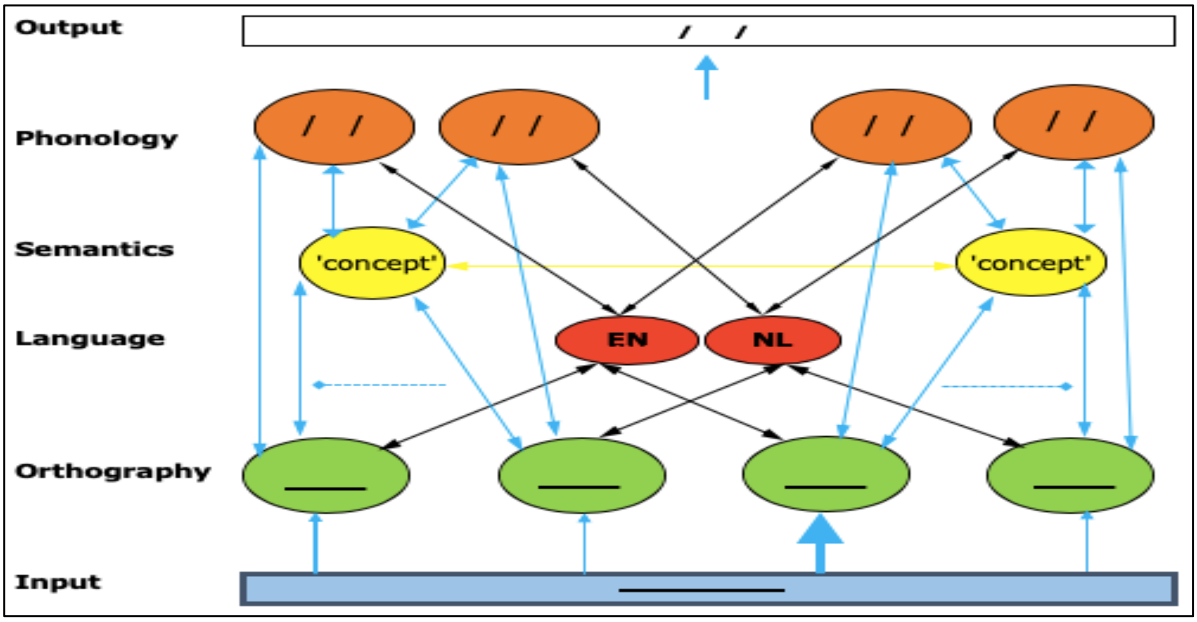

Figure 8: Architecture of Mulitlink (adapted from Dijkstra et al. 2018)

Additionally, the model illustrates that orthographical representations in one language are only indirectly linked to phonological lexical representations in another language (Dijkstra et al. 2018). Multilink demonstrates that translation equivalents are only linked through semantics and not through a word association route, thus contrasting with the RHM. Furthermore, it has a task/decision system that selects representations for output, sets parameters, and specifies responses according to context, much like the task schema in Green (1998). The task/decision system may check the degree of activation at the orthographic, phonological, or semantic layers, and check for language membership in both input and output (Dijkstra et al. 2018).

Dijkstra et al. tested multilink by performing a series of simulations on data from prior studies (Dijkstra et. al. 2010; Vanlangendonck, Rueschemeyer, & Dijkstra in preparation; De Groot, 2011) on word comprehension, word naming, and word translation to demonstrate its applicability in handling retrieval of words of different lengths, frequency, language membership, and cognate status. According to Dijkstra et al. (2018), Multilink serves as a starting point of a more general computational model for word retrieval in both comprehension and production (p.20).

Evaluating theories of the bilingual disadvantage in word-finding

In this section I will examine the various findings related to the bilingual disadvantage in lexical access, with emphasis on the studies that have focused on the two explanations pertaining to it – the frequency-lag account and cross-language interference. By looking at both accounts from different perspectives I will endeavor to disentangle the two, while at the same time demonstrate that one account cannot truly be singled out as the sole basis for the bilingual disadvantage and the TOT phenomenon.

Gollan and Acenas (2004) tested the nature of the tip-of-the-tongue state in two different bilingual groups; Spanish-English bilinguals who had acquired their two languages at an early age and had lived most of their lives in an English-speaking environment, and Tagalog-English bilinguals who reported having spent a more balanced number of years in both language environments. The participants were asked to name pictures and were compared to a monolingual control group. If they were unable to produce the target word, they were asked if they were experiencing a TOT and if they could report on the characteristic of the word (initial letter and number of syllables). If they were still unable to produce the target word, the experimenter told them the word and asked whether this was the word they had in mind or not. Gollan and Acenas reported that bilinguals did show more TOTs compared to the monolingual group, but cognates had a facilitatory effect in that they were able to retrieve the correct target word when they knew it in both languages. This was also found when they limited the comparison to bilinguals who rated their English as near native-like and were able to produce the same number of correct target words, which demonstrates that a higher number of TOTs was not due to relative differences in proficiency. The facilitatory effect from cognates, and the target words' relative translatability were interpreted as evidence against the cross-language interference hypothesis because it clearly predicts the exact opposite, that the non-selective activation of the second language should lead to retrieval failures. The authors did however include the possibility that less proficient bilinguals may be more subject to cross-language interference (Gollan & Acenas, 2004).

Further testing of the bilingual disadvantage was done by Gollan, Montoya, Cera, and Sandoval (2008) in two separate experiments. The first experiment compared English monolinguals' and English dominant Spanish-English bilinguals' performance on a picture-naming task. In line with the frequency-lag account, they predicted larger frequency effects in the bilingual group relative to monolinguals, and larger effects for Spanish within the bilingual group. Monolinguals named all 132 pictures in English, the bilinguals' naming was divided in three sections, English, Spanish, and either-language, with 44 pictures in each section. They found that bilinguals named pictures more slowly compared to monolinguals, and this disadvantage was more prominent for low-frequency words. Bilinguals were also slower to name in the non-dominant language (Spanish) compared to monolinguals. Gollan et al. (2008) attributed this frequency effect to reduced language use, directly supporting the frequency-lag account.

According to the frequency-lag account, increased use as time passes should lead to smaller frequency effects in older bilinguals compared to young monolinguals. Findings of greater frequency effects in older adults (Chae et al., 2002; Balota & Ferraro, 1993; Spieler & Balota, 2000) constitute a problem for the frequency-lag account (Gollan et al., 2008). The cross-language interference account, on the other hand, predicts that the bilingual advantage should increase as time passes, as old age is thought to diminish the ability to control the competition between two languages (Hernandes & Kohnert, 1999). Gollan et al. (2008) assert that the findings of larger frequency effects in older bilinguals might be due to age-related cognitive decline. To examine this further, they used the same stimuli as in experiment 1 to test cognitively healthy older monolinguals and Spanish-English bilinguals. The older bilinguals did not differ from the younger bilinguals in terms of dominance, reported use of English, or age of exposure to English. Experiment 2 replicated the results from experiment 1, but comparisons between the two indicated a difference in frequency effect; younger bilinguals demonstrated very large frequency effects in the non-dominant language (Spanish), compared to older bilinguals who demonstrated equal frequency effects in both the dominant and non-dominant language. Collectively, the results from both experiments challenge the cross-language interference account.

Previous studies on the TOT phenomenon in bilinguals did not control for variables such as syllable position and target word length. A TOT study on European Portuguese monolinguals (Pureza, Soares, & Comesana 2013), found that TOTs were resolved from priming of the last syllable in nonwords. Pureza et al. (2016) investigated these findings further in European Portuguese – English bilinguals and monolinguals, where they induced TOTs using a picture naming task in both languages and a lexical decision task. The bilinguals all had European Portuguese (EP) as their L1 and were highly proficient in their L2 (English). The stimuli (words represented by pictures) differed in terms of cognate status (cognate/noncognate), syllable position and word length. For each of the 80 target words, 16 phonetically related words (8 words and 8 nonwords) were created in each language and used in a lexical decision task following the naming of each picture. Syllabic nonword homophones were imbedded in some of the words for the lexical decision task to manipulate the TOTs and test TOT resolutions. The experiment was run in two parts, one for each language. The participants were asked to name pictures and indicate whether they knew the word or not by pressing designated keys on a keyboard representing *know, don't know* or *TOT.* If they pressed *know,* they typed the word. Following this was a lexical decision task in which they were asked to indicate whether the presented string of letters was a word or not. If the participants responded with a TOT, they were again presented with the previously seen picture and got a second chance at resolving the TOT state. In a previous study with EP monolinguals, Pureza et al. (2013) found that TOTs were resolved due to priming of the last syllable of the target word rather than the first, even when target words consisted of four syllables. According to Pureza et al. (2015) this surprise finding might be because the longer words' baseline level of activation within the TOT were already higher than that of shorter words. Results demonstrated a higher number of TOTs in L2 compared to L1, and the participants had more TOTs for noncognates than for cognates. Pureza et al. (2015) also found that bilinguals demonstrated more TOTs for longer words when performing in EP, but not for English. The results on TOT resolution were also affected by cognate and word length, and as expected, they found that bilinguals demonstrated more TOT resolutions for three-syllable cognates than two-syllable cognates. Priming for the last syllable as in Pureza et al. (2013) was, however not found; bilinguals who were primed by the first syllable resolved more TOTs than those who did not receive phonological priming or were primed by the last syllable (only borderline significant). Pureza et al. note that their findings of more TOTs in L2 than in L1, and more TOTs for noncognates were in accordance with the frequency-lag account (2015).

A version of the TOT states is also found for people who use sign language, which is called tip-of-the-fingers (TOF) (Thompson, Emmorey, & Gollan, 2005). Bilinguals who are fluent in a spoken language and a sign-language are called bimodal bilinguals. Pyers, Gollan, and Emmorey (2009) tested bimodal bilinguals to determine the source of the TOT states. They compared performance between English monolinguals, bimodal English bilinguals and Spanish-English bilinguals on a picture naming task with low-frequency words. When participants were unbale to retrieve a word, they were asked if they were in a TOT state. They had 30 seconds to try and retrieve the word before the experimenter told them the word. They were then asked if they knew the word and if it was the word they had in mind. The responses were classified in 5 categories: 1. GOT (correct retrieval), 2. +ToT for a failed or self-resolved retrieval of target, 3. -ToT for retrieval of incorrect target, 4. NotGOT for failed retrieval of a later recognized target, 5. PostDK (don't know) after being told the word. Pyers et al. (2009)

found that bilinguals had more +TOTs, more true TOTs, and less GOTs than monolinguals. Comparisons between unimodal (Spanish-English) bilinguals and bimodal bilinguals showed no difference in the number of TOTs (all categories). Pyers et al. argue that their findings cannot exclusively be associated with cross-language interference at the phonological level because there is naturally no need for phonological coding in sign language. Bimodal bilinguals had fewer -TOTs (retrieval of correct target), and slightly more correct retrievals (GOTs). In light of these findings, Pyers et al. (2009) assume that the majority of retrieval failures occur at the earliest level due to semantic blocking, or at the lemma or form level. This assumption would explain why bimodal bilinguals showed a trend towards more correct retrievals, in that they could avoid the minority of errors that occur at the phonological level, having no need for phonology. Pyers et al. (2009) do however, disregard the possibility for cross-language interference in this case, because previous findings have determined that bimodal bilinguals do not demonstrate advantages in executive function as observed for bilinguals (Carlson & Meltzoff, 2008; Bialystok, Luk, & Craik, 2008; Thomas-Sunesson, Hakuta, & Bialystok, 2018). Another possible explanation for their findings was the fact that bimodal bilinguals may use their languages more often than unimodal bilinguals. Some of the participants in the bimodal bilingual group (13 out of 22) were interpreters who often speak and sign at the same time, which means that they may use both languages at a higher frequency than unimodal bilinguals, resulting in slightly better retrieval.

The findings mentioned above all point to frequency of use to be the main source of the bilingual disadvantage, yet the equally demonstrated dual-language activation, led Gollan, Ferreira, Cera and Flett (2014) to investigate the possibility that reduced frequency of use and dual-language activation (and by extension cross-language interference) operate together in inducing the bilingual disadvantage in speech production. Gollan et al. (2014) therefore investigated whether translation equivalents (as predicted by the cross-language interference account) could explain why bilinguals are disadvantaged compared to monolinguals regarding the TOT state. Two groups of English dominant Spanish-English bilinguals participated, each in one experiment. In the first experiment, participants were presented with three Spanish words and asked to produce three semantically related words, after which they were shown a picture of an object they had to name in English. On half the trials, the Spanish translation equivalent was included among the list of primes, while the other half only held unrelated primes. If dual-language activation would affect the TOT rate, the Spanish translation primes was expected to cause an increased number of TOTs compared to the trials with unrelated primes. In addition to TOTs, they measured the time it took for the participant to name the (correct) object, to see if facilitation and competition effects arise at separate stages in processing. Previous studies have mainly focused on how the dominant language affects production in the less dominant language, and as a consequence, Gollan et al. (2014) focused their study on production of English target words.

The participants were explained the nature of a TOT before testing started and were instructed to report TOTs whenever they were unable to retrieve a word. If participants were in a TOT state, the experimenter waited a few seconds, before divulging the target words and asked if it was the word the participant was thinking of, and if they knew the word. The answers were classified as either GOTs, TOTs, or Other. The results demonstrated that primes from the less dominant language (Spanish) induced more TOTs compared to unrelated primes. This finding suggests that dual-language activation can increase the number of TOTs in bilinguals, which is consistent with the cross-language interference account. An additional finding in experiment 1 was that translation primes also caused faster naming of correct targets. For experiment 2, Gollan et al. (2014) changed the semantic association task to a phonological association task; asking the participants to produce phonologically related words, when presented with each Spanish prime. The results from experiment 2 was similar to that of Experiment 1, except for naming, times; there was no facilitation from translation primes compared to unrelated primes. According to Gollan et al. (2014), the findings are compatible with both the frequency-lag account and interference account.

From the above-mentioned evidence of the bilingual disadvantage in word finding, we can acknowledge that research do sometimes yield contrasting results. The components in the two main hypothesis' of the bilingual disadvantage in word-finding seem to be intertwined in a way that is particularly difficult to unwind. There is a strong consensus among researchers that frequency of use does influence lexical retrieval, but due to the robust finding of dual-language activation, the account of cross-language interference has as of yet not been invalidated. The next section will report on measuring language profile. As will become apparent, bilingual profiling is essential when investigating lexical processing in bilinguals.

Measuring Bilingual Profile

Bilinguals can differ from each other on a number of factors, such as age of acquisition (AoA), in what manner their languages were acquired, language use and history, and degree of proficiency, and dominance. According to Marian, Blumenfeld and Kaushanskaya (2007), inconsistencies found in research with bilinguals in lexical, phonological, and orthographical processing are all due to these differences. A previous study investigated the relationship between self-assessed proficiency and language performance in Spanish-English bilinguals (Delgado, Guerrero, Goggin, & Ellis, 1999). The participants were given a questionnaire and asked to rate their language skills based on everyday usage. Following this, they completed a picture-naming task, and Woodcock-Munoz subtests of language skills (Woodcock & Munoz-Sandoval, 1993). When comparing the self-assessed questionnaire with performance in these tasks they found that the participants had assessed their Spanish language skills more accurately than their English language skills. The participants were able to assess their oral language skill, and their reading/writing skills in Spanish in a way that correlated with their performance, while the assessment of oral skills in English did not correlate with the language tasks. The evaluation of their reading and writing skills in Spanish, on the other hand, correlated significantly with the Woodcock-Munoz subtests. Delgado et al. surmised that bilinguals, immersed in a school where English is the language of instruction, get more feedback on their reading and writing skills as opposed to their oral skills, which is more usual in a second language class (1999).

Jia et al. used a questionnaire to asses age of L2 acquisition, environmental variables, affective variables related to self-consciousness, cultural identity and self-evaluated proficiency in L1 and L2 (2002). In this they found that self-evaluation significantly correlated with behavioral performance. Further research on self-assessment was done by Flege, Mackay, and Piske (2002), who investigated how language dominance can affect degree of foreign accent and grammaticality. To do this they used a language history questionnaire that focused on age of arrival in the L2-speaking country/L2 learning, proficiency, immersion in L2, years of L2 schooling, percentage of use, and overall exposure. Flege et al. (2002) found that language history and degree of foreign accent correlated significantly, as well as language history and a task in grammaticality judgement. According to Marian et al. (2007), researchers often target information that is only relevant to what they want to manipulate experimentally, which results in separate questionnaires, thus complicating cross-experimental questionnaires. Marian et al. consequently developed the Language Experience and Proficiency Questionnaire (LEAP-Q) to serve as a stable self-assessment tool in determining both proficiency, language dominance, and variables related to experience across bilingual populations.

The first draft of the LEAP-Q included the following factors: language competence, age of acquisition, manner of language acquisition; prior language exposure; and current language use. Language competence had three distinct measures; language proficiency, language dominance, and language preference. Language proficiency gave ratings for proficiency in speaking, listening, reading, and writing, while participants reported on the language dominance order for each of the languages spoken. Questions that regarded preference were presented in a specific way, such as in what language they would prefer to read a text in if it were available in all their languages. Language acquisition referred to questions related to age of acquisition for each language: initial language exposure, age of attended fluency, the age of which they started to read, and age of attended fluency in reading. Prior and current language exposure evaluated exposure to language in a country, in a school environment, at work, and at home. Marian et al.'s first study examined the validity of the questionnaire with a set of bilinguals who answered the questionnaire (2007). From the responses they conducted a factor analysis to contrast statistical clustering of the questions. Based on the variables in each cluster the researchers gave them a logically suited label. The second study replicated the validity with a different group of bilinguals who also completed a set of standardized behavioral measures. The participant's self-rated proficiency from the questionnaire correlated with the results from the behavioral measures, which according to Marian et. al demonstrates that the LEAP-Q is an efficient and valid tool in assessing bilingual language status (Marian et al. 2007).

To get a full picture of the bilinguals in the present study, and examine what factors might predict lexical access, we included Marian et al.'s language experience and proficiency questionnaire. Our LEAP-Q version was somewhat modified to better help the participants understand the questions, and the order of some questions has changed. Although not too relevant in our study, some questions regarding dialect and accent were added since this version of the LEAP-Q will be used in a different study.

Language similarities

English and Norwegian both originated from Proto-Indo-European and belong to the Germanic language group, which is divided in three separate groups; East (now extinct), North (Icelandic, Faroese, Norwegian, Swedish, and Danish), and West (German, Dutch, Frisian and English). Their shared origin is seen in vocabulary, syntax, and phonology. English originated form Anglo-Frisian dialects, now referred to as Old English. Variants of Old Norse influenced Old English during the 8th and 9th centuries when Vikings colonized parts of Britain. Even though Old English is quite different from Modern English, hundreds of the words in Modern English have their roots in Old English and Old Norse, such as common nouns like *anger, bag, both, skill, sky* and *window*. In modern times, English has influenced Norwegian through various medias, creating loanwords like *jeans, boots, sagge* (to sag), *grille* (to grill). Some English loanwords are "Norwegianized" in the sense that orthography is altered slightly to better fit the phonotactic rules in Norwegian: Guide = Gaid; service = sørvis; dull = døll. English and Norwegian are therefore quite similar languages, with many cognates or near cognate words.

The present study

The present study aimed at investigating the factors that are related to TOT rates in both languages of a bilingual. There are two main theories about what causes a TOT. The first one is the frequency-lag account, which suggests that TOTs occur after lexical access and are due to the inability to access phonology. According to the frequency-lag account, bilinguals are disadvantaged compared to monolinguals on lexical retrieval due to the divided frequency of use between two different languages. The degree of access to correct phonology should also be related to frequency of use. A further prediction from the Frequency-lag account is that cognates should facilitate access, which means that cognates should show fewer TOTs. Proper names should be the same across languages and will therefore be unaffected by the frequency-lag. Some proper names do however change across languages and will subsequently be affected by frequency- lag.

The cross-language interference hypothesis suggests that TOTs occur during lemma selection because the translation equivalents in each language compete for selection. If failed retrieval of phonology does not influence word selection, there should be no difference between cognates and noncognates. The number of TOTs should be related to language dominance, because more dominance would mean fewer TOTs. Because competition is the main argument in the cross-language interference hypothesis, the number of TOTs should be related to factors that involve language control. More (intentional) language switching should generate more competition control and subsequently fewer TOTs, while accidental language intrusions indicate worse competition control and will lead to more TOTs.

By incorporating a self-assessment questionnaire to establish a bilingual profile we will be able to see what factors might predict the frequency of TOTs.

