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Planning Sentences in Second Language English

Effects of Language Similarity and Language Proficiency

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Abstract

This experiment examines the effects of syntactic structure, interlingual word similarity, and semantic relationships on second-language English sentence production and planning scope. Syntactic structure was manipulated by the two target lexical nouns either occurring together in the same phrase (i.e. the initial phrase of the utterance) or in different phrases. A second goal of the experiment was to examine how bilingual language profile, defined as vocabulary-size paired with self-reported proficiency and exposure measures, affects sentence production and planning scope. Twenty-nine Norwegian-English bilinguals performed a sentence production task using a picture-word interference paradigm where picture- and word-movement determined syntactic structure with reaction times being taken. The results showed significant effects of semantic interference in both phrasal conditions with the effect being significantly larger when both nouns appeared in the same phrase. The results further showed a significant effect of initial-phrase size with participants being faster to onset speech when the two lexical nouns appeared in different phrases. There was also a significant predictionary effect of elements of participants' bilingual language profile on the magnitude of the same phrase condition semantic interference effect. The results suggest that bilingual sentence production and planning scope differs from that of monolinguals, and that bilingual language profile affects bilingual language performance.

1. Introduction

When speaking, one must successfully translate a pre-lexical message to a coherent utterance in accordance with the grammatical, syntactic, morphological, and phonological rules of the language in question (e.g. Bock & Levelt, 1994; Levelt, 1989). There is a consensus that speakers do not usually plan entire utterances to the point of articulation prior to speech-onset. Instead, speakers plan up to a certain point before proceeding incrementally after speech-onset (Kempen & Hoenkamp, 1987; Levelt, 1989). A considerable body of experimental evidence supports this notion (e.g. Allum & Wheeldon, 2007, 2009; Konopka, 2012; Konopka, Meyer, & Forest, 2018; Smith & Wheeldon, 1999, 2004). The information which is planned prior to speech-onset is called the planning scope. It is not given that planning scope is constant across contexts and individuals, and it is possible that there are different scopes which operate differently from one another (e.g. Wheeldon, Ohlson, Ashby, & Gator, 2013) and that speakers adapt their planning strategy depending on the situation (e.g. Konopka et al., 2018). This process is further complicated for bilinguals who must encode their intended message in the appropriate language while managing competitors from the unintended language or languages (e.g. Costa, 2005; Green & Abutalebi, 2013; Misra, Guo, Bobb, & Kroll, 2012). The focus of this thesis is planning scope in the production of second-language English.

First, I will review relevant theories of monolingual language production and the evidence for a phrasal processing scope. I will then turn to bilingual language production and compare it to monolingual language production. I will then discuss the ways in which bilinguals differ from monolinguals both in terms of advantages and disadvantages before briefly discussing the possible effects of language similarity on bilingual performance. I will then describe two languages compared in this study (i.e. Norwegian and English). Finally, an experiment is reported which investigates the effect of bilingualism on second-language English production and planning in Norwegian-English bilinguals.

2. Monolingual sentence planning

2.1 Theoretical Background

The translation of a conceptual message to phonological form (and thus production) is in psycholinguistics called *lexicalization*. Models of language processing generally agree that this process is divided into multiple stages. Bock & Levelt (1994) proposed a model divided into three levels. First, speakers begin at the message level where a conceptual message is formed (i.e. a pre-lexical message where the semantic concepts are selected but that has not yet been translated into a coherent linguistic structure for output). This conceptual message is passed down to the grammatical encoding level which is divided into two sub-stages; the functional and positional processing stage. At the functional processing stage, concepts are translated into lemmas which contain information about a lexical item's meaning and part of speech (i.e. word class). Lemmas do not contain phonological information. The positional processing stage then determines the order of the lexical items and assigns any relevant inflections such as verb-tense, noun-case, plurality, and so forth. When grammatical encoding processes are complete, the message is sent to the phonological encoding stage which assigns the correct phonemes to each lexeme and passes this information on to the articulatory system which results in output. As can be seen, there are several challenges which must be overcome for a speaker to arrive at the desired output. First, they must select the correct lexeme for each concept (a problem complicated by the fact that not all conceptual elements need be expressible though a single lexeme). Second, grammatical encoding must ensure that grammatical, syntactic, and morphological information is applied correctly. Finally, the phonological encoding process must result in a coherent and comprehensible output.