Method

Collecting stimuli

We had some challenges in finding target words in Norwegian, particularly noncognates. Firstly, we discovered early on in the process that low frequency words in Norwegian are often derived from Greek and/or Latin, thus sharing orthography and semantics with English, which meant that we had to dig deep to find suitable targets in terms of matched frequency and syllables. Secondly, an additional challenge in making up the noncognate common nouns, was finding low frequency words that were written as a single unit in both Norwegian and English. According to the Norwegian Language Council (Språkrådet) words should be compounded when the first part of the word is stressed. If words are pronounced separately (i.e. both words are stressed) they should be written as two separate words (Språkrådet, 2017). The general rule then is that a lot of words and expressions are compounded in Norwegian, which is quite different from English, where one term can be made up from two different words example. Our targets could only be one single word, and we struggled to find three syllabic words in Norwegian that had equivalent translations English that were also compounded. As found by Pureza, Soares, Comesaña (2015), who induced TOTs using a picture naming task, bilinguals had more TOTs for longer (three syllables) than for shorter (two syllables) words in their L1 (European Portuguese). Surprisingly, this effect was not found when the participants performed the task in English. Pureza et al. (2015) demonstrated that the number of syllables does have an effect in inducing a TOT state. Our common noun cognates have an average of 2.85 syllables, while noncognates have an average of 2.25. These numbers should ideally be closer, but we were unable to find suitable words that were compounds both in Norwegian and English.

A third challenge arose in creating noncognate proper nouns. Certain proper nouns are translated from English to fit the phonotactic constraints within the language that's being translated. This is also the case for Norwegian translations of some English names. The many similarities between Norwegian and English, do however mean that a lot of English names do not conflict with the phonotactic constraints in the Norwegian language. Consequently, a lot of English names remain the same or are only slightly altered, which makes for a great pool of cognates, but not noncognates. Because names are more often translated in children's literature and animated movies/series, this was our main source for noncognate proper nouns. I suspect that we would have had an easier task in finding translated names had our participants been older, owing to the fact that English names and movie titles are no longer translated to the extent they were 30-40 years ago (Ellingsen & Grimen). The trend for translators today is to only translate names of people or places that are meaningful and when a story is set in an entirely fictitious world, such as J.K. Rowling's magical universe (Vogt, 2018).

Participants

Thirty Norwegian-English bilinguals (6 men and 23 women) ranging from the age of 18 to 40 participated in the study. The participants were predominantly recruited from various faculties at the University of Agder and from the Kristiansand area. All participants were native speakers of Norwegian and were proficient in English. They reported no language impairments such as dyslexia or stuttering. The participants received a gift certificate of 200 NOK for their participation. All participants were given an information sheet and signed a consent form that was preapproved by the Norwegian Center for Research Data (NSD), reference number:158894.

Materials and Design

Language Experience and Proficiency Questionnaire – LEAP-Q

A revised version of the LEAP-Q (Marian; Blumenfeld, Henrike K; Kaushanskaya, Margarita, 2007), was used to determine language proficiency. The LEAP-Q consisted of four parts; screening, language background, Norwegian and English proficiency, and dialect and accent. The screening determined whether the participant were eligible to take part in the study with questions regarding age, vision, handedness, years of education, and confirmation of no language impairments. In the language background section participants self-rate their languages in terms of acquisition, dominance and percentage of exposure to each language. For this study, the proficiency section asked the participants to list time spent in various language environments and self-rate proficiency in speaking, writing and grammar in both Norwegian and English, as well as proficiency in pronunciation and reading comprehension. The dialect and accent section asked participants about their dialect and their attitude towards it. In addition, due to the diversity in Norwegian dialects the participants rated how strongly regional their dialect was. For the sake of total anonymity, we changed "date of birth" to "age". We added a question to determine if the participants had normal to corrected hearing. We also added a question to determine what written form of Norwegian (Nynorsk/Bokmål) the participants predominantly use.

The “tip of the tongue” experiment

The “tip of the tongue” experiment (TOT) consisted of two parts – one Norwegian, and one English. Each part comprised 80 written definitions, 80 targets words and 240 foils, three for each target word, of which two were either semantically or phonetically related and one was unrelated. There were four different groups of target words: cognate common nouns, noncognate common nouns, cognate proper nouns, and noncognate proper nouns.

All the Norwegian target words were matched on number of syllables, phonemes, letters, hits in NoWac, frequency per million and hits in Google. The English common nouns were matched on number of syllables, phonemes, letters, frequency in Celex (per million), while the English proper nouns were matched only on hits in Google due to the fact that proper nouns are not searchable in Celex.

Table 1 Frequency and length characteristics of the target words in TOT task

	No. of syllables	No. of phonemes	No. of letters	Hits in NoWac	Frequency in Celex	Frequency per million	Hits in Google
Norwegian							
Cognate common nouns	2.85	6.95	7.25	484.34	—	0.695	30314935
Noncognate common nouns	2.25	5.9	6.45	486.15	—	0.6895	4922105.263
Cognate proper nouns	2.65	6.85	7.65	472.95	—	0.6785	61554842.11
Noncognate proper nouns	2.85	6.95	7.25	478.9	—	0.68215	29259861
English							
Cognate common nouns	3	6.85	7.6	—	2.43	—	35632500
Noncognate common nouns	2.60	6.70	8.10	—	2.31	—	27053250
Cognate proper nouns	2.25	5.7	6.8	—	—	—	242722000
Noncognate proper nouns	2.3	6.1	7.15	—	—	—	85335950

Procedure

The testing was done in two sessions on separate days, one for each language. The language order was counterbalanced, so that half of the participants did the Norwegian part first and half of them did English first. The testing was run in a quiet room and lasted between 45 to 90 minutes per session. The participants were instructed to speak in either Norwegian or English before they entered the language lab. The participants were given time to read through an information sheet and signed a consent form prior to testing. The participants sat in front of a computer screen while the experimenter sat beside them and controlled the keyboard. Each session started by filling in the first section of the LEAP-Q, before the experimenter launched the program, Open Sesame ((Mathôt, Schreij, & Theeuwes, 2012)

The participants were presented with a written instruction on the screen before the test started. The experimenter explained what a TOT was to make sure they understood the task at hand. Participants were instructed to answer as honestly as possible.

The participants were presented with definitions on the screen with a question underneath, saying: "Do you know this word". There were three possible answers; *yes, no,* and *TOT*. The experimenter pressed 1 for yes, 2 for no, and 3 for TOT. If they answered yes, they were asked to say the word. If they said no, the next definition would appear. If the participants answered TOT, they got three follow-up questions; "Can you guess the initial letter or sound?", "Can you guess the last letter or sound?", Can you guess the number of syllables?". Five different alternatives were then presented on the screen; the actual target, the three foils (semantically related, phonetically related and unrelated) and "none of the above". Following the TOT task, the participants completed the vocabulary task. After having completed the experiments in our study, our participants took part in another MA project on bilingual language processing.

Vocabulary task

The vocabulary tasks were composed of two parts – one synonym task, and one antonym task. There were 40 target words in each language; 20 for the synonym task and 20 for the antonym task. All target words were noncognate target words and there were three foils for each target word. The Norwegian target words were of very low frequency. Of the English synonyms were 8 adjective, 6 nouns, 4 verbs, and 2 that could be both a noun and a verb. The English antonyms consisted of 7 adjectives, 6 nouns, 6, verbs, and 1 that could be both a noun and a verb. Both the Norwegian synonyms and antonyms each consisted of 8 adjectives, 6 nouns and 6 verbs.

Results

Participants

The 30 participants in this study were between 18 and 36 years of age with an average of 23.6 years, of which 23 were female and 6 were male. They were all native Norwegian speakers and had English as a second language and spoke no other languages in the home. None reported having language impairments such as dyslexia or stuttering. They all had normal hearing and eyesight (or corrected to normal by glasses or contact lenses). 25 participants were right handed and 4 were left handed. Of all participants, 28 was born in Norway and 1 was born in the USA. Most of our participants were students at the University of Agder or recruited from the Kristiansand area. all participants 27 reported that Norwegian to be their dominant language while 2 of our participants reported English being their dominant language. 24 participants reported speaking a third language, 7 reported a fourth language and 1 participant reported a fifth language. The participants reported on having on average 16.4 years of education. Before being tested, all participants received a participation information sheet in which the requirements for joining the study was clearly stated. 30 individuals were recruited to participate in the study, but one participant opted out after the first task of the TOT-experiment, making the total number of participants tested 29. The participants completed a set of screening questions to determine if they were qualified to take part in our study, and completed a survey concerning language history, use, and proficiency.

LEAP-Q results

The results from the LEAP-Q are shown in tab separate categories, each with descriptions preceding a table. Table 1 below shows means and range of answers to questions in the LEAP-Q pertaining to the participants' language history and background. As can be seen, the participants reported on average living most of their lives in Norway in a Norwegian family. The average time spent in an English language environment was far less. On questions concerning language history, participants were asked to range on a scale from 0 to 10 on how much each condition contributed to language learning. The participants reported that interacting with family and schooling strongly contributed to learning Norwegian. Schooling, TV/streaming and listening to music was rated as most important contributors to learning. These numbers collectively indicate that language learning has happened through a combination of formal and informal channels. The label "age milestones" pertains to at what age the participants were when each aspect of language exposure and learning occurred. All participants reported having been exposed to Norwegian from birth, and the average age at which they were first exposed to English was around six years old, which is when children normally start school in Norway. The participants reported speaking fluent Norwegian four years after first exposure, while fluency in English was attained on average 6 years after first exposure. The participants took longer to attain fluency in reading English than in Norwegian.

The category *language use and identity* applies to the participants language use and how comfortable they are with their two languages. Amount of speaking relates to the total time spent speaking each language. The participants reported on average speaking Norwegian 80 % of the time, and English 19.3 % of the time. Of the 24 participants with knowledge of a third language, only 7 reported actually speaking it on a regular basis, which collectively made an average of 0.7 %. The average time spent reading Norwegian was 42.2 %, and the average for English was 57 %. Language of choice relates to the comfort the participants have in choosing what language to speak in. The question is formed as such: “When choosing a language to speak, with a person that is equally fluent in all your languages, what percentage of time would you choose to speak each language?” Participants reported on average choosing to speak Norwegian 80.1 % of the time, and English 19.3 % of the time. Cultural identity refers to what degree the participants identify with either Norwegian, British, American or other cultures. All participants said Norwegian was the culture they identified the most with and the average degree of identification was 8.9 out of 10. Other cultures mentioned with a small degree of identification for each were American, British, Canadian, Australian, Latino, French, Swiss, and Hawaiian.

Table 2: Participants' responses on questions related to language history, use, and identity

	Norwegian		English	
	M	Range	M	Range
Immersion duration (years and months)				
Country	22.3	16–30	1.10	0–16.5
Family	23.2	19–32.7	1.98	0–32.66
Contribution to language learning (0-10 scale)				
Interacting with friends	6.5	0–10	5.6	0–10
Interacting with family	9.3	6–10	3.0	0–10
Reading	6.4	2–10	7.7	3–10
School and education	7.4	0–10	8.0	1–10
Self-instruction	0.8	0–5	2.0	0–10
TV/streaming	3.6	0–10	7.2	3–10
Listening to music/media	2.3	0–10	6.5	1–10
Age milestones (years and months)				
First exposure to language	0.0	0	6.4	0–14
Attained fluency in speaking	4.4	1–10	12.6	6–20
Started reading	5.1	3–7	7.3	4–10
Attained fluency in reading	8.3	5–20	11.6	6–20
Language Use and Identity				
Amount of speaking (%)	74.7	10–99	24.3	1–90
Amount of reading (%)	42.2	5–94	57.0	5–95
Language of choice (%)	80.1	40–100	19.3	0–60
Cultural identity (0-10)	8.9	3–10		

The category proficiency applies to the proficiency in various aspects related to language, such as speaking, pronunciation, reading, writing, grammar, vocabulary, and spelling. Overall, the participants informed on being more proficient in Norwegian for each condition. Proficiency was on average estimated to be lower for vocabulary in both Norwegian and English. On questions regarding language exposure, the participants were asked to rate the degree of language exposure to both Norwegian and English. On overall exposure, the participants reported being exposed to Norwegian 55.7 percent of the time and English 42.7 percent of the time. On the questions related to interaction with family and friends the participants reported on being exposed to language on a scale from 0-10 in which 0 = never, 5 = half of the time, and 10 = almost always. From interaction with friends the average exposure to Norwegian was 8.4 and 3.0 for English. Language exposure to Norwegian from reading was on average rated as 3.7, while exposure to English was rated at 7.6. Reading was specified as books, magazines, and online material. Participants reported being exposed to English through TV/streaming to a much larger extent than Norwegian TV/streaming. The same difference is found for exposure through listening to music and other media with an average of 8.0 for English and 2.2 for Norwegian.

Table 3: Participants' responses on questions related to language exposure and proficiency

	Norwegian		English	
	M	Range	M	Range
Language exposure				
General exposure (%)	55.7	30–85	42.2	14–70
Interacting with friends (0-10)	8.4	3–10	3.1	0–7
Interacting with family (0-10)	9.0	1–10	1.2	0–9
Reading (0-10)	3.7	0–10	7.6	2–10
Self-instruction (0-10)	0.4	0–7	1.0	0–10
TV/streaming (0-10)	2.6	0–10	8.1	3–10
Listening to music/media (0-10)	2.2	0-10	8.0	3–10
Proficiency				
Speaking	9.4	8–10	7.9	4–10
Pronunciation	9.4	7–10	7.4	3–10
Reading	8.9	4–10	7.8	3–10
Writing	8.0	3–10	7.2	3–10
Grammar	8.0	5–10	7.0	5-10
Vocabulary	7.7	4–10	6.8	2–10
Spelling	8.1	4–10	7.0	3–10

Factor analysis

Similar to Marian et al (2007), we performed a factor analysis on the responses from the questionnaire. All non-numerical descriptive variables, along with the variables that showed little variation, were removed. A correlation matrix of the remaining 77 variables was done to see how they relate to each other. Variables with a correlation value greater than 0.8 with another variable were removed. All variables showed a correlation of >0.3 with at least one other variable. A parallel analysis was performed, from which eight factors were extracted.

Table 4: Factor analysis results

Factor 1: English Proficiency	Loading values	Factor 2: Norwegian Proficiency	Loading values	Factor 3: Norwegian Informal Learning	Loading values	Factor 4: English Pronunciation	Loading values
Eng. amount, reading	0.81	Nor. proficiency, writing	0.90	Nor. exposure self-instruction	0.84	Eng. improve pronunciation	0.75
Eng. proficiency, vocabulary	0.79	Nor. proficiency, reading	0.89	Nor. learning, music	0.83	Nor. cultural identification	0.68
Eng. exposure, reading	0.78	Nor. proficiency, spelling	0.84	Nor. exposure, music	0.80	Eng. good pronunciation important	0.69
Eng. proficiency, speaking	0.76	Nor. proficiency, vocabulary	0.72	Nor. learning, TV/streaming	0.77	Eng. improve accent, effort	0.57
Eng. proficiency, grammar	0.71	Nor. proficiency, speaking	0.68	Nor. exposure TV/streaming	0.71	Eng. want native-like pronunciation	0.50
Eng. exposure, total	0.70	Nor. proficiency, grammar	0.49	Nor. learning, self-instruction	0.69	Nor. proficiency, pronunciation	0.45
Eng. amount, speaking	0.70	Nor. proficiency, pronunciation	0.43	Nor. exposure, reading	0.60	Eng. correct grammar, importance	0.33
Eng. proficiency, writing	0.67	Nor. years in country	0.42	Eng. learning, self-instruction	0.41	Eng. exposure, TV/streaming	0.32
Eng. exposure, friends	0.61	Nor. modify dialect, degree	0.41	Eng. learning, TV/streaming	0.40	Eng. learning, Tv/streaming	0.30
Eng. learning, reading	0.56	Eng. proficiency, writing	0.40	Eng. learning, music	0.40	Attention to pronunciation	0.33
Eng. choice/comfort speaking	0.53	Eng. proficiency, grammar	0.35	Nor. learning, school	0.36	Nor. learning, reading	-0.35
Eng. learning, friends	0.51	Eng. learning, music	-0.37	Eng. started reading age	0.35	Eng. learning, friends	-0.43
Eng. correct grammar, importance	0.49	Nor. regional dialect, degree	-0.38	Nor. learning, reading	0.34	Nor. exposure, other dialects	-0.44
Eng. importance, accent	0.46	Eng. intrusion in Nor.	-0.45	Nor. exposure, other dialects	0.33	Age	-0.59
Nor. fluent speaking age	0.46			Eng. learning, school	0.32	Pronunciation not important	-0.72
Eng. exposure, music	0.43			Eng. exposure, self-instruction	0.32		
Eng. exposure, self-instruction	0.42						
Eng. exposure, TV/streaming	0.40						
Nor. fluent reading age	0.33						
Nor. regional dialect, degree	-0.34						
Eng. wanting native-like pronunciation	-0.40						
Nor. exposure, friends	-0.44						
Eng. learning, school	-0.50						
Nor. exposure, reading	-0.60						
Nor. accent in spoken Eng., degree	-0.75						
Nor. amount, reading	-0.82						
Proportion Variance	0.15	Proportion Variance	0.09	Proportion Variance	0.09	Proportion Variance	0.07
Cumulative Variance	0.15	Cumulative Variance	0.24	Cumulative Variance	0.32	Cumulative Variance	0.48

Factor 5: Late English Fluency	Loading values	Factor 6: Language Competition	Loading values	Factor 7: Late Norwegian Fluency	Loading values	Factor 8: Mixed Language Exposure	Loading values
Eng. age, fluent speaking	0.82	Nor. intrusion in Eng.	0.65	Nor. started reading age	0.82	Nor. dialect importance	0.75
Nor. years in country	0.70	Eng. age, started reading	0.58	Nor. fluent reading age	0.68	Nor. accent identified by others	0.59
Eng. age, started acquiring,	0.69	Eng. intrusion in Nor. speaking	0.51	Nor. proficiency speaking	0.49	Nor. exposure, friends	0.45
Eng. age, fluent reading	0.68	Nor. dialect modify degree	0.45	Age	0.48	Nor. learning, school	0.44
Eng. age, started reading	0.57	Eng. fluent reading age	0.40	Nor. proficiency pronunciation	0.46	Eng. exposure, TV/streaming	0.39
Nor. accent, identified by others	0.34	Eng. Wanting native-like pronunciation	0.39	Eng. started acquiring	0.36	Attention to pronunciation	0.38
Nor. accent, degree	0.32	Nor. learning from family	0.39	Nor. age, fluent speaking	0.31	Eng. correct grammar, importance	0.35
Eng. improve pronunciation	0.30	Eng. exposure to music	0.33	Nor. exposure, music	-0.30	Eng. learning, school	0.33
Attention, pronunciation	-0.44	Eng. learning from friends	0.31	Attention to pronunciation	-0.31	Nor. exposure, TV/streaming	0.32
Eng. exposure, family	-0.54	Nor. dialect regional, degree	-0.43	Eng. learning, reading	-0.32	Nor. learning, reading	0.31
Eng. intentional Intrusion in Nor.	-0.58	Eng. amount, speaking	-0.43	Nor. proficiency, grammar	-0.33	Nor. learning, family	-0.40
Eng. learning, family	-0.67	Eng. exposure, self-instruction	-0.54	Nor. dialect modify, degree	-0.41	Eng. choice/comfort speaking	-0.46
Nor. intentional intrusion in Eng.	-0.69	Eng. learning, self-instruction	-0.57	Nor. learning, reading	-0.44	Eng. amount, speaking	-0.48
		Nor. age, fluent speaking	-0.57	Nor. exposure, other dialects	-0.63	Nor. learning, friends	-0.52
						Eng. exposure, friends	-0.56
Proportion Variance	0.08	Proportion Variance	0.07	Proportion Variance	0.06	Proportion Variance	0.06
Cumulative Variance	0.41	Cumulative Variance	0.55	Cumulative Variance	0.67	Cumulative Variance	0.61

Factor 1 was associated with *English Proficiency*, due to the majority of variables related to English proficiency, such as vocabulary, speaking, grammar, and writing. Other positively loading variables were related to English exposure in total and exposure from reading, friends, music, self-instruction and TV/streaming. The total amount of reading and speaking the participants reported on, as well as the comfort they had in speaking English were also of relevance in choosing the factor title. Variables related to Norwegian exposure from friends and reading, and the total amount of time spent on reading Norwegian loaded negatively, which supports the choice of factor name.

Factor 2 was titled *Norwegian proficiency* and included seven positively loading variables being related to Norwegian proficiency, with proficiency in writing having the highest positively loading value, after which followed proficiency in reading, spelling, vocabulary, speaking, grammar, and pronunciation. The number of years spent in Norway is also a positive value and correlates with proficiency. There were three negatively loading variables; English learning from music, degree of regional dialect, and degree of English intrusion when speaking Norwegian. Collectively, the variables agree with the factor title.

Factor 3 was named *Norwegian informal learning* firstly due to the positively loading variables related to learning from Norwegian reading, music, TV/streaming and self-instruction. Other positively loading variables were Norwegian exposure to self-instruction, music, TV/streaming, and reading. The variable Norwegian formal learning (school) had a lower loading value, which makes naming the factor "informal" the sensible alternative. This factor did not have any negatively loading variables.

Factor 4 contains several variables with positive loading values related to pronunciation, such as wanting to improve English pronunciation, the degree of importance of a good English accent, and the amount of effort put in to improving English accent. Other positively loading variables were the degree of Norwegian cultural identity, and proficiency in Norwegian pronunciation which does not necessarily fit with the factor name. Yet, the majority of variables associated with English pronunciation indicate that *English Pronunciation* is an appropriate title for these variables. Additionally, the variable pronunciation is not important to me had a negative loading value of -0.72, validating the factor title.

Factor 5 had variables related to age, such as age of acquisition of English, what age they were when they started reading, and the age of speaking and reading English fluently. The degree of Norwegian accent (self-perceived and as identified by others) also had positive loading values, which suggests that *late English fluency* correlates with a heavier Norwegian accent when speaking English. The negatively loading variables English exposure from family and English learning from family, and the degree of Norwegian intrusion when speaking English correlates with being fluent in English at a later age.

Factor 6 was initially rather difficult to interpret, because of the combination of both exposure and learning in both languages. In the end we landed on *Language competition,* due to the positively loading variables of accidental intrusion when speaking in both English and Norwegian. The age at which the participants started reading and became fluent in reading also had positive loading values, which could indicate that a bilingual's two languages compete more due to having started reading at a later stage in life. The degree at which the participant report on modifying their Norwegian dialect could also be seen as a kind of language competition in their language history, on account of the vast differences in regional dialects in Norway. What may contradict this is that the degree of regional Norwegian dialect loaded negatively, which would have made more sense if it loaded positively, similarly to what extent they have to modify their dialect. This does however fit well if the modification of one's dialect has been thoroughly exercised to the point of erasing its original regionality.

Factor 7 was titled *Late Norwegian Fluency* and included the variables age, the age at which the participants first started to read and speak Norwegian and when they became fluent in both reading and speaking. The age at which the participants started acquiring English loaded positively, which might be consistent with a later Norwegian fluency if participants started acquiring English around the same time as Norwegian. The negatively loading variables of proficiency in Norwegian grammar and contribution to learning indicates that the factor can be associated with late Norwegian proficiency.

Factor 8 – *Mixed Language Exposure* was, like factor 6, comparably difficult to interpret because of the contrasting variables. It was initially labelled "Norwegian language environment" due to the four highest loading variables being related to Norwegian, yet only one of the five were related to exposure. The importance of speaking one's own dialect, and the degree of Norwegian accent, Norwegian exposure form friends and Norwegian learning from school were the highest loading variables. Following these, were English exposure from TV/streaming, attention to pronunciation (in general), the importance of correct English grammar, and learning English from school. Other positively loading variables were Norwegian exposure from TV/streaming and learning Norwegian through reading. The negatively loading variables were learning Norwegian through family, the comfort of choosing to speak English, the amount of time the participants spend speaking English, learning Norwegian through friends, and exposure to English trough friends.

TOT Results

ANOVAs were run on the TOTs experiment findings for each response type. These were two-way ANOVAs crossing factors of language and condition. There were no significant effects for the simple count or TOTs. There was, however, a significant difference in the proportion of TOTs. When combining "knows" and the number of TOTs we found which target words the participants actually knew. By doing this, we found that the proportion of TOTs in English was greater than the proportion of TOTs in Norwegian. For the "know" responses there was a significant difference between languages, in that they knew more words in Norwegian. The "don't know" condition refers to the number of target words the participants did not know. For the "don't know" responses, there was a significant difference between languages; more targets were unknown in English compared to Norwegian.

Table 5. TOT results. Number of responses from the TOTs task grouped by condition (CCN= cognate common noun; NCN, noncognate common noun; CPN= cognate proper noun; NPN=noncognate proper noun)

	Norwegian				NOR total	English				ENG total	Grand total
Target type	CCN	NCN	CPN	NPN		CCN	NCN	CPN	NPN		
Response											
Known	184	265	151	260	860	155	137	83	127	502	1362
Unknown	370	287	409	299	1365	387	413	484	422	1706	3071
TOT	26	28	20	21	95	38	30	13	31	112	207
Correct phoneme	39	36	40	29	144	29	36	11	31	107	
TOT proportion	0.12	0.10	0.12	0.07		0.20	0.18	0.14	0.20		
Sum total	580	580	580	580	2320	580	580	580	580	2320	4640

Linear multiple regression analyses were run for TOTs proportions and "don't knows" in each language with the scores from the vocabulary tasks and the eight factors as predictors. Table five shows which of the factors significantly predicted performance on TOT experiment. The English TOTs proportions were significantly predicted by factor 8, *Mixed language exposure.* The *English vocabulary* correlated negatively with TOT proportions and only reached borderline significance. Other factors that reached borderline significance in predicting TOT proportions were factor 1, *English proficiency,* and factor 5, *late English fluency.* Factor 3, *Norwegian informal learning,* and factor 2, *Norwegian proficiency* were in a negative relationship to English TOT proportions.

English "don't knows" were significantly predicted by three factors; English vocabulary, factor 5, *late English fluency* and factor 6, *language competition.* English vocabulary and *language competition* correlated negatively while *late English fluency* had strong positive correlations to English “don’t knows”. Norwegian TOT proportions were significantly predicted by four factors; factor 1 *English proficiency*, factor 2 *Norwegian proficiency,* factor 6 *language competition,* and factor 8 *mixed language exposure.* Factor 2 correlated negatively, while the other factors correlated positively with Norwegian TOT proportions. Norwegian “don’t knows” were significantly predicted by 2 factors; factor 2 *Norwegian proficiency,* which correlated negatively, and factor 5 *late English fluency* which correlated positively. Norwegian vocabulary correlated negatively but only reached borderline significance.

Table 6 Significant results from multiple regression analysis for TOT experiment.

Factors	English TOT proportions		English “don’t knows”		Norwegian TOT proportions		Norwegian “don’t knows”	
	t-value	p-value	t-value	p-value	t-value	p-value	t-value	p-value
English Vocab	-2.05	0.05	-3.49	0.002	—	—	—	—
Norwegian vocab	—	—	—	—	—	—	-1.98	0.06
F 1English proficiency	2.06	0.05	—	—	2.22	0.04	—	—
F 2 Norwegian proficiency	-1.93	0.06	—	—	-4.74	0.00	-2.56	0.01
F 3 Norwegian informal learning	-1.95	0.06	—	—	—	—	—	—
F 5 Late English fluency	1.87	0.07	2.22	0.03	—	—	2.13	0.04
F 6 Language competition	—	—	-2.83	0.01	2.21	0.03	—	—
F 8 Mixed language exposure	1.87	0.04	—	—	2.28	0.03	—	—

Discussion

In the present study we aimed to examine the occurrence of TOTs in 29 Norwegian-English bilinguals in a word-finding task, and how the findings relate to the bilingual profile. TOTs were induced by definition sentences in which the target words were of relatively low frequency. The testing was done in two separate sessions – one in English and one in Norwegian. The TOT target words held four conditions in each language, cognate common nouns, noncognate common nouns, cognate proper nouns, and noncognate proper nouns. All participants completed a language experience and proficiency questionnaire (Leap-Q) and a vocabulary task as part of the experiment. Results showed no significant effects for the simple count of TOTs, but there was a significant difference in the proportion of TOTs in Norwegian and English, in that there were more TOTs in English. The total number of “knows” was greater for Norwegian than in English, meaning that they knew more words in Norwegian.

Surprisingly, there was no expected cognate effect, i.e. the bilinguals had an almost equal number of TOTs for cognates and noncognates in both languages.

This discussion will focus on the components of the bilingual profile that predicted performance on the TOT tasks. This will subsequently be connected with the main theories that explain the bilingual disadvantage.

A linear multiple regression analysis was done for TOT proportions and "don't knows" with vocabulary scores and factors as predictors. From this we found that English TOT proportions were significantly predicted by factor 8 (*Mixed language exposure).* There was a negative relationship between English vocabulary and English TOT proportion, but this was only borderline significant. Other borderline significant factors were *English proficiency, Norwegian informal learning, Norwegian proficiency,* and *late English fluency.* Finding that factor eight significantly predicted English TOT proportions was somewhat ambiguous. At first sight it is not easy to make out how a mixed language environment may predict TOT proportions. The four highest loading variables in this factor was the degree of importance of Norwegian dialect, degree of Norwegian accent as perceived by other, exposure to Norwegian from friends, and how much school contributed to learning of Norwegian. The highest loading variable connected to English is exposure to English through TV and /or streaming. Negatively loading variables were learning Norwegian through family, how often they chose to speak English, the total amount of time they speak English, how much family contributed in learning Norwegian, and exposure to English from friends. Taking all of these variables together, adding the fact that the factor significantly predicts TOT proportions in English, it is plausible to speculate that the factor is incorrectly labelled and that it possibly reflects something else entirely. It makes sense however, that English vocabulary has a negative relationship to TOT proportions, because a lower vocabulary score in English would mean that the interconnections among words are weaker and generate less phonological activation (Brown, 2012). However, the factor *English proficiency* almost reached significance, which is seemingly inconsistent with a lower vocabulary score in English. The Norwegian TOT proportions were significantly predicted by the factors regarding proficiency in both L1 and L2; although *Norwegian proficiency* had a negative relationship. *Language competition,* and *mixed language exposure* also significantly predicted Norwegian TOT proportions which might indicate that English (L2 for most participants) negatively affected lexical access in Norwegian (L1 for most participants). Self-assessed ratings of proficiency might not correlate with actual vocabulary size or performance in the TOT experiment. On the one hand, some participants may have rated their overall proficiency superficially high and demonstrated a smaller vocabulary than what would be expected. On the other hand, it is also possible that some participants might have been too modest and undersold their proficiency level and performed beyond their self-rating. There is also the possibility that overall higher proficiency in L2 and a larger sized vocabulary would lead to more TOTs because you simply know more words and therefore have a larger lexicon to sift through. Seeing as there are many factors that might influence self-ratings, it would have been better to have a larger group of participants to obtain more comprehensible groupings in factors.

English vocabulary had a negative relationship to the English "don't knows", which was to be expected. If you have a small vocabulary, you will naturally not be able to get to target words, because they simply do not exist in your lexicon. The English "don't knows" were also significantly predicted by the factors *late English fluency* and *language competition. Language competition* was difficult to interpret because variables form both languages loaded positively. Our initial label choice was made on account of the high loading variables related to language intrusions (see table 4) but a better alternative label would possibly have been "informal language learning", due to the fact that the language exposure and learning-related variables came from friends and family. The same is applicable to "don't knows" since our stimulus set consisted of low frequency words that you would not necessarily acquire from informal exposure and learning. The Norwegian "don't knows" were significantly predicted by the factor *Norwegian proficiency.* The majority of the variables that grouped in the factor were related to Norwegian proficiency (writing, reading, speaking, etc.), which made the factor coherent and easy to label, thus giving the factor more validity in terms of its relationship to the TOT proportions and the "don't knows".

The finding of more TOTs in L2 than in L1 is consistent with the frequency-lag account. The hypothesis claims that TOTs occur due to a restricted access to phonology, and that the degree of access should be related to frequency of use; i.e. more frequent use generates greater access. Our results did show that our participants had access to more phonology in Norwegian than in English. Participants also reported, on average, a more frequent use and exposure to Norwegian compared to English. However, a finding that is in conflict with the frequency-lag account is the absence of a cognate effect. According to Costa et al. (2000), cognates facilitate lexical access due to their shared phonological representations and should keep the speaker from falling into a TOT state. There was no such finding for either common nouns or proper nouns in both languages. These effect absences could of course be due to weaknesses in our stimuli set or the low number of participants. It is possible that we failed to find a cognate effect because the frequency of our cognates was merely too low. According to Gollan et al. (2014), the use of definition stimuli might be more strenuous for participants to follow and thus elicit more TOTs compared to a translation task or picture naming.

The cross-language interference hypothesis argues that TOTs occur due to competition between translation equivalents in both languages. Two variables related to language intrusion, both Norwegian intrusion in English and vice versa appears in factor 6, *language competition,* which significantly predicted TOT proportions in Norwegian. Factor 8 significantly predicted English TOT proportions but does not include variables involving language control, which makes it difficult to relate it to competition. Factor 5, *late English fluency*, although only borderline significant, did include two negatively loading variables related to control; intentional intrusion in both language directions. This demonstrates that less switching, and consequently worse language control, can predict more TOTs.

Weaknesses in our study

As mentioned above, there are components of our study that could have been done differently First of all, there were too few participants in our study, which makes it difficult to say anything for certain about out data and factors. Furthermore, our participants were a very uniform group, which yielded less variation on some of more interesting variables. Moreover, the stimulus set was exceptionally challenging to construct, which may have influenced the results. Because English and Norwegian belong to the same language family, they share a lot of cognate or near cognate words. Specifically, many low frequency words in Norwegian are foreign words, often derived from Latin, Greek, or French and are frequently cognates in English and Norwegian. The issue of language similarity made it more complicated to find words that were noncognate while at the same time of relatively low frequency. Whereas the target words needed to be matched for frequency, we had to discard some very low frequency words. This decision may have made some of the Norwegian target words too easy compared to the English ones. There is also a possibility that mutual activation and more competition occurred because of the similarities between Norwegian and English.

We expected that it would be a challenge to find noncognate proper names as they are rarely translated in Norwegian, and if they are, it is mostly in children's literature or Tv/movies. More often than not, the names are only slightly altered to fit Norwegian phonotactics, which makes them unfit to use as noncognates. Thus, in finding noncognate proper nouns we had to delve deep to find names that had been altered enough to fit the condition. As the results show, there was no significant difference between cognate and noncognate proper nouns in Norwegian, something that might indicate that the noncognates selected for Norwegian were too easy to access because the majority of names came from children's literature and TV. Moreover, we had no suitable way of checking the frequency of proper names way of checking proper names for frequency. We chose to use Google hits as an indicator; however, this might not have been the best tool.

Another problem with our study was the lack of a proper protocol for the TOT task. We discovered early on in testing that participants sometimes opted for the TOT alternative when they had actually accessed the target word but wanted to be sure before they answered. After this was discovered, only one of the experimenters chose to follow up with a question to check that the participant had actually experienced a TOT; "was this the actual word you were thinking of?". More than once did the participants admit they were thinking of something else entirely. A practice trial would also be wise to include in the future, to see if participants completely understand the task at hand. An additional issue with the stimulus set was the definitions which may or may not have been adequate. For future research it would therefore be wise to have a neutral group judging the definitions based on their goodness of fit.

Conclusion

The overall results from this study is consistent with previous findings; that bilinguals experience more TOTs in their L2 compared to their L1. This is in line with the frequency-lag account but does not necessary exclude the cross-language interference hypothesis. By comparing the TOT score together with the LEAP-Q we were able to tease out what factors predicted TOT proportions in each language as well as the "don't knows". We found that language competition did indeed predict Norwegian TOT proportions and the English "don't knows". From these findings one can deduce that dual-language activation, and by extension cross-language interference, did play a part in the lexical retrieval failures of our participants. Additionally, we also found that proficiency in English almost reached significance in predicting English TOT proportions which might imply that more TOTs actually demonstrate a widened lexicon, but one is only partially able to retrieve its vast content.

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Appendixes

Appendix (p. 1 of 2). Language Experience and Proficiency Questionnaire.

Last Name		First Name		Today's Date	
Age		Date of Birth		Male ☐	Female ☐

(1) Please list all the languages you know in order of dominance:

1 Language A	2 Language B	3 Language C	4 Language D	5 Language E

(2) Please list all the languages you know **in order of acquisition** (your native language first):

1 Language A	2 Language B	3 Language C	4 Language D	5 Language E

(3) Please list what percentage of the time you are *currently* and *on average* exposed to each language.
(*Your percentages should add up to 100%*):

List language here:	Language A	Language B	Language C	Language D	Language E
List percentage here:					

(4) When choosing to read a text available in all your languages, in what percentage of cases would you choose to read it in each of your languages? Assume that the original was written in another language, which is unknown to you.
(*Your percentages should add up to 100%*):

List language here	Language A	Language B	Language C	Language D	Language E
List percentage here:					

(5) When choosing a language to speak with a person who is equally fluent in all your languages, what percentage of time would you choose to speak each language? Please report percent of total time.
(*Your percentages should add up to 100%*):

List language here	Language A	Language B	Language C	Language D	Language E
List percentage here:					

(6) Please name the cultures with which you identify. On a scale from zero to ten, please rate the extent to which you identify with each culture. (Examples of possible cultures include US-American, Chinese, Jewish-Orthodox, etc.):

List cultures here	Culture A (click here for scale)	Culture B (click here for scale)	Culture C (click here for scale)	Culture D (click here for scale)	Culture E (click here for scale)

(7) How many years of formal education do you have? ______
Please check your highest education level (or the approximate U.S. equivalent to a degree obtained in another country):

☐ Less than High School
☐ High School
☐ Professional Training
☐ Some College
☐ College
☐ Some Graduate
☐ Masters
☐ PhD/MD/JD
☐ Other:

(8) Date of immigration to the United States, if applicable: ______
If you have ever lived in another country, please provide name of country and dates of residence:
______

(9) Have you ever had a vision problem ☐, hearing impairment ☐, language disability ☐, or learning disability ☐? (Check all applicable).
If yes, please explain (including any corrections): ______

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Appendix (p. 2 of 2). Language Experience and Proficiency Questionnaire.

Language: Language X

This is my (please select from scroll-down menu: First, Second, Third, etc.) language.
All questions below refer to your knowledge of Language X.

(1) Age when you…:

began acquiring Language X:	*became fluent* in Language X:	*began reading* in Language X:	*became fluent reading* in Language X:

(2) Please list the number of years and months you spent in each language environment:

	Years	Months
A country where Language X is spoken		
A family where Language X is spoken		
A school and/or working environment where Language X is spoken		

(3) On a scale from zero to ten, please select *your level of proficiency* in speaking, understanding, and reading Language X from the scroll-down menus:

Speaking	(click here for scale)	Understand spoken language	(click here for scale)	Reading	(click here for scale)

(4) On a scale from zero to ten, please select how much the following factors contributed to you learning Language X:

Interacting with friends	(click here for scale)	Language tapes/self instruction	(click here for scale)
Interacting with family	(click here for scale)	Watching TV	(click here for scale)
Reading	(click here for scale)	Listening to the radio	(click here for scale)

(5) Please rate to what extent you are currently exposed to Language X in the following contexts:

Interacting with friends	(click here for scale)	Listening to radio/music	(click here for scale)
Interacting with family	(click here for scale)	Reading	(click here for scale)
Watching TV	(click here for scale)	Language-lab/self-instruction	(click here for scale)

(6) In your perception, how much of a foreign accent do you have in Language X?
(click here for scale)

(7) Please rate how frequently others identify you as a non-native speaker based on your accent in Language X:
(click here for scale)

PARTICIPANT INFORMATION SHEET AND CONSENT FORM

INVITATION TO PARTICIPATE IN A RESEARCH PROJECT

REPRESENTATION AND PROCESSING OF ENGLISH AS A SECOND LANGUAGE

We are looking for Native speakers of Norwegian to take part in a language study investigating the processing of English as a second language.

In order to participate in this study you need to be a **Native speaker** of Norwegian with no other home languages (excluding perhaps English) and have a reasonable proficiency in English as your second language. You should have normal or corrected-to-normal vision and hearing and have no diagnosed language impairments such as dyslexia or stuttering.

The study has three main components:

1. A language background questionnaire
2. Some word finding tests.
3. A picture description task

Completeing all tasks will take around 3 hours, divided across three days.

The study is run by Masters students Lone Sunnset (lone.staule@gmail.com), Susanne M. Avila (susanne.mollestad@gmail.com) and Mikael Andre Albrecht (mikaelandrealbrecht@hotmail.com). Please contact them if you have any queries about the study. This research is supervised by Professor Linda Wheeldon (linda.r.wheeldon@uia.no) and Professor Allison Wetterlin (Allison.wetterlin@uia.no).

WHAT IS THE STUDY ABOUT?

This study is designed to investigate aspects of the use of English as a second language, in particular, in the use of English by speakers that have Norwegian as their first language. We are interested in how aspects of bilingual learning and language-use relate to language processing. The study has three components which will be completed both in Norwegian and English:

1. A questionnaire asking questions about your language background and about how you rate your own level of proficiency in different aspects of the languages that you speak. It should take about 20 minutes to complete.
2. Some simple language tests assessing vocabulary in Norwegian and English (Approx 1 hour).
3. A picture naming task in which you describe pictures in English as fast and accurately as you can. (Approx 30 mins)

If, after having read the information below, you decide to take part in the study please complete the consent form at the end of this document.