As may be expected, the production of language requires considerable cognitive resources to commence (Levelt, 1989). Production, as previously mentioned, commences incrementally rather than all at once which when bearing in mind that sentences can differ greatly in complexity and length is a sensible strategy to limit cognitive load and ensure fluent conversation (Levelt, 1989). The size of this unit is the planning scope. Incrementality and scope are thus directly correlated; a greater scope means less room for incrementality and vice-versa.

2.2 Monolingual Planning Scope

A considerable body of research has investigated planning scope in monolingual speakers working in their first-language. A key question in such research is how large the planning scope is and whether it is susceptible to change depending on context, speaker, or other factors. Smith & Wheeldon (1999) conducted a study comprised of five experiments with the aim of determining the scope of conceptual and grammatical encoding during spoken language production. To do this the authors used a picture-movement paradigm where participants were shown a horizontal array of three pictures with on-screen movement manipulating the size of the initial phrase as in examples (1) and (2) below.

(1) [The dog and the foot] move above the kite (complex-simple)

(2) [The dog] moves above the foot and the kite (simple-complex)

The second experiment used longer target sentences for the double-clause conditions as shown in examples (3) and (4) and included single-clause sentences for both phrase conditions (i.e. complex and simple initial structures) as shown in examples (5) and (6) to determine whether some planning takes place beyond the first phrase.

(3) [The dog and the foot] move up and [the kite] moves down (complex-simple)

(4) [The dog] moves up and [the foot and the kite] move down (simple-complex)

(5) [The dog and the foot] move up (complex)

(6) [The dog] moves up (simple)

Both experiments showed significantly longer onset latencies for the double clause complex-simple condition (i.e. examples (1) and (3)) compared to their simple-complex counterparts (i.e. examples (2) and (4)). In Experiment 2, the onset latencies for single-clause sentences (i.e. examples (5) and (6)) were significantly shorter than for their respective double-clause counterparts (i.e. examples (3) and (4) respectively) suggesting that some less thorough planning took place beyond the first phrase (as the onset latencies should otherwise have been the same for both the single and double clause sentences). Experiment 3 tested whether this pattern was due to the design by having the pictures remain in place until voice-offset rather than disappear immediately following voice-onset as had been the case in the previous two experiments. The effects were reduced but remained significant. Only part of the effects can therefore be attributed to the visual display. Experiment 4 added a preview-phase where participants previewed the pictures, but not the movement, of the upcoming trial. This preview phase facilitated lemma access by allowing participants time to retrieve the picture-names of each item prior to the onset of movement. The difference between the two double-clause sentence types like examples (3) and (4) was greatly reduced and so was the difference between the two single-clause sentence types like examples (5) and (6). This suggests that the difference between complex-phrase initial and simple-phrase initial structure was largely due to the complex-initial structures requiring the retrieval of two lemmas compared to one for the simple-initial sentences. However, the effect was not completely removed suggesting that some higher-level processing takes place as well. Experiment 5 used structures like examples (7) and (8) with preview conditions for half the trials in each condition to rule out that the observed effects were attributable to the nature of the visual display.

(7) [The dog and the kite] move up (complex)

(8) [The dog] which is next to the kite moves up (relative clause)

Latencies were significantly longer in both non-previewed conditions. Experiment 5 determined latencies by comparing similarly moving trials to one another thus reducing the likelihood that the effects were caused by the display. The authors argue that one must complete grammatical encoding prior to noun articulation and that this process must be completed for the first noun prior to speech-onset. For complex-initial sentences grammatical encoding must be completed for both nouns contained within the first phrase. Nouns beyond the first phrase, however, need not be fully grammatically encoded and the results suggest that this process is initiated but not completed for such elements. Taken together, the results reported by Smith & Wheeldon (1999) provide evidence supporting a phrasal scope for more thorough and low-level processing with higher level processing taking place for elements beyond the first phrase prior to speech onset.