The study will collect and record personal information about you. However, you will never at any time be mentioned as an individual in relation to this study. Your personal data will be assigned a number code related to your name and stored on a non-networked, password protected PC. Only the laboratory directors and experimenters will have access to your data and to the key relating your data number to your name. In addition we will record the responses you produce during the experiment, this includes key strokes and speech. These data will be also be anonymised and treated as described above.

Acknowledgements

Thank you, family and friends for supporting me on this journey. A special thanks to Siri, my sister, who has been an inspiration to me. You have been of great help, and I could not have done this without you.

Thank you to Susanne, Malin and Linda for keeping my spirits up!

Table of contents

Introduction

In many places all around the world the use of two or more languages is widespread and bilingualism and multilingualism is deemed to be the norm rather than the exception. How do we acquire multiple languages? How does language processing differ between bilinguals and monolinguals? How does bilingualism shape the mind? The phenomenon of bilingualism raises countless questions and has fascinated researchers for decades. The main focus in research has been on how the two language systems are represented in the bilingual mind and if they are connected. The present study will focus on bilingual speech production and specifically lexical access failures.

Have you ever been engaged in a conversation with someone else (or yourself for that matter) and found that you've had difficulties retrieving a word you know very well? Sometimes you are able to access partial phonological information like initial letter ("I know it starts with a /t/"), or number of syllables, and at times you are unable to retrieve it without some assistance from the one you are conversing with. This sensation is called a "tip of the tongue" (TOT) state, and it occurs when a speaker is unable to produce a word combined with the feeling of being imminently close to lexical retrieval. This occurs frequently for both monolinguals and bilinguals; however, research has found that bilinguals are more likely to fall into a TOTs state when speaking in their second language (L2), and when they are speaking in their dominant language (L1) they tend to experience more TOTs than monolinguals (Ecke, 2004).

In this study we aimed to examine the occurrence of induced TOTs in Norwegian-English bilinguals using a lexical retrieval task in order to investigate the roots of lexical retrieval failures in bilingual word production. There are two main theoretical hypotheses that aim to explain the occurrence of the "tip-of-the-tongue" state. The weaker-links/frequency-lag account suggests that bilinguals are disadvantaged relative to monolinguals on tasks that require lexical retrieval because of their divided frequency of use between two different languages (Gollan, Montoya, Cera, & Sandoval, 2008). According to Michael and Gollan (2005), words of lower frequency (words that are used less in everyday language) are more susceptible to the failure of lexical retrieval relative to high frequency words. The alternative explanation is the cross-language interference hypothesis (Green, 1998; Kroll, Bobb, & Wodniecka, 2006), which suggests that lexical candidates from both languages compete for selection even when the speaker intends to speak in one language.

Bilinguals differ from each other in many ways: Age of acquisition, how they acquired their languages, proficiency, and language use are all variables that may influence lexical processing and thus produce conflicting findings in experimental research. Therefore, as part of our study, we have included bilingual profile as an independent variable. By doing this we will be able to investigate what factors are related to the number of TOTs in both languages of a bilingual. We will then connect these findings to the main theories explaining the bilingual disadvantage.

The structure of this paper will be as follows. The first section will serve as insight into the bilingual disadvantage. Then, the key models of bilingualism will be described with an emphasis on bilingual speech production. Next follows a section on how bilinguals differ and how a bilingual exerts language control. Following this is a section on word translation, comprehension and dual-language activation. A comprehensive overview of previous research on the bilingual disadvantage in word finding ensues to better understand the present study. A brief overview of the primary differences between English and Norwegian will be given, as well as further discussion on the importance of bilingual profiling. Finally, the present study will be explained and connected to the main theories and previous research.

The bilingual disadvantage

Aside from the many advantages that transpire from being a bilingual – such as being able to communicate with people from cultures different to one's own and opening up new social, and career opportunities, evidence from behavioral studies comparing bilinguals and monolinguals furthermore demonstrate advantages in cognitive control (Carlson & Meltzoff, 2008; Prior & Gollan, 2011). These behavioral studies have been accompanied by a range of linguistic tasks that, in addition, reveal the negative aspect to bilingualism. What is evident from these studies is that bilinguals are disadvantaged when it comes to measurements of vocabulary size (Bialystok, Luk & Craik, 2008; Thomas-Sunesson et al. 2016; Friesen, Luo, Luk & Bialystok, 2015). Bilinguals generally name fewer items when compared to monolinguals in naming tests and demonstrate longer naming latencies in picture naming tasks (Gollan Fennema-Notestine, Montoya & Jernigan, 2007; Ivanova & Costa, 2008). Bilinguals also produce fewer items on verbal fluency tasks, in which participants are asked to generate as many words as possible from a given category (Bialystok, Luk, & Craik, 2008). Research has also found that when reading or listening in one language, a bilingual's second language is also activated (Dijkstra and Van Heuven, 2002; Jared & Kroll, 2001). This phenomenon has been labelled dual-language activation. Translation equivalents that share both form, meaning, and phonology are called cognates. An extensive body of research has evidenced that lexical decision (Van Hell

& Dijkstra, 2002; Lemhöfer & Dijkstra, 2004) and picture naming (Costa, Caramazza & Sebastián-Gálles, 2000) in both L2 and L1 is faster for cognates than for matched controlled words. Sunderman and Kroll (2006) investigated lexical processing in two groups of English-Spanish bilinguals (one less proficient and the other more proficient in Spanish), in which the participants did a translation recognition task. The participants were asked to decide whether presented word-pairs (one Spanish and one English) were translation equivalents or not. For each word-pair, there were six distractor words, one form related to the first item (an English word with lexical similarity to the Spanish word), one form related to the second item (a lexical neighbor in English), and one meaning related. The participants were told to answer as fast and accurately as possible. By measuring the time it took for the participants to reject the pairs as translation equivalents, Sunderman and Kroll found that both words that were similar in form and meaning influenced performance (2006). In other words, because of dual-language activation, the bilinguals were slower to reject words that were similar in either form or meaning. Additionally, the findings by Sunderman and Kroll (2006) indicate that cognates may cause latencies due to increased competition.

As previously mentioned, bilinguals are more susceptible to fall into the TOTs state which occurs when a speaker is unable to produce a word combined with the feeling of being imminently close to lexical retrieval. The speaker will on occasion be able to access partial lexical information of the intended word, such as word class, initial or final letter, and the number of syllables. According to Brown and McNeill (1966), this type of speech error phenomenon is quite common and presents itself for monolinguals fairly often in natural settings and about 10-20 % of attempts of retrieving low frequency target words in an experiment setting. Previous research comparing monolinguals and bilinguals have found that bilinguals experience more TOTs when compared to monolinguals (Gollan & Acenas, 2004) and occurs increasingly in older age (Burke, Mackay, Worthley, & Wade 1991).

Two explanations have been posed to explain the bilingual disadvantage: the cross-language interference account (Abutalebi & Green, 2007; Green 1998; Kroll & Gollan, 2014), and the frequency-lag account (weaker links) (Gollan et al., 2005, 2008). The cross-language interference account suggests that a bilingual's nontarget language competes against the target language in production. The frequency-lag account suggests that bilinguals are disadvantaged compared to monolinguals on tasks that require lexical retrieval because of their divided frequency of use between two different languages (Gollan, Montoya, Cera, & Sandoval, 2008). According to Michael and Gollan (2005), words of lower frequency are more susceptible to the failure of lexical retrieval relative to high frequency words. A bilingual's natural use of two languages results in less use of each language, which becomes evident when comparing bilinguals and monolinguals of each language.

In the following section I will discuss the theoretical models that aim to explain lexical selection in bilingual speech production and comprehension, as well as the theories that describe how the two languages of a bilingual are represented. In doing so, I will link the theories to either of the above-mentioned explanations for the bilingual disadvantage. As will become apparent, the dividing lines between the two are not clear-cut and some models lend themselves to both accounts.

Models of language processing

Before exploring the theories that explain bilingual language processing, it will be helpful to look at a speech production model in the monolingual domain, as most bilingual word production models posit similar processing stages.

An influential model was proposed by Levelt (2001), which has a serial two-system architecture, in which production occurs in two stages (as seen in figure 1). The first stage is called lexical selection, where the appropriate concept is chosen from the mental lexicon. Within lexical selection there are three stages, the first being "perspective taking," where the focus is on activating the most appropriate concept among related concepts that are coactivated. Thus, in a situation where the speaker is shown a picture of a horse and asked to name it, concepts like *horse*, *stallion*, and *animal* are all activated at the same time. Each active concept will then spread activation to corresponding lexical items (lemmas) in the speaker's mental lexicon, and the target lemma will be selected after competition. Following the lemma selection, the form encoding system is triggered, where the phonological codes (/h, ɔ, r, s/) are activated and placed together as phonological segments. These segments then form syllables incrementally, and are input to the final phonetic encoding step, creating the "articulatory score". The articulators then interpret this "score" and overt speech is produced (Levelt, 2001).

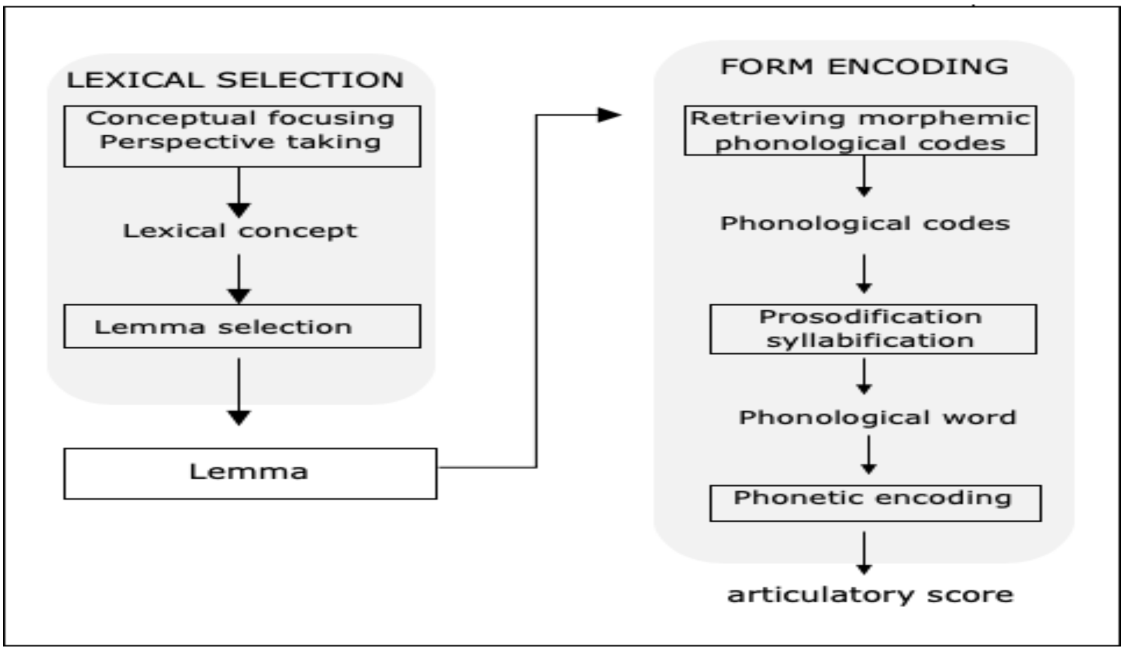

Figure 1: Architecture of spoken word production model (adapted from Levelt, 2001)

Levelt's speech production model is a discreet model, which means that phonological encoding only begins after a lexical node has been selected for production and that the previously activated, but not selected, lexical representations do not activate their corresponding phonological segments. A cascaded model, on the other hand, assume similar activation flow in all levels. In other words, any activated lexical representation will send activation down to its corresponding phonological properties, which in extension would imply that both languages are activated down to the phonological level.

Bilingual word production

A bilingual has a potentially more complex job to perform in speech production than the average monolingual, due to the finding that both languages of a bilingual are constantly active, even when context only requires the use of one language. Costa (2005) evaluated the various views concerning bilingual speech production; how activation flows in the selection processes and whether these are restricted to one of the two languages of a bilingual. Models of speech production primarily have a top-down structure, and similar to monolingual speech production, Costa assumes three levels of representation. The first is the semantic level, where the speaker decides what concept he or she wants to convey. The second level is the lexical level with words and their grammatical properties. The third and last level is where the words are coded for phonology. According to Costa (2001), researchers have previously been unanimous to the idea that language is specified at the conceptual system, so that the activation flow towards the lexical level would be restricted to the words belonging to the target language. However, later models have postulated the idea that activation flows from the conceptual level to lexical candidates from both languages (e.g., Costa, Miozzo, & Caramazza, 1999; Gollan & Acenas, 2004), thereby insisting that language is non-specific at the lexical level as well. The selection of the lexical nodes is followed by the activation of the phonological segments belonging to that node.

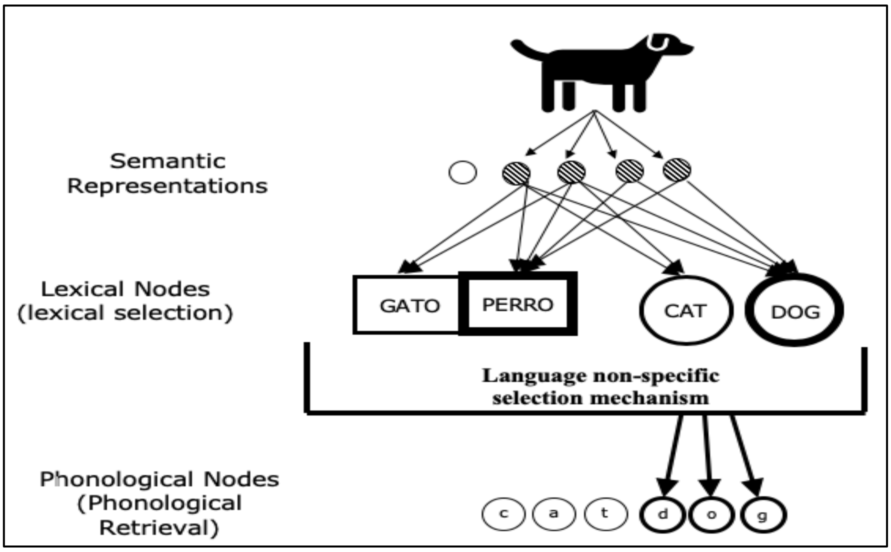

Figure 2: Architecture of the bilingual word production system (adapted from Costa, 2005)

According to Costa there are contrasting views concerning language specificity on the phonological level as well. Discrete models of speech production hold that the selection of the language nodes will filter out unwanted activation and consequently hold off activation from spreading to the phonological level, essentially similar to that of phonological encoding for monolingual speakers (Costa, 2005). Costa does, however, make it clear that the issue of activation flow from the lexical nodes to their corresponding phonological representations is debatable. Based on previous research, Costa argues that the conceptual system will activate both languages of a bilingual at the same time, and that the lexical system is language non-selective.

Inhibitory control in language production and comprehension

Following the notion of non-selective language activation there must be a mechanism to modify the competition that arises in lexical selection and controls performance. One such mechanism is described in the Inhibitory Control (IC) model, proposed by Green (1998) (as seen in figure

5). The model explains in detail how the cognitive system deals with the increased competition in bilingual lexical selection (Kroll & Tokowicz 2005).

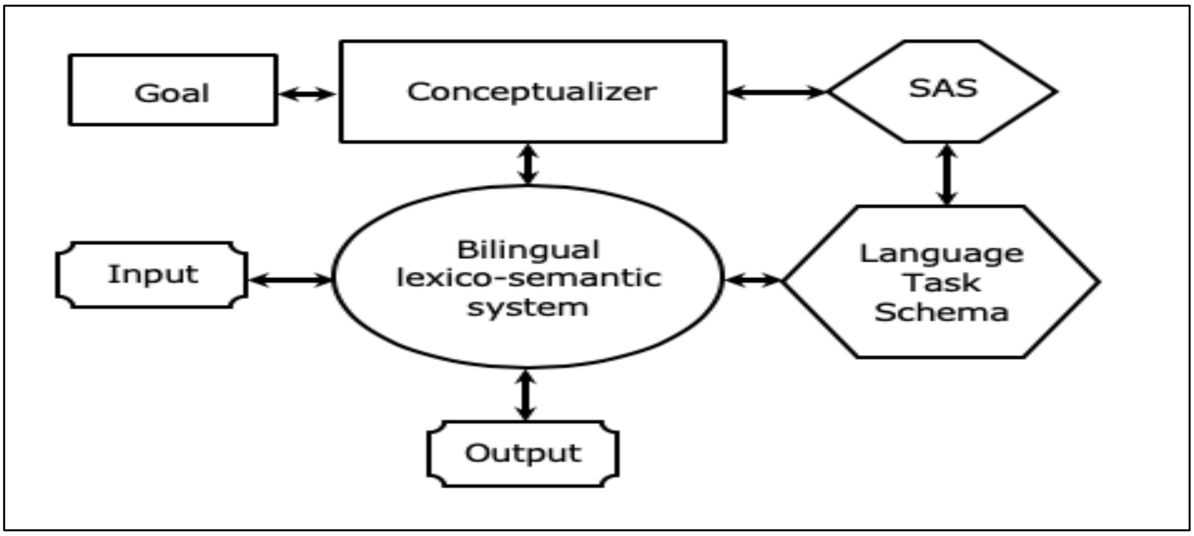

Figure 3: Architecture of the IC model (adapted from Green 1998)

The IC model deals with language production, in which conceptual representations are assumed to be formed at the onset of planning. According to Green (1998), each lexical representation is associated with a language tag, and lexical nodes can be suppressed if they are associated with the non-target language in a particular communicative context. The organization of the IC model is made up of several components, one being the conceptualizer, which builds conceptual representations, driven by a goal (speech, comprehension, or word-recognition). The conceptualizer activates the supervisory attentional system (SAS) and the lexico-semantic system simultaneously. The SAS controls the activation of the task schemas (similar to the task schemas in BIA), which establishes the demands for the task at hand. The fundamental function of the task schema is to trigger lemmas in the intended language of use and at the same time inhibit lemmas in the other language. The semantic system activates lexical nodes in both languages, and the nodes in the non-target language are then suppressed reactively. Inhibition is proportional to the level of activation of the lexical nodes in the non-target language – the more activation the unintended language receives the stronger inhibition is needed. In other words, the lexical candidates that are activated in L1, which is presumably more dominant and will forward more candidates, cause more competition and therefore require greater inhibitory processes. The model thus predicts that language switching costs will be greater when switching from L2 to L1 than the reverse. This prediction was supported by research on language switching (Meuter & Allport, 1999).

Costa and Santesteban (2004) investigated the language switching performance in two groups; L2 learners and highly proficient bilinguals. The aim was to replicate Meuter and Allport (1999), and to test whether proficiency in the participants' L2 would affect the pattern of switching performance (Costa & Santesteban, 2004). In experiment 1 the participants were considered to be L2 learners, with L1 being the dominant language. They were asked to name pictures as quickly as possible in the language indicated by the color of the pictures (red for L1 and blue for L2), thus making them switch between the two languages. The results replicated the asymmetrical switching cost found in Meuter and Allport (1999) – the switching cost was greater when switching into L1 than into L2. Following the hypothesis made by the IC model (Green, 1998), which predicts that switching from L2 to L1 creates a greater switch cost, they did a second experiment in which highly proficient bilinguals performed the same task, predicting the switching cost to be reduced (or possibly even eliminated). The results demonstrated that balanced bilinguals (in terms of language dominance), suffer the same switching costs in both languages, which might be considered a null result (results do not support the predictions). Costa and Santesteban did however attribute these results to inhibition: "[w]hen the difference in proficiency is small (highly proficient bilinguals), a similar degree of inhibition is applied to the two languages and symmetrical switching costs are observed." (2004, p. 498). These findings raise questions of how bilingual profile can affect language control.

Effects of individual differences on bilingual profile

Not only do bilinguals differ in terms of proficiency, but also in what contexts they use their two languages. Green and Abutalebi (2013) proposed the Adaptive Control Hypothesis as an extension of the IC model to explain the various control processes that are involved in language control in different bilingual speakers. In their attempt to describe the various interactional contexts, Green and Abutalebi also describe how bilinguals differ. An L2 learner is considered a bilingual and so are highly proficient bilinguals. This means that there are several groups of bilinguals, and they should be treated as such, at least in an experimental setting. The hypothesis suggests that there are three separate interactional contexts with distinct demands, to which the control processes have to adapt.

In a *single-language context,* each language of a bilingual is used in separate environments, such as using the L2 while at work and the L1 at home. Another example would be that of using one language at school or university, while sticking to the other language with family and friends. Switching between languages rarely happens in this context. In a *dual-*

language context, both languages are used but usually with different individuals. Language-switching may occur frequently in conversations in this context, but not within utterances. In a *dense code-switching context,* speakers alternate between the two languages within a conversation, as well as blending the languages, constructing hybrid utterances. The speakers in a dense code-switching context would also adapt words form one language to the context of the other (Green & Abutalebi, 2013).

The conceptual architecture of the model is made up of the interactional context, *the speech pipeline, control process, and meta-control processes* (as seen in figure 6). The speech pipeline is the conceptual representation of the linguistic sensorimotor that is incorporated in speech production and comprehension. These representations are presumably controlled by processes in working memory to establish the goal of communication. The meta-process sets the parameters of the control processes (Green &Abutalebi, 2013).

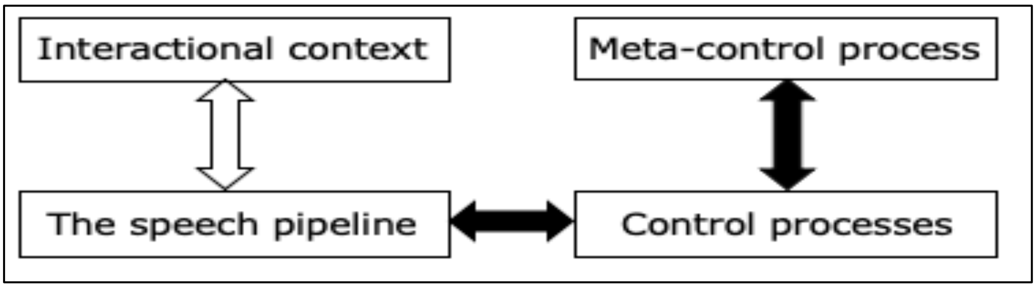

Figure 4: Architecture of the adaptive control hypothesis. Filled arrows represent internal control processes (adapted from Green & Abutalebi, 2013)

As previously mentioned, in Green's inhibitory control model (1998), selecting a language requires the activation of the task schema. In concern with the Adaptive Control hypothesis, Green and Abutalebi surmise that the task schemas are in a competitive relationship in single- and dual- language contexts, in contrast with the dense code-switching context, in which the task schemas are in a co-operative relationship. Green and Abutalebi propose a further breakdown of the control process, seeing as different control processes are being used in each interactional context. According to Green and Abutalebi there are eight control processes. The first control process is labelled *Goal maintenance* and refers to the task of establishing and maintaining the goal to speak in one language and not the other. Disturbances around a conversation, such as nearby speakers of the other language may trigger the other language to a certain extent, which creates the need for interference control to be able to maintain the goal of speaking the intended language. Green and Abutalebi have labeled two control processes: *Conflict monitoring,* which detects conflict, and *interferences suppression* inhibits disturbances. The fourth control process is labelled *salient cue detection,* which signifies cues such as a new speaker entering the conversation, which may require switching to L2. The fifth process is labelled *selective response inhibition,* which stops the speaker from speaking the current language and initiate the sixth process – *task disengagement.* Switching to the other language is the seventh process, labelled *task engagement*. The eighth and last process is labelled *opportunistic planning,* which involves adapting the words of one language to the syntactic frames of the other (Green & Abutalebi, 2013).

Green and Abutalebi assume that the above-mentioned interactional contexts affect the demands on the control processes in different ways. In the single-language context, the control processes are goal maintenance, control monitoring, and interference suppression. The dual-language context requires the same processes, as well as salient cue detection, selective response inhibition, task disengagement, and task engagement. Lastly, opportunistic planning is required in the dense code-switching context – meaning that they modify the words of one language to fit into the syntax of the other. Owing to the fact that speakers in the dual-language context exert more control processes, Green and Abutalebi predict that they will be more accomplished in inhibition, and thus perform better in tasks requiring it, compared to speakers in the other contexts mentioned above (Green & Abutalebi, 2013).

The theory of inhibitory control has been the most common component to explain the bilingual advantage in executive functioning: "inhibition based on the assumption that the nontarget language is suppressed to avoid interference" (Bialystok, 2015 p.118). The positive effects of bilingualism have been found in all stages across the lifespan (Bialystok, 2011), by comparing monolinguals and bilinguals on various tasks that measure different aspects of executive functioning. The explanation proposed for the enhanced executive control found in these studies is that bilinguals use this system to manage attention to jointly activated competing languages. Direct evidence comes from neuroimaging studies of executive control tasks, demonstrating that not only do bilinguals perform these executive control tasks more effectively than monolinguals but hey also recruit different brain networks in those performances (Luk, Anderson, Craik, Grady & Bialystok, 2010; Kałamała, Drożdżowicz, Szewczyk, Marzecová, and Wodniecka, 2017).

The adaptive control hypothesis does, as mentioned, predict that speakers in a dual-language context will be highly skilled in tasks that require inhibition. Prior and Gollan (2011) investigated the possibility that skilled language switchers would be better at other switching tasks compared to monolinguals. In their study, three groups, one monolingual and two bilingual ones completed several non-linguistic (cognitive) and linguistic tasks. In the cognitive task, the participants performed color and shape judgments on visual stimuli, in which they were asked to press buttons in response to shapes (circles and triangles) that were either red or green. The cue for color was a color gradient and the cue for shape was a series of small black shapes. In the language switching task the participants were asked to name digits out loud. When cued by the American flag they named the digits in English, the Mexican flag cued Spanish, and the Chinese flag cued Mandarin. The results demonstrated a smaller switching cost for the Spanish-English bilinguals, but not for the Mandarin-English bilinguals. Prior and Gollan attributed this finding to the fact that Spanish-English bilinguals reported switching languages more often in daily conversations, compared to the Mandarin-English bilinguals. Mandarin-English bilinguals also had lower fluency scores and self-rated their proficiency lower than the Spanish-English group. Prior and Gollan concluded that the advantages in executive control can differ across bilingual populations and therefore emphasize the importance of taking into consideration the varying proficiency levels and language use, and variables such as socio-economic status (2011, p. 689).

In relation to our study, The IC-model is in accord with the cross-language interference account, seeing as competition is at the base of the model, yet the extension of it, the adaptive control hypothesis (Green & Abutalebi, 2013) also speaks for the frequency-lag account. The interactional contexts – *single-language, dual-language*, and *dense code-switching* – describe the individual differences between bilinguals in terms of how they use their two languages. Some bilinguals may use their two languages separately to a larger extent (single-language context), which may comply with frequency of use.

Word translation

The revised hierarchical model (RHM) is a model of bilingual lexical representation and is based on the assumption that a bilingual's two systems are represented separately but share conceptual representation. The relative strength of connections between words and concepts in the bilingual memory are, according to the model, asymmetric in the two languages (Kroll & Stewart, 1994). The assumptions pertaining to this asymmetry is that L1 words have a direct link to their meanings, while L2 words are accessed via their L1 equivalents (as seen in figure 7). This asymmetry reflects the outcome of late acquisition of L2 for bilinguals who already possess a fully developed lexicon for words in L1, yet it is assumed that the links between words and concepts in L2 will strengthen as proficiency increases, making it possible to process L2 words directly. Another consequence of this asymmetry was discovered by Kroll and

Stewart (1994), who found that semantic categorization of experimental stimuli led to co-activation of overlapping conceptual representations and consequently slowed processing from L1 to L2 due to the need for inhibition. Translating from L2 to L1 was found to be processed faster due to its direct lexical connections and was thus immune to semantic manipulation (Kroll & Stewart, 1994).

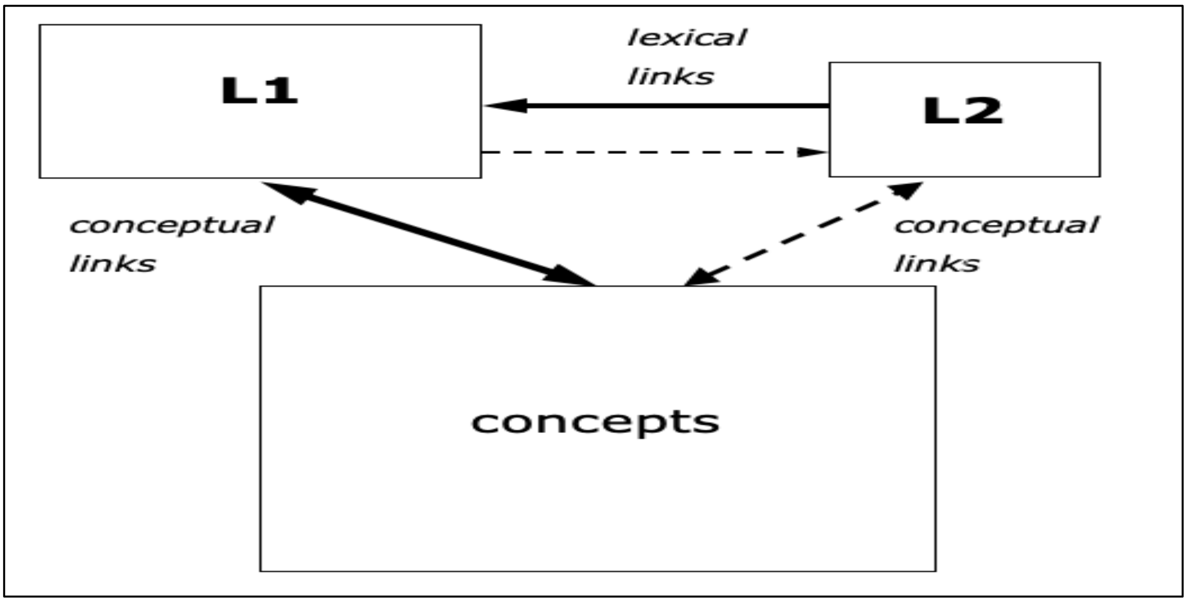

Figure 5: Architecture of RHM, adapted from Kroll & Stewart, 1994

Ibrahim, Cowell, and Varley (2017) proposed that the asymmetries found in Kroll and Stewart (1994) may, however, stem from differences in the frequency of word use across languages, rather than the strength of lexical links. They explored this hypothesis in three experiments. The first experiment was a "within-language synonym task" where they compared access to a high-frequency (HF) vs low-frequency (LF) words to examine the possible asymmetry between the two directions. Monolingual participants were presented with nouns of both low and high frequency and asked to produce a synonym to each word. The second experiment was done in a similar way, except the stimuli was blocked into one semantically related category and one form related category, to learn whether both semantics and form would interfere in retrieval of low-frequency synonyms. In the third experiment, the researchers examined whether two groups of Russian-English bilinguals' performance on a translation task was modulated by their frequency of L2 use (English). In agreement with RHM, Ibrahim et al. (2017) predicted that the L1 dominant group would translate faster from L2 to L1, while the L2 dominant group were predicted to show the reverse effect; faster translation from L1 to L2.

The results from Experiment 1 demonstrated a significant effect of word frequency, meaning that high frequency synonyms were accessed faster than low-frequency words, which according to Ibrahim et al. (2017) replicates that of the bilingual translation pattern found in Kroll and Stewart (1994). Another significant finding was that concrete items were processed faster than abstract items and even more so in the high- to low-frequency direction. The results from Experiment 2 (HF to LF direction) demonstrated that semantical categorization slowed conversion into LF words significantly compared to the randomized nouns, which again reproduce the findings of Kroll and Stewart (1994). Furthermore, Ibrahim et al. found that form blocking caused a more robust interference, indicating that the interference in Kroll and Stewart and the monolingual synonym task may not have been due to semantics alone, but an indication of LF words' sensitivity to various types of interference (2017, p. 53). The results from the LF to HF direction demonstrated no semantic interference. According to Ibrahim et al. (2017) these results are in line with the translation asymmetry predicted by the RHM. The blocking of form-related words generated interference effects in both directions of synonym production. The results from the third experiment were consistent with the predictions in RHM; Russian-dominant bilinguals translated faster into their L1, and Russian to English translations were more susceptible to semantic interference than the English to Russian translations. The English-dominant bilinguals translated equally fast in both directions but were affected by semantic interference in the English to Russian translations. These results also correspond with the frequency-lag account; HF words were accessed faster than LF words and may indicate that more frequent use of English modifies the translation asymmetry.

Dual language activation

One of the models that proposes non-selective language activation in bilinguals is the Bilingual Interactive Activation model (BIA). Initially put forth by Dijkstra and Van Heuven (2002), the BIA is first and foremost a model relating to word comprehension, with the purpose of explaining how bilinguals retrieve orthographical representations from their mental lexicon that correspond to a written word (Dijkstra and Van Heuven 2002, in Altarriba & Heredia, 2008, p.60). The BIA has a similar structure and parameter settings to that of McClelland and Rumelhart (1981), a model pertaining to monolingual visual perception.

The BIA (as seen in figure 3) assumes a bottom-up activation, which means that perception is initiated by presentation of stimuli, e.g. a written word. BIA is a computational network model, structured by four hierarchical levels (letter features, letters, words and language nodes), that interact and are activated in unison. When a string of letters is presented, features represented by the letters in the different positions are activated and in turn excite letters that contain similar features and simultaneously inhibit letters with contrasting features. The letters further excite words in both languages containing the letters in the correct position and inhibit the words with letters in the incorrect position.

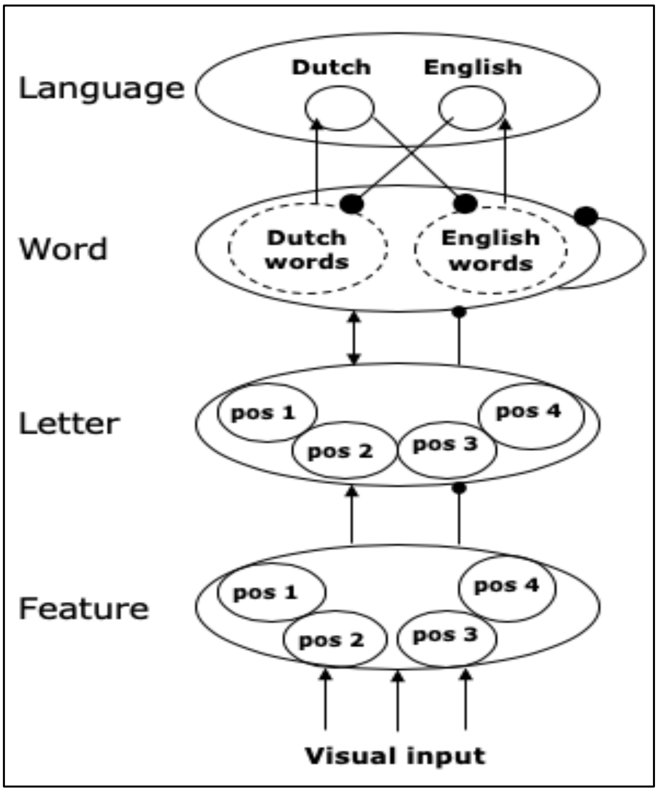

Figure 6: Architecture of the BIA model (adapted from Dijkstra & Van Heuven, 2002)

At the word level, the BIA assumes two integrated lexicons (one for each language), in which lexical access is parallel and non-selective. This essentially leads to competition for selection between the lexical alternatives from both languages, compared to a system with two separate lexicons, where competition effects are limited to only one language (Dijkstra & Van Heuven, 2002). When a word is presented, they activate language nodes, while simultaneously sending activation back to the letter level. The activated language nodes inhibit competing words from the other language lexicon and word recognition occurs when the level of activation of a word surpasses a recognition level, depending on such factors as how similar the words are across the two languages, word frequency (number of occurrences in a given corpus), recency of use, and L2 proficiency (Dijkstra, 2005).

The BIA was later extended and renamed BIA+ by Dijkstra and Van Heuven (2002) and incorporates semantic and phonological representations as part of the word recognition process (as seen in figure 4) This means that orthographic inputs activate associated phonological and semantic representations, as well as associated language nodes, which act as a marker in specifying a words' language membership (Van Heuven & Coderre, 2015). According to Dijkstra and Van Heuven (2002) it is the input word's likeness to the internal lexical representations that determines the level of activation, rather than what language it belongs to. The BIA+ also includes a task schema with the ability to influence output following lexical access, to control for non-linguistic factors, such as task demands, participant expectations, and instructions. The task schema continuously interprets input from the word recognition process in order to produce contextually correct output (Libben, Goral & Libben, 2017, p. 110).

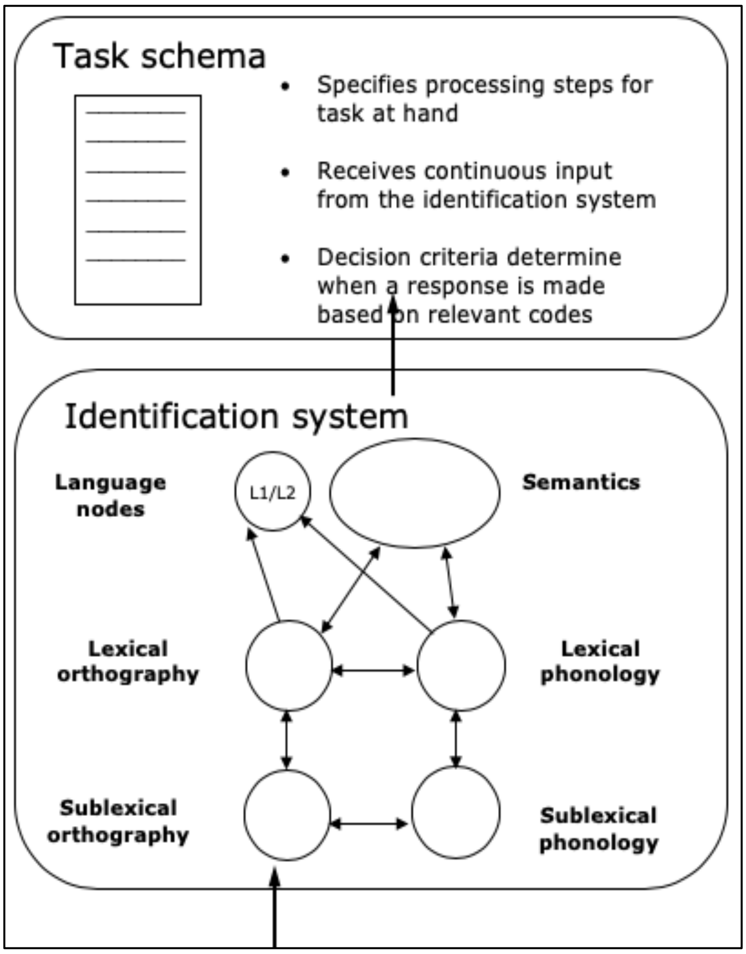

Figure 7: Architecture of the BIA+ (adapted from Dijkstra & Van Heuven, 2002)

If lexical access is non-selective across languages, as predicted by the BIA+, the consequences of cross-language activity should influence performance. Dijkstra and Lemhöfer (2004) provided evidence of such cross-language activity by investigating Dutch-English bilinguals' performance on lexical decision tasks. The participants were aurally or visually presented with a range of words and non-words and asked to indicate whether the presented items were words or not, with the press of a button. In the generalized lexical decision tasks, the participants were presented with words from both languages, as well as non-words that comply with the phonotactic rules of both languages. Dijkstra and Lemhöfer (2004), predicted that the participants would recognize cognates faster, thus facilitating the word-retrieval process.

The results suggest that cross-linguistic orthographic and semantic overlap in the test items led to facilitation as predicted. In the generalized lexical decision tasks, response times were faster for cognates and more accurate than the English and Dutch control words. They suggested that cognates were processed faster due to the shared semantic representation, which feeds back to the orthographic representations, and in that way strengthens both activations. The evidence provided by Dijkstra and Lemhöfer (2004), supports the BIA model, specifically by demonstrating that cognates facilitate processing.

The above-mentioned models each give possible descriptions for speech production, word recognition- and translation. To be able to account for all of these components of language processing, Dijkstra et al. (2018) proposed a computational model that combines several characteristics of BIA+ and RHM. Multilink can be used to simulate both monolingual and bilingual processing of words of varying length, frequency, and cross-linguistic similarity, such as cognates and interlingual homographs. The model can simulate processing of tasks such as lexical decision, orthographic and semantic priming, word naming, and production of word translation. Multilink can also account for varying L2 proficiency due to its ability to fine-tune lexicon and parameter settings.

The architecture of Multilink (as seen in figure 8) is structured in six layers; input, orthography, language, semantics, phonology and output. The model is interactional, which means that activation flows in both directions. Written input will activate various lexical-orthographic representations, which in turn activate their semantic and phonological counterparts, as well as associated language membership representations (Dijkstra et al., 2018). Similar to BIA+ and RHM, Multilink assumes that lexical retrieval is a nonselective process. The bilingual lexicon is integrated, meaning that there is just one pool of words from the two (or more) languages. The activation of competitors from one or two languages depends on their orthographical overlap with the input word. Activated words that receive no further input will eventually decline towards its resting level of activation. Each word's resting level activation depends on its frequency.