Subsequent studies examining planning scope in spoken sentence production have ruled out several further alternative explanations for the observation that utterances with longer initial phrases take longer for speakers to onset (e.g. Allum & Wheeldon, 2009, 2007; Martin, Crowther, Knight, Tamborello, & Yang, 2010; Zhao, Alario, & Yang, 2014). Martin, et al. (2010) reported four experiments testing alternate explanations for the finding that simple-initial sentences are faster to onset than complex-initial sentences. More specifically, they tested the retrievability account and the visual grouping account. The retrievability account posits that the difference in onset latencies is due to a difference in the retrievability in the second content-word of the target sentence. For example, in Smith & Wheeldon's (1999) experiments the first content word was always a noun, but the second content word depended on the condition. In the simple-initial conditions the second content word was always the verb “moves”, while in the complex-initial conditions the second content word was any of a large set of lexical nouns. According to the retrievability account it is therefore possible that the observed effect of longer latencies for complex-phrase initial sentences is due to the second lexical item (i.e. the less predictable lexical noun) being harder to retrieve than the highly repeated and predictable inflected form of the verb “to move” in the simple-initial conditions. To test this account, Martin et al. (2010) designed Experiment 1a and 1b to use similar stimuli to that of Smith & Wheeldon (1999) with the middle item of Experiment 1b always being coloured yellow. Experiment 1b gave rise to target responses like those shown in example (9) and (10) below.

(9) [The fork] **moves** above the yellow kite and the dog

(10) [The fork and the **yellow** kite] move above the dog

In Experiment 2, the retrievability of movement verbs was manipulated so that simple-initial sentences contained a harder to retrieve verb than the complex-initial sentences. This was done to equate the retrievability between the movement verb in the simple-initial condition and the noun in the complex-initial condition. Neither manipulation removed the effect of initial phrase size on onset latencies which argues against a retrievability account.

A second alternate account is the visual grouping account which posits that it is the grouping of items in the visual display that elicit the difference in onset latencies. To address this, Martin et al (2010) designed Experiment 3 to use stationary displays that elicited responses like in example (11) and (12) below which remained displayed until speech-offset. Experiment 3a used a similar design in stimuli to Experiment 1a, while Experiment 3b used a similar design in stimuli to Experiment 1b meaning the middle picture in Experiment 3b was coloured yellow to facilitate retrievability.

(11) [The fork] is above the yellow kite and the dog

(12) [The fork and the yellow kite] are above the dog

The results showed that complex-phrase initial structures took significantly longer to onset than simple-initial structurers, though the latency difference was greatly reduced. The final experiment sought to further investigate possible effects of visual grouping by having participants in Experiment 4a produce sentences with the same syntactic structures as in

Experiment 3a. Participants in Experiment 4b, on the other hand, simply named displayed pictures individually from left to right. Participants in both experiment 4a and 4b saw the same displays meaning all pictures were black and white line-drawings. The results of Experiment 4a showed that participants were again slower to onset speech for complex-initial structures, but no observable difference between displays was present in Experiment 4b despite participants seeing the exact same displays. Taken together, the experiments reported by Martin et al. (2010) provide strong for the phrase as the default planning scope, and strongly suggest that differences in onset latencies between simple- and complex-initial structures cannot wholly be attributed to retrievability or visual grouping.