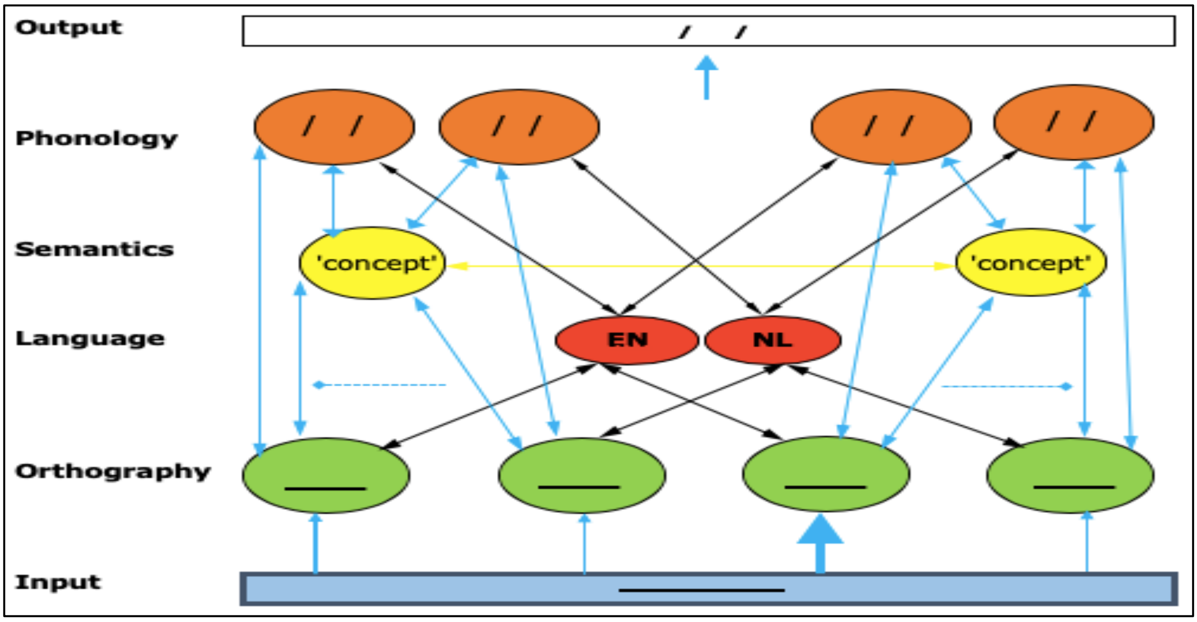

Figure 8: Architecture of Mulitlink (adapted from Dijkstra et al. 2018)

Additionally, the model illustrates that orthographical representations in one language are only indirectly linked to phonological lexical representations in another language (Dijkstra et al. 2018). Multilink demonstrates that translation equivalents are only linked through semantics and not through a word association route, thus contrasting with the RHM. Furthermore, it has a task/decision system that selects representations for output, sets parameters, and specifies responses according to context, much like the task schema in Green (1998). The task/decision system may check the degree of activation at the orthographic, phonological, or semantic layers, and check for language membership in both input and output (Dijkstra et al. 2018).

Dijkstra et al. tested multilink by performing a series of simulations on data from prior studies (Dijkstra et. al. 2010; Vanlangendonck, Rueschemeyer, & Dijkstra in preparation; De Groot, 2011) on word comprehension, word naming, and word translation to demonstrate its applicability in handling retrieval of words of different lengths, frequency, language membership, and cognate status. According to Dijkstra et al. (2018), Multilink serves as a starting point of a more general computational model for word retrieval in both comprehension and production (p.20).

Evaluating theories of the bilingual disadvantage in word-finding

In this section I will examine the various findings related to the bilingual disadvantage in lexical access, with emphasis on the studies that have focused on the two explanations pertaining to it – the frequency-lag account and cross-language interference. By looking at both accounts from different perspectives I will endeavor to disentangle the two, while at the same time demonstrate that one account cannot truly be singled out as the sole basis for the bilingual disadvantage and the TOT phenomenon.

Gollan and Acenas (2004) tested the nature of the tip-of-the-tongue state in two different bilingual groups; Spanish-English bilinguals who had acquired their two languages at an early age and had lived most of their lives in an English-speaking environment, and Tagalog-English bilinguals who reported having spent a more balanced number of years in both language environments. The participants were asked to name pictures and were compared to a monolingual control group. If they were unable to produce the target word, they were asked if they were experiencing a TOT and if they could report on the characteristic of the word (initial letter and number of syllables). If they were still unable to produce the target word, the experimenter told them the word and asked whether this was the word they had in mind or not. Gollan and Acenas reported that bilinguals did show more TOTs compared to the monolingual group, but cognates had a facilitatory effect in that they were able to retrieve the correct target word when they knew it in both languages. This was also found when they limited the comparison to bilinguals who rated their English as near native-like and were able to produce the same number of correct target words, which demonstrates that a higher number of TOTs was not due to relative differences in proficiency. The facilitatory effect from cognates, and the target words' relative translatability were interpreted as evidence against the cross-language interference hypothesis because it clearly predicts the exact opposite, that the non-selective activation of the second language should lead to retrieval failures. The authors did however include the possibility that less proficient bilinguals may be more subject to cross-language interference (Gollan & Acenas, 2004).

Further testing of the bilingual disadvantage was done by Gollan, Montoya, Cera, and Sandoval (2008) in two separate experiments. The first experiment compared English monolinguals' and English dominant Spanish-English bilinguals' performance on a picture-naming task. In line with the frequency-lag account, they predicted larger frequency effects in the bilingual group relative to monolinguals, and larger effects for Spanish within the bilingual group. Monolinguals named all 132 pictures in English, the bilinguals' naming was divided in three sections, English, Spanish, and either-language, with 44 pictures in each section. They found that bilinguals named pictures more slowly compared to monolinguals, and this disadvantage was more prominent for low-frequency words. Bilinguals were also slower to name in the non-dominant language (Spanish) compared to monolinguals. Gollan et al. (2008) attributed this frequency effect to reduced language use, directly supporting the frequency-lag account.

According to the frequency-lag account, increased use as time passes should lead to smaller frequency effects in older bilinguals compared to young monolinguals. Findings of greater frequency effects in older adults (Chae et al., 2002; Balota & Ferraro, 1993; Spieler & Balota, 2000) constitute a problem for the frequency-lag account (Gollan et al., 2008). The cross-language interference account, on the other hand, predicts that the bilingual advantage should increase as time passes, as old age is thought to diminish the ability to control the competition between two languages (Hernandes & Kohnert, 1999). Gollan et al. (2008) assert that the findings of larger frequency effects in older bilinguals might be due to age-related cognitive decline. To examine this further, they used the same stimuli as in experiment 1 to test cognitively healthy older monolinguals and Spanish-English bilinguals. The older bilinguals did not differ from the younger bilinguals in terms of dominance, reported use of English, or age of exposure to English. Experiment 2 replicated the results from experiment 1, but comparisons between the two indicated a difference in frequency effect; younger bilinguals demonstrated very large frequency effects in the non-dominant language (Spanish), compared to older bilinguals who demonstrated equal frequency effects in both the dominant and non-dominant language. Collectively, the results from both experiments challenge the cross-language interference account.

Previous studies on the TOT phenomenon in bilinguals did not control for variables such as syllable position and target word length. A TOT study on European Portuguese monolinguals (Pureza, Soares, & Comesana 2013), found that TOTs were resolved from priming of the last syllable in nonwords. Pureza et al. (2016) investigated these findings further in European Portuguese – English bilinguals and monolinguals, where they induced TOTs using a picture naming task in both languages and a lexical decision task. The bilinguals all had European Portuguese (EP) as their L1 and were highly proficient in their L2 (English). The stimuli (words represented by pictures) differed in terms of cognate status (cognate/noncognate), syllable position and word length. For each of the 80 target words, 16 phonetically related words (8 words and 8 nonwords) were created in each language and used in a lexical decision task following the naming of each picture. Syllabic nonword homophones were imbedded in some of the words for the lexical decision task to manipulate the TOTs and test TOT resolutions. The experiment was run in two parts, one for each language. The participants were asked to name pictures and indicate whether they knew the word or not by pressing designated keys on a keyboard representing *know, don't know* or *TOT.* If they pressed *know,* they typed the word. Following this was a lexical decision task in which they were asked to indicate whether the presented string of letters was a word or not. If the participants responded with a TOT, they were again presented with the previously seen picture and got a second chance at resolving the TOT state. In a previous study with EP monolinguals, Pureza et al. (2013) found that TOTs were resolved due to priming of the last syllable of the target word rather than the first, even when target words consisted of four syllables. According to Pureza et al. (2015) this surprise finding might be because the longer words' baseline level of activation within the TOT were already higher than that of shorter words. Results demonstrated a higher number of TOTs in L2 compared to L1, and the participants had more TOTs for noncognates than for cognates. Pureza et al. (2015) also found that bilinguals demonstrated more TOTs for longer words when performing in EP, but not for English. The results on TOT resolution were also affected by cognate and word length, and as expected, they found that bilinguals demonstrated more TOT resolutions for three-syllable cognates than two-syllable cognates. Priming for the last syllable as in Pureza et al. (2013) was, however not found; bilinguals who were primed by the first syllable resolved more TOTs than those who did not receive phonological priming or were primed by the last syllable (only borderline significant). Pureza et al. note that their findings of more TOTs in L2 than in L1, and more TOTs for noncognates were in accordance with the frequency-lag account (2015).

A version of the TOT states is also found for people who use sign language, which is called tip-of-the-fingers (TOF) (Thompson, Emmorey, & Gollan, 2005). Bilinguals who are fluent in a spoken language and a sign-language are called bimodal bilinguals. Pyers, Gollan, and Emmorey (2009) tested bimodal bilinguals to determine the source of the TOT states. They compared performance between English monolinguals, bimodal English bilinguals and Spanish-English bilinguals on a picture naming task with low-frequency words. When participants were unbale to retrieve a word, they were asked if they were in a TOT state. They had 30 seconds to try and retrieve the word before the experimenter told them the word. They were then asked if they knew the word and if it was the word they had in mind. The responses were classified in 5 categories: 1. GOT (correct retrieval), 2. +ToT for a failed or self-resolved retrieval of target, 3. -ToT for retrieval of incorrect target, 4. NotGOT for failed retrieval of a later recognized target, 5. PostDK (don't know) after being told the word. Pyers et al. (2009)

found that bilinguals had more +TOTs, more true TOTs, and less GOTs than monolinguals. Comparisons between unimodal (Spanish-English) bilinguals and bimodal bilinguals showed no difference in the number of TOTs (all categories). Pyers et al. argue that their findings cannot exclusively be associated with cross-language interference at the phonological level because there is naturally no need for phonological coding in sign language. Bimodal bilinguals had fewer -TOTs (retrieval of correct target), and slightly more correct retrievals (GOTs). In light of these findings, Pyers et al. (2009) assume that the majority of retrieval failures occur at the earliest level due to semantic blocking, or at the lemma or form level. This assumption would explain why bimodal bilinguals showed a trend towards more correct retrievals, in that they could avoid the minority of errors that occur at the phonological level, having no need for phonology. Pyers et al. (2009) do however, disregard the possibility for cross-language interference in this case, because previous findings have determined that bimodal bilinguals do not demonstrate advantages in executive function as observed for bilinguals (Carlson & Meltzoff, 2008; Bialystok, Luk, & Craik, 2008; Thomas-Sunesson, Hakuta, & Bialystok, 2018). Another possible explanation for their findings was the fact that bimodal bilinguals may use their languages more often than unimodal bilinguals. Some of the participants in the bimodal bilingual group (13 out of 22) were interpreters who often speak and sign at the same time, which means that they may use both languages at a higher frequency than unimodal bilinguals, resulting in slightly better retrieval.

The findings mentioned above all point to frequency of use to be the main source of the bilingual disadvantage, yet the equally demonstrated dual-language activation, led Gollan, Ferreira, Cera and Flett (2014) to investigate the possibility that reduced frequency of use and dual-language activation (and by extension cross-language interference) operate together in inducing the bilingual disadvantage in speech production. Gollan et al. (2014) therefore investigated whether translation equivalents (as predicted by the cross-language interference account) could explain why bilinguals are disadvantaged compared to monolinguals regarding the TOT state. Two groups of English dominant Spanish-English bilinguals participated, each in one experiment. In the first experiment, participants were presented with three Spanish words and asked to produce three semantically related words, after which they were shown a picture of an object they had to name in English. On half the trials, the Spanish translation equivalent was included among the list of primes, while the other half only held unrelated primes. If dual-language activation would affect the TOT rate, the Spanish translation primes was expected to cause an increased number of TOTs compared to the trials with unrelated primes. In addition to TOTs, they measured the time it took for the participant to name the (correct) object, to see if facilitation and competition effects arise at separate stages in processing. Previous studies have mainly focused on how the dominant language affects production in the less dominant language, and as a consequence, Gollan et al. (2014) focused their study on production of English target words.

The participants were explained the nature of a TOT before testing started and were instructed to report TOTs whenever they were unable to retrieve a word. If participants were in a TOT state, the experimenter waited a few seconds, before divulging the target words and asked if it was the word the participant was thinking of, and if they knew the word. The answers were classified as either GOTs, TOTs, or Other. The results demonstrated that primes from the less dominant language (Spanish) induced more TOTs compared to unrelated primes. This finding suggests that dual-language activation can increase the number of TOTs in bilinguals, which is consistent with the cross-language interference account. An additional finding in experiment 1 was that translation primes also caused faster naming of correct targets. For experiment 2, Gollan et al. (2014) changed the semantic association task to a phonological association task; asking the participants to produce phonologically related words, when presented with each Spanish prime. The results from experiment 2 was similar to that of Experiment 1, except for naming, times; there was no facilitation from translation primes compared to unrelated primes. According to Gollan et al. (2014), the findings are compatible with both the frequency-lag account and interference account.

From the above-mentioned evidence of the bilingual disadvantage in word finding, we can acknowledge that research do sometimes yield contrasting results. The components in the two main hypothesis' of the bilingual disadvantage in word-finding seem to be intertwined in a way that is particularly difficult to unwind. There is a strong consensus among researchers that frequency of use does influence lexical retrieval, but due to the robust finding of dual-language activation, the account of cross-language interference has as of yet not been invalidated. The next section will report on measuring language profile. As will become apparent, bilingual profiling is essential when investigating lexical processing in bilinguals.

Measuring Bilingual Profile

Bilinguals can differ from each other on a number of factors, such as age of acquisition (AoA), in what manner their languages were acquired, language use and history, and degree of proficiency, and dominance. According to Marian, Blumenfeld and Kaushanskaya (2007), inconsistencies found in research with bilinguals in lexical, phonological, and orthographical processing are all due to these differences. A previous study investigated the relationship between self-assessed proficiency and language performance in Spanish-English bilinguals (Delgado, Guerrero, Goggin, & Ellis, 1999). The participants were given a questionnaire and asked to rate their language skills based on everyday usage. Following this, they completed a picture-naming task, and Woodcock-Munoz subtests of language skills (Woodcock & Munoz-Sandoval, 1993). When comparing the self-assessed questionnaire with performance in these tasks they found that the participants had assessed their Spanish language skills more accurately than their English language skills. The participants were able to assess their oral language skill, and their reading/writing skills in Spanish in a way that correlated with their performance, while the assessment of oral skills in English did not correlate with the language tasks. The evaluation of their reading and writing skills in Spanish, on the other hand, correlated significantly with the Woodcock-Munoz subtests. Delgado et al. surmised that bilinguals, immersed in a school where English is the language of instruction, get more feedback on their reading and writing skills as opposed to their oral skills, which is more usual in a second language class (1999).

Jia et al. used a questionnaire to asses age of L2 acquisition, environmental variables, affective variables related to self-consciousness, cultural identity and self-evaluated proficiency in L1 and L2 (2002). In this they found that self-evaluation significantly correlated with behavioral performance. Further research on self-assessment was done by Flege, Mackay, and Piske (2002), who investigated how language dominance can affect degree of foreign accent and grammaticality. To do this they used a language history questionnaire that focused on age of arrival in the L2-speaking country/L2 learning, proficiency, immersion in L2, years of L2 schooling, percentage of use, and overall exposure. Flege et al. (2002) found that language history and degree of foreign accent correlated significantly, as well as language history and a task in grammaticality judgement. According to Marian et al. (2007), researchers often target information that is only relevant to what they want to manipulate experimentally, which results in separate questionnaires, thus complicating cross-experimental questionnaires. Marian et al. consequently developed the Language Experience and Proficiency Questionnaire (LEAP-Q) to serve as a stable self-assessment tool in determining both proficiency, language dominance, and variables related to experience across bilingual populations.

The first draft of the LEAP-Q included the following factors: language competence, age of acquisition, manner of language acquisition; prior language exposure; and current language use. Language competence had three distinct measures; language proficiency, language dominance, and language preference. Language proficiency gave ratings for proficiency in speaking, listening, reading, and writing, while participants reported on the language dominance order for each of the languages spoken. Questions that regarded preference were presented in a specific way, such as in what language they would prefer to read a text in if it were available in all their languages. Language acquisition referred to questions related to age of acquisition for each language: initial language exposure, age of attended fluency, the age of which they started to read, and age of attended fluency in reading. Prior and current language exposure evaluated exposure to language in a country, in a school environment, at work, and at home. Marian et al.'s first study examined the validity of the questionnaire with a set of bilinguals who answered the questionnaire (2007). From the responses they conducted a factor analysis to contrast statistical clustering of the questions. Based on the variables in each cluster the researchers gave them a logically suited label. The second study replicated the validity with a different group of bilinguals who also completed a set of standardized behavioral measures. The participant's self-rated proficiency from the questionnaire correlated with the results from the behavioral measures, which according to Marian et. al demonstrates that the LEAP-Q is an efficient and valid tool in assessing bilingual language status (Marian et al. 2007).

To get a full picture of the bilinguals in the present study, and examine what factors might predict lexical access, we included Marian et al.'s language experience and proficiency questionnaire. Our LEAP-Q version was somewhat modified to better help the participants understand the questions, and the order of some questions has changed. Although not too relevant in our study, some questions regarding dialect and accent were added since this version of the LEAP-Q will be used in a different study.

Language similarities

English and Norwegian both originated from Proto-Indo-European and belong to the Germanic language group, which is divided in three separate groups; East (now extinct), North (Icelandic, Faroese, Norwegian, Swedish, and Danish), and West (German, Dutch, Frisian and English). Their shared origin is seen in vocabulary, syntax, and phonology. English originated form Anglo-Frisian dialects, now referred to as Old English. Variants of Old Norse influenced Old English during the 8th and 9th centuries when Vikings colonized parts of Britain. Even though Old English is quite different from Modern English, hundreds of the words in Modern English have their roots in Old English and Old Norse, such as common nouns like *anger, bag, both, skill, sky* and *window*. In modern times, English has influenced Norwegian through various medias, creating loanwords like *jeans, boots, sagge* (to sag), *grille* (to grill). Some English loanwords are "Norwegianized" in the sense that orthography is altered slightly to better fit the phonotactic rules in Norwegian: Guide = Gaid; service = sørvis; dull = døll. English and Norwegian are therefore quite similar languages, with many cognates or near cognate words.

The present study

The present study aimed at investigating the factors that are related to TOT rates in both languages of a bilingual. There are two main theories about what causes a TOT. The first one is the frequency-lag account, which suggests that TOTs occur after lexical access and are due to the inability to access phonology. According to the frequency-lag account, bilinguals are disadvantaged compared to monolinguals on lexical retrieval due to the divided frequency of use between two different languages. The degree of access to correct phonology should also be related to frequency of use. A further prediction from the Frequency-lag account is that cognates should facilitate access, which means that cognates should show fewer TOTs. Proper names should be the same across languages and will therefore be unaffected by the frequency-lag. Some proper names do however change across languages and will subsequently be affected by frequency- lag.

The cross-language interference hypothesis suggests that TOTs occur during lemma selection because the translation equivalents in each language compete for selection. If failed retrieval of phonology does not influence word selection, there should be no difference between cognates and noncognates. The number of TOTs should be related to language dominance, because more dominance would mean fewer TOTs. Because competition is the main argument in the cross-language interference hypothesis, the number of TOTs should be related to factors that involve language control. More (intentional) language switching should generate more competition control and subsequently fewer TOTs, while accidental language intrusions indicate worse competition control and will lead to more TOTs.

By incorporating a self-assessment questionnaire to establish a bilingual profile we will be able to see what factors might predict the frequency of TOTs.