An further issue which is inherent to conducting studies on phrasal planning scope in English is that the initial phrase in English serves multiple roles (Allum & Wheeldon, 2007). First, it is the first grammatical phrase, second it is the subject phrase, and third the first noun of said phrase is the head of the subject phrase. It is difficult to determine which of these three aspects constrain the scope of sentence planning. Allum & Wheeldon (2007) reported four experiments in which three experiments were conducted in Japanese which, unlike English, is a head-final language (i.e. the head follows its complements). This syntactic characteristic of Japanese allowed the design of stimuli in which the initial phrase was not so heavily conflated. The experiments used a paradigm where pictures were presented vertically, and their colour determined whether they were subject (light-blue) or complement (white). The first experiment replicated the finding that complex-initial sentences take longer to onset than simple-initial sentences but with the initial phrase being a verb-argument phrase showing that such phrases can function as a planning unit. Experiment 2 used sentences like example (1) below where the subject-phrase came after a prepositional phrase (PP), and like example (2) where a complex verb-argument phrase contains two simple noun phrases that are hierarchically equal meaning both should serve the message-level role of theme. Sentences like example (2) were thus coordinated noun phrases.

(1) "The flower above the dog is red"

[Inu no ue no] [hana wa] aka desu.

[Dog^{GEN} above^{GEN}] [flower^{TOP}] red is.

(2) "The dog and the clock are red"

[Inu to hana wa] aka desu

[Dog^{CONJ} clock^{TOP}] red are.

The results showed longer latencies for sentences like example (2) and the authors argue that this may be due to the two elements forming one unit from the view of thematic representation while structures like in example (1) are viewed as two separate units; namely modifier and theme. The third experiment embedded an initial subordinate functional phrase (defined by the authors as a phrase that represents a conceptual function) within a larger verb-argument-, subject-, or topic phrase. Each sentence contained four nouns, and the sentence-initial PP expanded in size at the expense of the subsequent head noun phrase. Onset latencies increased alongside the size of the initial functional phrase suggesting that scope increased alongside said phrase. The final experiment replicated the findings of Experiment 2 and 3 in English. Taken together, the results obtained by Allum & Wheeldon (2007) argue strongly for the sentence-initial functional phrase as the initial planning unit.

Allum & Wheeldon (2009) further investigated the scope of lexical access during sentence production in Japanese and English. First, a pre-experiment confirmed that previewing a picture or a printed picture name resulted in the same degree of onset-latency reduction. Experiment 1 used this to investigate whether lexical access is completed for both nouns of a coordinated noun phrase in Japanese. The results showed that previewing either noun in the coordinated noun phrase reduced onset-latencies. However, there was a greater effect for previewing the first noun suggesting that, while both nouns are planned to the point of lexical access, the first noun undergoes more thorough planning. Experiment 2 used a different structure and showed that previewing the first noun still yielded shorter onsets while previewing the second noun here yielded an inhibitory effect suggesting that scope is not defined solely by thematic roles. Experiment 3 replicated the findings of Experiment 1 in English. Experiment 4 expanded on the finding by Allum & Wheeldon (2007) that onsets to sentences with PP subject-phrases were faster than to sentences with coordinate noun phrase subject-phrases by examining PP subject-phrases and then contrasting the results with those obtained from coordinate noun phrase subject-phrases. This was done to investigate whether this difference was due to lack of lexical processing.

The results showed that previewing the first noun in a PP subject-phrase (i.e. a noun phrase followed by a modifying PP) that contained two nouns had a significant faciliatory effect on latencies. However, previewing the second noun yielded no effect on onset latencies suggesting different (and possibly more thorough) processing for coordinate noun phrase than PP subject-phrases. Because coordinate noun phrases were presented horizontally while PPs were presented vertically it is possible that this difference was due to the visual display. Experiment 5 therefore removed this difference and was conducted using Japanese stimuli where the head-final characteristic of Japanese caused the modifying PP to come before the head noun phrase (unlike in English where the noun phrase precedes the PP modifier). The data showed a substantial preview-effect for the first noun, but not for the second (i.e. the head). This suggests that in head-final languages it is not necessary to thoroughly process the head-element of the subject-phrase prior to speech-onset and further suggests that it is the sentence-initial syntactic characteristic of the first element that results in thorough processing.