Method

Collecting stimuli

We had some challenges in finding target words in Norwegian, particularly noncognates. Firstly, we discovered early on in the process that low frequency words in Norwegian are often derived from Greek and/or Latin, thus sharing orthography and semantics with English, which meant that we had to dig deep to find suitable targets in terms of matched frequency and syllables. Secondly, an additional challenge in making up the noncognate common nouns, was finding low frequency words that were written as a single unit in both Norwegian and English. According to the Norwegian Language Council (Språkrådet) words should be compounded when the first part of the word is stressed. If words are pronounced separately (i.e. both words are stressed) they should be written as two separate words (Språkrådet, 2017). The general rule then is that a lot of words and expressions are compounded in Norwegian, which is quite different from English, where one term can be made up from two different words example. Our targets could only be one single word, and we struggled to find three syllabic words in Norwegian that had equivalent translations English that were also compounded. As found by Pureza, Soares, Comesaña (2015), who induced TOTs using a picture naming task, bilinguals had more TOTs for longer (three syllables) than for shorter (two syllables) words in their L1 (European Portuguese). Surprisingly, this effect was not found when the participants performed the task in English. Pureza et al. (2015) demonstrated that the number of syllables does have an effect in inducing a TOT state. Our common noun cognates have an average of 2.85 syllables, while noncognates have an average of 2.25. These numbers should ideally be closer, but we were unable to find suitable words that were compounds both in Norwegian and English.

A third challenge arose in creating noncognate proper nouns. Certain proper nouns are translated from English to fit the phonotactic constraints within the language that's being translated. This is also the case for Norwegian translations of some English names. The many similarities between Norwegian and English, do however mean that a lot of English names do not conflict with the phonotactic constraints in the Norwegian language. Consequently, a lot of English names remain the same or are only slightly altered, which makes for a great pool of cognates, but not noncognates. Because names are more often translated in children's literature and animated movies/series, this was our main source for noncognate proper nouns. I suspect that we would have had an easier task in finding translated names had our participants been older, owing to the fact that English names and movie titles are no longer translated to the extent they were 30-40 years ago (Ellingsen & Grimen). The trend for translators today is to only translate names of people or places that are meaningful and when a story is set in an entirely fictitious world, such as J.K. Rowling's magical universe (Vogt, 2018).

Participants

Thirty Norwegian-English bilinguals (6 men and 23 women) ranging from the age of 18 to 40 participated in the study. The participants were predominantly recruited from various faculties at the University of Agder and from the Kristiansand area. All participants were native speakers of Norwegian and were proficient in English. They reported no language impairments such as dyslexia or stuttering. The participants received a gift certificate of 200 NOK for their participation. All participants were given an information sheet and signed a consent form that was preapproved by the Norwegian Center for Research Data (NSD), reference number:158894.

Materials and Design

Language Experience and Proficiency Questionnaire – LEAP-Q

A revised version of the LEAP-Q (Marian; Blumenfeld, Henrike K; Kaushanskaya, Margarita, 2007), was used to determine language proficiency. The LEAP-Q consisted of four parts; screening, language background, Norwegian and English proficiency, and dialect and accent. The screening determined whether the participant were eligible to take part in the study with questions regarding age, vision, handedness, years of education, and confirmation of no language impairments. In the language background section participants self-rate their languages in terms of acquisition, dominance and percentage of exposure to each language. For this study, the proficiency section asked the participants to list time spent in various language environments and self-rate proficiency in speaking, writing and grammar in both Norwegian and English, as well as proficiency in pronunciation and reading comprehension. The dialect and accent section asked participants about their dialect and their attitude towards it. In addition, due to the diversity in Norwegian dialects the participants rated how strongly regional their dialect was. For the sake of total anonymity, we changed "date of birth" to "age". We added a question to determine if the participants had normal to corrected hearing. We also added a question to determine what written form of Norwegian (Nynorsk/Bokmål) the participants predominantly use.

The "tip of the tongue" experiment

The "tip of the tongue" experiment (TOT) consisted of two parts – one Norwegian, and one English. Each part comprised 80 written definitions, 80 targets words and 240 foils, three for each target word, of which two were either semantically or phonetically related and one was unrelated. There were four different groups of target words: cognate common nouns, noncognate common nouns, cognate proper nouns, and noncognate proper nouns.

All the Norwegian target words were matched on number of syllables, phonemes, letters, hits in NoWac, frequency per million and hits in Google. The English common nouns were matched on number of syllables, phonemes, letters, frequency in Celex (per million), while the English proper nouns were matched only on hits in Google due to the fact that proper nouns are not searchable in Celex.

Table 1 Frequency and length characteristics of the target words in TOT task

	No. of syllables	No. of phonemes	No. of letters	Hits in NoWac	Frequency in Celex	Frequency per million	Hits in Google
Norwegian							
Cognate common nouns	2.85	6.95	7.25	484.34	—	0.695	30314935
Noncognate common nouns	2.25	5.9	6.45	486.15	—	0.6895	4922105.263
Cognate proper nouns	2.65	6.85	7.65	472.95	—	0.6785	61554842.11
Noncognate proper nouns	2.85	6.95	7.25	478.9	—	0.68215	29259861
English							
Cognate common nouns	3	6.85	7.6	—	2.43	—	35632500
Noncognate common nouns	2.60	6.70	8.10	—	2.31	—	27053250
Cognate proper nouns	2.25	5.7	6.8	—	—	—	242722000
Noncognate proper nouns	2.3	6.1	7.15	—	—	—	85335950

Procedure

The testing was done in two sessions on separate days, one for each language. The language order was counterbalanced, so that half of the participants did the Norwegian part first and half of them did English first. The testing was run in a quiet room and lasted between 45 to 90 minutes per session. The participants were instructed to speak in either Norwegian or English before they entered the language lab. The participants were given time to read through an information sheet and signed a consent form prior to testing. The participants sat in front of a computer screen while the experimenter sat beside them and controlled the keyboard. Each

session started by filling in the first section of the LEAP-Q, before the experimenter launched the program, Open Sesame ((Mathôt, Schreij, & Theeuwes, 2012)
The participants were presented with a written instruction on the screen before the test started. The experimenter explained what a TOT was to make sure they understood the task at hand. Participants were instructed to answer as honestly as possible.

The participants were presented with definitions on the screen with a question underneath, saying: "Do you know this word". There were three possible answers; *yes, no,* and *TOT*. The experimenter pressed 1 for yes, 2 for no, and 3 for TOT. If they answered yes, they were asked to say the word. If they said no, the next definition would appear. If the participants answered TOT, they got three follow-up questions; "Can you guess the initial letter or sound?", "Can you guess the last letter or sound?", Can you guess the number of syllables?". Five different alternatives were then presented on the screen; the actual target, the three foils (semantically related, phonetically related and unrelated) and "none of the above". Following the TOT task, the participants completed the vocabulary task. After having completed the experiments in our study, our participants took part in another MA project on bilingual language processing.

Vocabulary task

The vocabulary tasks were composed of two parts – one synonym task, and one antonym task. There were 40 target words in each language; 20 for the synonym task and 20 for the antonym task. All target words were noncognate target words and there were three foils for each target word. The Norwegian target words were of very low frequency. Of the English synonyms were 8 adjective, 6 nouns, 4 verbs, and 2 that could be both a noun and a verb. The English antonyms consisted of 7 adjectives, 6 nouns, 6, verbs, and 1 that could be both a noun and a verb. Both the Norwegian synonyms and antonyms each consisted of 8 adjectives, 6 nouns and 6 verbs.

Results

Participants

The 30 participants in this study were between 18 and 36 years of age with an average of 23.6 years, of which 23 were female and 6 were male. They were all native Norwegian speakers and had English as a second language and spoke no other languages in the home. None reported having language impairments such as dyslexia or stuttering. They all had normal hearing and eyesight (or corrected to normal by glasses or contact lenses). 25 participants were right handed and 4 were left handed. Of all participants, 28 was born in Norway and 1 was born in the USA. Most of our participants were students at the University of Agder or recruited from the Kristiansand area. all participants 27 reported that Norwegian to be their dominant language while 2 of our participants reported English being their dominant language. 24 participants reported speaking a third language, 7 reported a fourth language and 1 participant reported a fifth language. The participants reported on having on average 16.4 years of education. Before being tested, all participants received a participation information sheet in which the requirements for joining the study was clearly stated. 30 individuals were recruited to participate in the study, but one participant opted out after the first task of the TOT-experiment, making the total number of participants tested 29. The participants completed a set of screening questions to determine if they were qualified to take part in our study, and completed a survey concerning language history, use, and proficiency.

LEAP-Q results

The results from the LEAP-Q are shown in tab separate categories, each with descriptions preceding a table. Table 1 below shows means and range of answers to questions in the LEAP-Q pertaining to the participants' language history and background. As can be seen, the participants reported on average living most of their lives in Norway in a Norwegian family. The average time spent in an English language environment was far less. On questions concerning language history, participants were asked to range on a scale from 0 to 10 on how much each condition contributed to language learning. The participants reported that interacting with family and schooling strongly contributed to learning Norwegian. Schooling, TV/streaming and listening to music was rated as most important contributors to learning. These numbers collectively indicate that language learning has happened through a combination of formal and informal channels. The label "age milestones" pertains to at what age the participants were when each aspect of language exposure and learning occurred. All participants reported having been exposed to Norwegian from birth, and the average age at which they were first exposed to English was around six years old, which is when children normally start school in Norway. The participants reported speaking fluent Norwegian four years after first exposure, while fluency in English was attained on average 6 years after first exposure. The participants took longer to attain fluency in reading English than in Norwegian.

The category *language use and identity* applies to the participants language use and how comfortable they are with their two languages. Amount of speaking relates to the total time spent speaking each language. The participants reported on average speaking Norwegian 80 % of the time, and English 19.3 % of the time. Of the 24 participants with knowledge of a third language, only 7 reported actually speaking it on a regular basis, which collectively made an average of 0.7 %. The average time spent reading Norwegian was 42.2 %, and the average for English was 57 %. Language of choice relates to the comfort the participants have in choosing what language to speak in. The question is formed as such: "When choosing a language to speak, with a person that is equally fluent in all your languages, what percentage of time would you choose to speak each language?" Participants reported on average choosing to speak Norwegian 80.1 % of the time, and English 19.3 % of the time. Cultural identity refers to what degree the participants identify with either Norwegian, British, American or other cultures. All participants said Norwegian was the culture they identified the most with and the average degree of identification was 8.9 out of 10. Other cultures mentioned with a small degree of identification for each were American, British, Canadian, Australian, Latino, French, Swiss, and Hawaiian.

Table 2: Participants' responses on questions related to language history, use, and identity

	Norwegian		English	
	M	Range	M	Range
Immersion duration (years and months)				
Country	22.3	16–30	1.10	0–16.5
Family	23.2	19–32.7	1.98	0–32.66
Contribution to language learning (0-10 scale)				
Interacting with friends	6.5	0–10	5.6	0–10
Interacting with family	9.3	6–10	3.0	0–10
Reading	6.4	2–10	7.7	3–10
School and education	7.4	0–10	8.0	1–10
Self-instruction	0.8	0–5	2.0	0–10
TV/streaming	3.6	0–10	7.2	3–10
Listening to music/media	2.3	0–10	6.5	1–10
Age milestones (years and months)				
First exposure to language	0.0	0	6.4	0–14
Attained fluency in speaking	4.4	1–10	12.6	6–20
Started reading	5.1	3–7	7.3	4–10
Attained fluency in reading	8.3	5–20	11.6	6–20
Language Use and Identity				
Amount of speaking (%)	74.7	10–99	24.3	1–90
Amount of reading (%)	42.2	5–94	57.0	5–95
Language of choice (%)	80.1	40–100	19.3	0–60
Cultural identity (0-10)	8.9	3–10		

The category proficiency applies to the proficiency in various aspects related to language, such as speaking, pronunciation, reading, writing, grammar, vocabulary, and spelling. Overall, the participants informed on being more proficient in Norwegian for each condition. Proficiency was on average estimated to be lower for vocabulary in both Norwegian and English. On questions regarding language exposure, the participants were asked to rate the degree of language exposure to both Norwegian and English. On overall exposure, the participants reported being exposed to Norwegian 55.7 percent of the time and English 42.7 percent of the time. On the questions related to interaction with family and friends the participants reported on being exposed to language on a scale from 0-10 in which 0 = never, 5 = half of the time, and 10 = almost always. From interaction with friends the average exposure to Norwegian was 8.4 and 3.0 for English. Language exposure to Norwegian from reading was on average rated as 3.7, while exposure to English was rated at 7.6. Reading was specified as books, magazines, and online material. Participants reported being exposed to English through TV/streaming to a much larger extent than Norwegian TV/streaming. The same difference is found for exposure through listening to music and other media with an average of 8.0 for English and 2.2 for Norwegian.

Table 3: Participants' responses on questions related to language exposure and proficiency

	Norwegian		English	
	M	Range	M	Range
Language exposure				
General exposure (%)	55.7	30–85	42.2	14–70
Interacting with friends (0-10)	8.4	3–10	3.1	0–7
Interacting with family (0-10)	9.0	1–10	1.2	0–9
Reading (0-10)	3.7	0–10	7.6	2–10
Self-instruction (0-10)	0.4	0–7	1.0	0–10
TV/streaming (0-10)	2.6	0–10	8.1	3–10
Listening to music/media (0-10)	2.2	0-10	8.0	3–10
Proficiency				
Speaking	9.4	8–10	7.9	4–10
Pronunciation	9.4	7–10	7.4	3–10
Reading	8.9	4–10	7.8	3–10
Writing	8.0	3–10	7.2	3–10
Grammar	8.0	5–10	7.0	5-10
Vocabulary	7.7	4–10	6.8	2–10
Spelling	8.1	4–10	7.0	3–10

Factor analysis

Similar to Marian et al (2007), we performed a factor analysis on the responses from the questionnaire. All non-numerical descriptive variables, along with the variables that showed little variation, were removed. A correlation matrix of the remaining 77 variables was done to see how they relate to each other. Variables with a correlation value greater than 0.8 with another variable were removed. All variables showed a correlation of >0.3 with at least one other variable. A parallel analysis was performed, from which eight factors were extracted.

Table 4: Factor analysis results

Factor 1: English Proficiency	Loading values	Factor 2: Norwegian Proficiency	Loading values	Factor 3: Norwegian Informal Learning	Loading values	Factor 4: English Pronunciation	Loading values
Eng. amount, reading	0.81	Nor. proficiency, writing	0.90	Nor. exposure self-instruction	0.84	Eng. improve pronunciation	0.75
Eng. proficiency, vocabulary	0.79	Nor. proficiency, reading	0.89	Nor. learning, music	0.83	Nor. cultural identification	0.68
Eng. exposure, reading	0.78	Nor. proficiency, spelling	0.84	Nor. exposure, music	0.80	Eng. good pronunciation important	0.69
Eng. proficiency, speaking	0.76	Nor. proficiency, vocabulary	0.72	Nor. learning, TV/streaming	0.77	Eng. improve accent, effort	0.57
Eng. proficiency, grammar	0.71	Nor. proficiency, speaking	0.68	Nor. exposure TV/streaming	0.71	Eng. want native-like pronunciation	0.50
Eng. exposure, total	0.70	Nor. proficiency, grammar	0.49	Nor. learning, self-instruction	0.69	Nor. proficiency, pronunciation	0.45
Eng. amount, speaking	0.70	Nor. proficiency, pronunciation	0.43	Nor. exposure, reading	0.60	Eng. correct grammar, importance	0.33
Eng. proficiency, writing	0.67	Nor. years in country	0.42	Eng. learning, self-instruction	0.41	Eng. exposure, TV/streaming	0.32
Eng. exposure, friends	0.61	Nor. modify dialect, degree	0.41	Eng. learning, TV/streaming	0.40	Eng. learning, Tv/streaming	0.30
Eng. learning, reading	0.56	Eng. proficiency, writing	0.40	Eng. learning, music	0.40	Attention to pronunciation	0.33
Eng. choice/comfort speaking	0.53	Eng. proficiency, grammar	0.35	Nor. learning, school	0.36	Nor. learning, reading	-0.35
Eng. learning, friends	0.51	Eng. learning, music	-0.37	Eng. started reading age	0.35	Eng. learning, friends	-0.43
Eng. correct grammar, importance	0.49	Nor. regional dialect, degree	-0.38	Nor. learning, reading	0.34	Nor. exposure, other dialects	-0.44
Eng. importance, accent	0.46	Eng. intrusion in Nor.	-0.45	Nor. exposure, other dialects	0.33	Age	-0.59
Nor. fluent speaking age	0.46			Eng. learning, school	0.32	Pronunciation not important	-0.72
Eng. exposure, music	0.43			Eng. exposure, self-instruction	0.32		
Eng. exposure, self-instruction	0.42						
Eng. exposure, TV/streaming	0.40						
Nor. fluent reading age	0.33						
Nor. regional dialect, degree	-0.34						
Eng. wanting native-like pronunciation	-0.40						
Nor. exposure, friends	-0.44						
Eng. learning, school	-0.50						
Nor. exposure, reading	-0.60						
Nor. accent in spoken Eng., degree	-0.75						
Nor. amount, reading	-0.82						
Proportion Variance	0.15	Proportion Variance	0.09	Proportion Variance	0.09	Proportion Variance	0.07
Cumulative Variance	0.15	Cumulative Variance	0.24	Cumulative Variance	0.32	Cumulative Variance	0.48

Factor 5: Late English Fluency	Loading values	Factor 6: Language Competition	Loading values	Factor 7: Late Norwegian Fluency	Loading values	Factor 8: Mixed Language Exposure	Loading values
Eng. age, fluent speaking	0.82	Nor. intrusion in Eng.	0.65	Nor. started reading age	0.82	Nor. dialect importance	0.75
Nor. years in country	0.70	Eng. age, started reading	0.58	Nor. fluent reading age	0.68	Nor. accent identified by others	0.59
Eng. age, started acquiring,	0.69	Eng. intrusion in Nor. speaking	0.51	Nor. proficiency speaking	0.49	Nor. exposure, friends	0.45
Eng. age, fluent reading	0.68	Nor. dialect modify degree	0.45	Age	0.48	Nor. learning, school	0.44
Eng. age, started reading	0.57	Eng. fluent reading age	0.40	Nor. proficiency pronunciation	0.46	Eng. exposure, TV/streaming	0.39
Nor. accent, identified by others	0.34	Eng. Wanting native-like pronunciation	0.39	Eng. started acquiring	0.36	Attention to pronunciation	0.38
Nor. accent, degree	0.32	Nor. learning from family	0.39	Nor. age, fluent speaking	0.31	Eng. correct grammar, importance	0.35
Eng. improve pronunciation	0.30	Eng. exposure to music	0.33	Nor. exposure, music	-0.30	Eng. learning, school	0.33
Attention, pronunciation	-0.44	Eng. learning from friends	0.31	Attention to pronunciation	-0.31	Nor. exposure, TV/streaming	0.32
Eng. exposure, family	-0.54	Nor. dialect regional, degree	-0.43	Eng. learning, reading	-0.32	Nor. learning, reading	0.31
Eng. intentional Intrusion in Nor.	-0.58	Eng. amount, speaking	-0.43	Nor. proficiency, grammar	-0.33	Nor. learning, family	-0.40
Eng. learning, family	-0.67	Eng. exposure, self-instruction	-0.54	Nor. dialect modify, degree	-0.41	Eng. choice/comfort speaking	-0.46
Nor. intentional intrusion in Eng.	-0.69	Eng. learning, self-instruction	-0.57	Nor. learning, reading	-0.44	Eng. amount, speaking	-0.48
		Nor. age, fluent speaking	-0.57	Nor. exposure, other dialects	-0.63	Nor. learning, friends	-0.52
						Eng. exposure, friends	-0.56
Proportion Variance	0.08	Proportion Variance	0.07	Proportion Variance	0.06	Proportion Variance	0.06
Cumulative Variance	0.41	Cumulative Variance	0.55	Cumulative Variance	0.67	Cumulative Variance	0.61

Factor 1 was associated with *English Proficiency*, due to the majority of variables related to English proficiency, such as vocabulary, speaking, grammar, and writing. Other positively loading variables were related to English exposure in total and exposure from reading, friends, music, self-instruction and TV/streaming. The total amount of reading and speaking the participants reported on, as well as the comfort they had in speaking English were also of relevance in choosing the factor title. Variables related to Norwegian exposure from friends and reading, and the total amount of time spent on reading Norwegian loaded negatively, which supports the choice of factor name.

Factor 2 was titled *Norwegian proficiency* and included seven positively loading variables being related to Norwegian proficiency, with proficiency in writing having the highest positively loading value, after which followed proficiency in reading, spelling, vocabulary, speaking, grammar, and pronunciation. The number of years spent in Norway is also a positive value and correlates with proficiency. There were three negatively loading variables; English learning from music, degree of regional dialect, and degree of English intrusion when speaking Norwegian. Collectively, the variables agree with the factor title.

Factor 3 was named *Norwegian informal learning* firstly due to the positively loading variables related to learning from Norwegian reading, music, TV/streaming and self-instruction. Other positively loading variables were Norwegian exposure to self-instruction, music, TV/streaming, and reading. The variable Norwegian formal learning (school) had a lower loading value, which makes naming the factor “informal” the sensible alternative. This factor did not have any negatively loading variables.