It remains possible that the results obtained by Allum & Wheeldon (2007; 2009) are due to language-specific characteristics of Japanese and English. Arguing against this explanation of the results, Zhao, Alario, & Yang (2014) conducted a similar experiment to that of Allum & Wheeldon (2007) in another head-final language, namely Mandarin Chinese. Their results replicated they key finding by showing a significant difference in onset latencies for sentences with an initial coordinate noun phrase and sentences with an initial PP, with coordinated noun phrase initial structures again taking longer to onset. This suggests that such differences in onset latencies are not solely attributable to language-specific characteristics, but rather reflect changes in speakers' planning scope. Furthermore, by following the same logic as employed by Allum & Wheeldon (2009), Zhao et al. (2014) conducted a second experiment in which a preview period was added. The results showed that the facilitation effect of previewing the second noun was greater for targets with initial coordinate noun phrases than for targets with initial PPs. Lastly, to investigate whether the results were due to visual grouping, Zhao et al. (2014) reported a third experiment in which participants were shown the same types of colour cues (like those used by Allum & Wheeldon, 2007) but instead simply listed the items with no further structure (similar to Martin et al. (2010), Experiment 4b). Results showed that the difference in onset latencies between initial phrase types was significantly greater in the first experiment (which used full sentences) than in the listing condition used in the third experiment thus suggesting that the visual display was not the sole reason for the observed difference.

The results obtained by Zhao et al. (2014) replicate key findings obtained by Allum & Wheeldon (2007; 2009) in a novel language (i.e. Mandarin Chinese) and further suggest that the findings by either study are not simply due to language-specific characteristics. Taken together with the results obtained by Martin et al. (2010) it also seems unlikely that these effects are the result of retrievability, or the visual display used. Therefore, these results provide further support for the functional phrase hypothesis for sentence planning scope.

2.3 Relationships Between Scopes

The experiments summarized above suggest that speakers plan a unit larger than a single word, but smaller than a full clause. However, it is not given that the scopes of lexical and structural planning always coincide. Konopka (2012) reported two picture-naming experiments where the structures of complex noun phrases were manipulated to be either more- or less familiar. More familiar structures were created through priming on a preceding trial. Moreover, participants' familiarity with lexical items was manipulated by using high- or low-frequency object-names in Experiment 1, and by way of recent usage in Experiment 2. That is, participants in Experiment 2 first completed a sentence completion task. In this task, participants completed a sentence where the sentence-final word was a contextually unambiguous and incompletely spelled word. A subset of these sentences ended with a low frequency word and these were later repeated in the experimental stimuli. Low frequency words which were produced by the participants in the sentence completion task should therefore be more familiar than low frequency words which were not. The results showed that structural priming and the ease of lexical retrieval reduced onset latencies in both experiments. The results further suggested that speakers generate a rudimentary structural frame without the need for lexical support. This in turn suggests that structural and lexical planning scope need not coincide, and further suggests that repetition of a sentence structure across trials may affect the ease of generating said structure and thus with greater ease in constructing this structure the window of lexical scope may be affected accordingly.

One study by Wheeldon, Ohlson, Ashby, & Gator (2013) reported three experiments which investigated the relationship between lexical and structural planning scopes. As shown by Konopka (2012) it is not a given that these coincide and research into their relationship is therefore important in determining the nature of the relationship between these scopes. The experiments used a similar picture-movement paradigm to that used by Smith & Wheeldon (1999) but with the addition of the picture preview technique used by Allum & Wheeldon (2009). In Experiment 1, participants saw a horizontal array of four pictures with one of these having been previewed. Participants were unaware of which position the previewed picture would appear in following the preview phase. Experiment 2 was identical to Experiment 1 with one exception; namely that the previewed picture always occurred in the second position making the previewed information much easier for participants to use. Both Experiment 1 and 2 showed reliable effects of initial phrase-type with longer onset latencies for sentences with initial coordinate noun phrases than for simple initial phrase sentences. Experiment 2 showed a significant effect of phrase type with participants experiencing a larger faciliatory effect when the predictably placed previewed noun occurred within the first phrase than when it did not. This suggests that participants did not extend their grammatical processing scope (i.e. the scope of low-level grammatical processing of lexical items) to incorporate the second noun in the simple-initial phrase condition even when they knew the previewed picture would occur in the second position. However, the presence of a smaller preview-effect for the simple initial phrase sentences does suggest that the second noun was processed but to a much less thorough extent than the first noun.