Factor 4 contains several variables with positive loading values related to pronunciation, such as wanting to improve English pronunciation, the degree of importance of a good English accent, and the amount of effort put in to improving English accent. Other positively loading variables were the degree of Norwegian cultural identity, and proficiency in Norwegian pronunciation which does not necessarily fit with the factor name. Yet, the majority of variables associated with English pronunciation indicate that *English Pronunciation* is an appropriate title for these variables. Additionally, the variable pronunciation is not important to me had a negative loading value of -0.72, validating the factor title.

Factor 5 had variables related to age, such as age of acquisition of English, what age they were when they started reading, and the age of speaking and reading English fluently. The degree of Norwegian accent (self-perceived and as identified by others) also had positive loading values, which suggests that *late English fluency* correlates with a heavier Norwegian accent when speaking English. The negatively loading variables English exposure from family and English learning from family, and the degree of Norwegian intrusion when speaking English correlates with being fluent in English at a later age.

Factor 6 was initially rather difficult to interpret, because of the combination of both exposure and learning in both languages. In the end we landed on *Language competition,* due to the positively loading variables of accidental intrusion when speaking in both English and Norwegian. The age at which the participants started reading and became fluent in reading also had positive loading values, which could indicate that a bilingual's two languages compete more due to having started reading at a later stage in life. The degree at which the participant report on modifying their Norwegian dialect could also be seen as a kind of language competition in their language history, on account of the vast differences in regional dialects in Norway. What may contradict this is that the degree of regional Norwegian dialect loaded negatively, which would have made more sense if it loaded positively, similarly to what extent they have to modify their dialect. This does however fit well if the modification of one's dialect has been thoroughly exercised to the point of erasing its original regionality.

Factor 7 was titled *Late Norwegian Fluency* and included the variables age, the age at which the participants first started to read and speak Norwegian and when they became fluent in both reading and speaking. The age at which the participants started acquiring English loaded positively, which might be consistent with a later Norwegian fluency if participants started acquiring English around the same time as Norwegian. The negatively loading variables of proficiency in Norwegian grammar and contribution to learning indicates that the factor can be associated with late Norwegian proficiency.

Factor 8 – *Mixed Language Exposure* was, like factor 6, comparably difficult to interpret because of the contrasting variables. It was initially labelled "Norwegian language environment" due to the four highest loading variables being related to Norwegian, yet only one of the five were related to exposure. The importance of speaking one's own dialect, and the degree of Norwegian accent, Norwegian exposure form friends and Norwegian learning from school were the highest loading variables. Following these, were English exposure from TV/streaming, attention to pronunciation (in general), the importance of correct English grammar, and learning English from school. Other positively loading variables were Norwegian exposure from TV/streaming and learning Norwegian through reading. The negatively loading variables were learning Norwegian through family, the comfort of choosing to speak English, the amount of time the participants spend speaking English, learning Norwegian through friends, and exposure to English trough friends.

TOT Results

ANOVAs were run on the TOTs experiment findings for each response type. These were two-way ANOVAs crossing factors of language and condition. There were no significant effects for the simple count or TOTs. There was, however, a significant difference in the proportion of TOTs. When combining "knows" and the number of TOTs we found which target words the participants actually knew. By doing this, we found that the proportion of TOTs in English was greater than the proportion of TOTs in Norwegian. For the "know" responses there was a significant difference between languages, in that they knew more words in Norwegian. The "don't know" condition refers to the number of target words the participants did not know. For the "don't know" responses, there was a significant difference between languages; more targets were unknown in English compared to Norwegian.

Table 5. TOT results. Number of responses from the TOTs task grouped by condition (CCN= cognate common noun; NCN, noncognate common noun; CPN= cognate proper noun; NPN=noncognate proper noun)

	Norwegian				NOR total	English				ENG total	Grand total
Target type	CCN	NCN	CPN	NPN		CCN	NCN	CPN	NPN		
Response											
Known	184	265	151	260	860	155	137	83	127	502	1362
Unknown	370	287	409	299	1365	387	413	484	422	1706	3071
TOT	26	28	20	21	95	38	30	13	31	112	207
Correct phoneme	39	36	40	29	144	29	36	11	31	107	
TOT proportion	0.12	0.10	0.12	0.07		0.20	0.18	0.14	0.20		
Sum total	580	580	580	580	2320	580	580	580	580	2320	4640

Linear multiple regression analyses were run for TOTs proportions and "don't knows" in each language with the scores from the vocabulary tasks and the eight factors as predictors. Table five shows which of the factors significantly predicted performance on TOT experiment. The English TOTs proportions were significantly predicted by factor 8, *Mixed language exposure.* The *English vocabulary* correlated negatively with TOT proportions and only reached borderline significance. Other factors that reached borderline significance in predicting TOT proportions were factor 1, *English proficiency,* and factor 5, *late English fluency.* Factor 3, *Norwegian informal learning,* and factor 2, *Norwegian proficiency* were in a negative relationship to English TOT proportions.

English "don't knows" were significantly predicted by three factors; English vocabulary, factor 5, *late English fluency* and factor 6, *language competition.* English vocabulary and *language competition* correlated negatively while *late English fluency* had strong positive correlations to English “don’t knows”. Norwegian TOT proportions were significantly predicted by four factors; factor 1 *English proficiency*, factor 2 *Norwegian proficiency,* factor 6 *language competition,* and factor 8 *mixed language exposure.* Factor 2 correlated negatively, while the other factors correlated positively with Norwegian TOT proportions. Norwegian “don’t knows” were significantly predicted by 2 factors; factor 2 *Norwegian proficiency,* which correlated negatively, and factor 5 *late English fluency* which correlated positively. Norwegian vocabulary correlated negatively but only reached borderline significance.

Table 6 Significant results from multiple regression analysis for TOT experiment.

Factors	English TOT proportions		English “don’t knows”		Norwegian TOT proportions		Norwegian “don’t knows”	
	t-value	p-value	t-value	p-value	t-value	p-value	t-value	p-value
English Vocab	-2.05	0.05	-3.49	0.002	—	—	—	—
Norwegian vocab	—	—	—	—	—	—	-1.98	0.06
F 1English proficiency	2.06	0.05	—	—	2.22	0.04	—	—
F 2 Norwegian proficiency	-1.93	0.06	—	—	-4.74	0.00	-2.56	0.01
F 3 Norwegian informal learning	-1.95	0.06	—	—	—	—	—	—
F 5 Late English fluency	1.87	0.07	2.22	0.03	—	—	2.13	0.04
F 6 Language competition	—	—	-2.83	0.01	2.21	0.03	—	—
F 8 Mixed language exposure	1.87	0.04	—	—	2.28	0.03	—	—

Discussion

In the present study we aimed to examine the occurrence of TOTs in 29 Norwegian-English bilinguals in a word-finding task, and how the findings relate to the bilingual profile. TOTs were induced by definition sentences in which the target words were of relatively low frequency. The testing was done in two separate sessions – one in English and one in Norwegian. The TOT target words held four conditions in each language, cognate common nouns, noncognate common nouns, cognate proper nouns, and noncognate proper nouns. All participants completed a language experience and proficiency questionnaire (Leap-Q) and a vocabulary task as part of the experiment. Results showed no significant effects for the simple count of TOTs, but there was a significant difference in the proportion of TOTs in Norwegian and English, in that there were more TOTs in English. The total number of “knows” was greater for Norwegian than in English, meaning that they knew more words in Norwegian.

Surprisingly, there was no expected cognate effect, i.e. the bilinguals had an almost equal number of TOTs for cognates and noncognates in both languages.

This discussion will focus on the components of the bilingual profile that predicted performance on the TOT tasks. This will subsequently be connected with the main theories that explain the bilingual disadvantage.

A linear multiple regression analysis was done for TOT proportions and "don't knows" with vocabulary scores and factors as predictors. From this we found that English TOT proportions were significantly predicted by factor 8 (*Mixed language exposure).* There was a negative relationship between English vocabulary and English TOT proportion, but this was only borderline significant. Other borderline significant factors were *English proficiency, Norwegian informal learning, Norwegian proficiency,* and *late English fluency.* Finding that factor eight significantly predicted English TOT proportions was somewhat ambiguous. At first sight it is not easy to make out how a mixed language environment may predict TOT proportions. The four highest loading variables in this factor was the degree of importance of Norwegian dialect, degree of Norwegian accent as perceived by other, exposure to Norwegian from friends, and how much school contributed to learning of Norwegian. The highest loading variable connected to English is exposure to English through TV and /or streaming. Negatively loading variables were learning Norwegian through family, how often they chose to speak English, the total amount of time they speak English, how much family contributed in learning Norwegian, and exposure to English from friends. Taking all of these variables together, adding the fact that the factor significantly predicts TOT proportions in English, it is plausible to speculate that the factor is incorrectly labelled and that it possibly reflects something else entirely. It makes sense however, that English vocabulary has a negative relationship to TOT proportions, because a lower vocabulary score in English would mean that the interconnections among words are weaker and generate less phonological activation (Brown, 2012). However, the factor *English proficiency* almost reached significance, which is seemingly inconsistent with a lower vocabulary score in English. The Norwegian TOT proportions were significantly predicted by the factors regarding proficiency in both L1 and L2; although *Norwegian proficiency* had a negative relationship. *Language competition,* and *mixed language exposure* also significantly predicted Norwegian TOT proportions which might indicate that English (L2 for most participants) negatively affected lexical access in Norwegian (L1 for most participants). Self-assessed ratings of proficiency might not correlate with actual vocabulary size or performance in the TOT experiment. On the one hand, some participants may have rated their overall proficiency superficially high and demonstrated a smaller vocabulary than what would be expected. On the other hand, it is also possible that some participants might have been too modest and undersold their proficiency level and performed beyond their self-rating. There is also the possibility that overall higher proficiency in L2 and a larger sized vocabulary would lead to more TOTs because you simply know more words and therefore have a larger lexicon to sift through. Seeing as there are many factors that might influence self-ratings, it would have been better to have a larger group of participants to obtain more comprehensible groupings in factors.

English vocabulary had a negative relationship to the English "don't knows", which was to be expected. If you have a small vocabulary, you will naturally not be able to get to target words, because they simply do not exist in your lexicon. The English "don't knows" were also significantly predicted by the factors *late English fluency* and *language competition. Language competition* was difficult to interpret because variables form both languages loaded positively. Our initial label choice was made on account of the high loading variables related to language intrusions (see table 4) but a better alternative label would possibly have been "informal language learning", due to the fact that the language exposure and learning-related variables came from friends and family. The same is applicable to "don't knows" since our stimulus set consisted of low frequency words that you would not necessarily acquire from informal exposure and learning. The Norwegian "don't knows" were significantly predicted by the factor *Norwegian proficiency.* The majority of the variables that grouped in the factor were related to Norwegian proficiency (writing, reading, speaking, etc.), which made the factor coherent and easy to label, thus giving the factor more validity in terms of its relationship to the TOT proportions and the "don't knows".

The finding of more TOTs in L2 than in L1 is consistent with the frequency-lag account. The hypothesis claims that TOTs occur due to a restricted access to phonology, and that the degree of access should be related to frequency of use; i.e. more frequent use generates greater access. Our results did show that our participants had access to more phonology in Norwegian than in English. Participants also reported, on average, a more frequent use and exposure to Norwegian compared to English. However, a finding that is in conflict with the frequency-lag account is the absence of a cognate effect. According to Costa et al. (2000), cognates facilitate lexical access due to their shared phonological representations and should keep the speaker from falling into a TOT state. There was no such finding for either common nouns or proper nouns in both languages. These effect absences could of course be due to weaknesses in our stimuli set or the low number of participants. It is possible that we failed to find a cognate effect because the frequency of our cognates was merely too low. According to Gollan et al. (2014), the use of definition stimuli might be more strenuous for participants to follow and thus elicit more TOTs compared to a translation task or picture naming.

The cross-language interference hypothesis argues that TOTs occur due to competition between translation equivalents in both languages. Two variables related to language intrusion, both Norwegian intrusion in English and vice versa appears in factor 6, *language competition,* which significantly predicted TOT proportions in Norwegian. Factor 8 significantly predicted English TOT proportions but does not include variables involving language control, which makes it difficult to relate it to competition. Factor 5, *late English fluency*, although only borderline significant, did include two negatively loading variables related to control; intentional intrusion in both language directions. This demonstrates that less switching, and consequently worse language control, can predict more TOTs.

Weaknesses in our study

As mentioned above, there are components of our study that could have been done differently First of all, there were too few participants in our study, which makes it difficult to say anything for certain about out data and factors. Furthermore, our participants were a very uniform group, which yielded less variation on some of more interesting variables. Moreover, the stimulus set was exceptionally challenging to construct, which may have influenced the results. Because English and Norwegian belong to the same language family, they share a lot of cognate or near cognate words. Specifically, many low frequency words in Norwegian are foreign words, often derived from Latin, Greek, or French and are frequently cognates in English and Norwegian. The issue of language similarity made it more complicated to find words that were noncognate while at the same time of relatively low frequency. Whereas the target words needed to be matched for frequency, we had to discard some very low frequency words. This decision may have made some of the Norwegian target words too easy compared to the English ones. There is also a possibility that mutual activation and more competition occurred because of the similarities between Norwegian and English.

We expected that it would be a challenge to find noncognate proper names as they are rarely translated in Norwegian, and if they are, it is mostly in children's literature or Tv/movies. More often than not, the names are only slightly altered to fit Norwegian phonotactics, which makes them unfit to use as noncognates. Thus, in finding noncognate proper nouns we had to delve deep to find names that had been altered enough to fit the condition. As the results show, there was no significant difference between cognate and noncognate proper nouns in Norwegian, something that might indicate that the noncognates selected for Norwegian were too easy to access because the majority of names came from children's literature and TV. Moreover, we had no suitable way of checking the frequency of proper names way of checking proper names for frequency. We chose to use Google hits as an indicator; however, this might not have been the best tool.

Another problem with our study was the lack of a proper protocol for the TOT task. We discovered early on in testing that participants sometimes opted for the TOT alternative when they had actually accessed the target word but wanted to be sure before they answered. After this was discovered, only one of the experimenters chose to follow up with a question to check that the participant had actually experienced a TOT; "was this the actual word you were thinking of?". More than once did the participants admit they were thinking of something else entirely. A practice trial would also be wise to include in the future, to see if participants completely understand the task at hand. An additional issue with the stimulus set was the definitions which may or may not have been adequate. For future research it would therefore be wise to have a neutral group judging the definitions based on their goodness of fit.

Conclusion

The overall results from this study is consistent with previous findings; that bilinguals experience more TOTs in their L2 compared to their L1. This is in line with the frequency-lag account but does not necessary exclude the cross-language interference hypothesis. By comparing the TOT score together with the LEAP-Q we were able to tease out what factors predicted TOT proportions in each language as well as the "don't knows". We found that language competition did indeed predict Norwegian TOT proportions and the English "don't knows". From these findings one can deduce that dual-language activation, and by extension cross-language interference, did play a part in the lexical retrieval failures of our participants. Additionally, we also found that proficiency in English almost reached significance in predicting English TOT proportions which might imply that more TOTs actually demonstrate a widened lexicon, but one is only partially able to retrieve its vast content.

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Appendixes

Appendix (p. 1 of 2). Language Experience and Proficiency Questionnaire.

Last Name		First Name		Today's Date	
Age		Date of Birth		Male ☐	Female ☐

(1) Please list all the languages you know in order of dominance:

1 Language A	2 Language B	3 Language C	4 Language D	5 Language E

(2) Please list all the languages you know **in order of acquisition** (your native language first):

1 Language A	2 Language B	3 Language C	4 Language D	5 Language E

(3) Please list what percentage of the time you are *currently* and *on average* exposed to each language.
(*Your percentages should add up to 100%*):

List language here:	Language A	Language B	Language C	Language D	Language E
List percentage here:					

(4) When choosing to read a text available in all your languages, in what percentage of cases would you choose to read it in each of your languages? Assume that the original was written in another language, which is unknown to you.
(*Your percentages should add up to 100%*):

List language here	Language A	Language B	Language C	Language D	Language E
List percentage here:					

(5) When choosing a language to speak with a person who is equally fluent in all your languages, what percentage of time would you choose to speak each language? Please report percent of total time.
(*Your percentages should add up to 100%*):

List language here	Language A	Language B	Language C	Language D	Language E
List percentage here:					

(6) Please name the cultures with which you identify. On a scale from zero to ten, please rate the extent to which you identify with each culture. (Examples of possible cultures include US-American, Chinese, Jewish-Orthodox, etc.):

List cultures here	Culture A (click here for scale)	Culture B (click here for scale)	Culture C (click here for scale)	Culture D (click here for scale)	Culture E (click here for scale)

(7) How many years of formal education do you have? ____________________
Please check your highest education level (or the approximate U.S. equivalent to a degree obtained in another country):

☐ Less than High School	☐ Some College	☐ Masters
☐ High School	☐ College	☐ PhD/MD/JD
☐ Professional Training	☐ Some Graduate	☐ Other:

(8) Date of immigration to the United States, if applicable: ____________________
If you have ever lived in another country, please provide name of country and dates of residence:
____

(9) Have you ever had a vision problem ☐, hearing impairment ☐, language disability ☐, or learning disability ☐? (Check all applicable).
If yes, please explain (including any corrections): ____________________

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Appendix (p. 2 of 2). Language Experience and Proficiency Questionnaire.

Language: Language X

This is my (please select from scroll-down menu: First, Second, Third, etc.) language.
All questions below refer to your knowledge of Language X.

(1) Age when you…:

began acquiring Language X:	*became fluent* in Language X:	*began reading* in Language X:	*became fluent reading* in Language X:

(2) Please list the number of years and months you spent in each language environment:

	Years	Months
A country where Language X is spoken		
A family where Language X is spoken		
A school and/or working environment where Language X is spoken		

(3) On a scale from zero to ten, please select *your level of proficiency* in speaking, understanding, and reading Language X from the scroll-down menus:

Speaking	(click here for scale)	Understand spoken language	(click here for scale)	Reading	(click here for scale)

(4) On a scale from zero to ten, please select how much the following factors contributed to you learning Language X:

Interacting with friends	(click here for scale)	Language tapes/self instruction	(click here for scale)
Interacting with family	(click here for scale)	Watching TV	(click here for scale)
Reading	(click here for scale)	Listening to the radio	(click here for scale)

(5) Please rate to what extent you are currently exposed to Language X in the following contexts:

Interacting with friends	(click here for scale)	Listening to radio/music	(click here for scale)
Interacting with family	(click here for scale)	Reading	(click here for scale)
Watching TV	(click here for scale)	Language-lab/self-instruction	(click here for scale)

(6) In your perception, how much of a foreign accent do you have in Language X?
(click here for scale)

(7) Please rate how frequently others identify you as a non-native speaker based on your accent in Language X:
(click here for scale)

PARTICIPANT INFORMATION SHEET AND CONSENT FORM

INVITATION TO PARTICIPATE IN A RESEARCH PROJECT

REPRESENTATION AND PROCESSING OF ENGLISH AS A SECOND LANGUAGE

We are looking for Native speakers of Norwegian to take part in a language study investigating the processing of English as a second language.

In order to participate in this study you need to be a **Native speaker** of Norwegian with no other home languages (excluding perhaps English) and have a reasonable proficiency in English as your second language. You should have normal or corrected-to-normal vision and hearing and have no diagnosed language impairments such as dyslexia or stuttering.

The study has three main components:

1. A language background questionnaire
2. Some word finding tests.
3. A picture description task

Completeing all tasks will take around 3 hours, divided across three days.

The study is run by Masters students Lone Sunnset (lone.staule@gmail.com), Susanne M. Avila (susanne.mollestad@gmail.com) and Mikael Andre Albrecht (mikaelandrealbrecht@hotmail.com). Please contact them if you have any queries about the study. This research is supervised by Professor Linda Wheeldon (linda.r.wheeldon@uia.no) and Professor Allison Wetterlin (Allison.wetterlin@uia.no).

WHAT IS THE STUDY ABOUT?

This study is designed to investigate aspects of the use of English as a second language, in particular, in the use of English by speakers that have Norwegian as their first language. We are interested in how aspects of bilingual learning and language-use relate to language processing. The study has three components which will be completed both in Norwegian and English:

1. A questionnaire asking questions about your language background and about how you rate your own level of proficiency in different aspects of the languages that you speak. It should take about 20 minutes to complete.
2. Some simple language tests assessing vocabulary in Norwegian and English (Approx 1 hour).
3. A picture naming task in which you describe pictures in English as fast and accurately as you can. (Approx 30 mins)

If, after having read the information below, you decide to take part in the study please complete the consent form at the end of this document.

The study will collect and record personal information about you. However, you will never at any time be mentioned as an individual in relation to this study. Your personal data will be assigned a number code related to your name and stored on a non-networked, password protected PC. Only the laboratory directors and experimenters will have access to your data and to the key relating your data number to your name. In addition we will record the responses you produce during the experiment, this includes key strokes and speech. These data will be also be anonymised and treated as described above.