Experiment 3 tested for an upper limit to different scopes (i.e. lexical, grammatical processing, and structural scope) by increasing the number of lexical items in the initial functional phrase to four lexical nouns. Participants previewed what would always be the third picture, and the initial phrase contained either two or three lexical nouns while the second phrase contained two or one respectively. The results showed that Initial phrase type was significant as sentences with shorter initial phrases yielded faster onsets than those with longer initial phrases. However, there was no effect of picture preview. This suggests that structural scope was phrasal (due to longer initial phrase sentences taking longer to onset) but that lexical scope can be smaller than the initial phrase when it becomes too long, and that speakers do not need to retrieve all lexical nouns of a phrase when the phrase extends a certain amount of lexical nouns. In short, the results obtained by Wheeldon et al. (2013) argue for a phrasal scope for structural planning which constrains the upper limit of lexical planning scope but that the scope of lexical planning can be smaller than a full phrase if the number of lexical items exceeds a certain amount.

3. Bilingual Language Production

Bilingual language production must be conducted in a manner in which the correct language is selected for the task at hand. This process is complicated by the fact that there is experimental evidence that suggests that bilinguals are not able to selectively work in one of their languages, but that instead all a bilingual's languages are simultaneously active at any given time (e.g. Costa, 2005; Costa, Caramazza, & Sebastian-Galles, 2000; Guo, Liu, Misra, & Kroll, 2011; Kroll & Stewart, 1994; Misra et al., 2012). Important evidence for language nonselectivity in bilingual language production comes from studies of cognates and false friends. Cognates are in psycholinguistics words that share form and meaning across two or more languages (e.g. "*film*", "*egg*", and "*glass*" are all cognates of Norwegian and English) while false friends are words that share form but not meaning across languages (e.g. "*barn*" meaning a farm building often used for storage in English, but "*child*" or "*children*" in Norwegian). Both cognates and false friends thus by definition only be present in bilingual lexicons as they require interlingual information shared between languages to exist.

Costa, Caramnazza, & Sebastian-Galles (2000) reported two experiments where Catalan-Spanish bilinguals performed a picture-naming task. The picture names were either cognates or non-cognates (i.e. words that share no cross-lingual relationship) and participants named the pictures in Spanish (meaning the bilingual participants named in their second language). When compared to Spanish monolinguals performing the same task the bilingual participants showed significantly faster naming times for cognates than for non cognates while monolinguals showed no significant difference between the two conditions. In Experiment 2, participants either performed the picture-naming task in their dominant first language (L1) or in their nondominant second language (L2). This was done to test whether the size of the cognate effect is dependent on whether participants perform the task in their dominant or non-dominant language. The results again showed a significant cognate effect on picture naming latencies, but the obtained effect was significantly greater than when participants named in their nondominant L2. One possible explanation for this which is presented by the authors is that the effect is greater when naming in one's L2 because the unselected lexical node belongs to the more dominant L1 which can in turn exert a stronger effect on the weaker L2 than vice-versa due to the more dominant nature of the L1.

In terms of perception bilinguals have been shown to recognise cognates faster than non-cognates while in turn recognising false friends more slowly (e.g. Lemhöfer & Dijkstra, 2004) though Brenders, van Hell, & Dijkstra (2011) showed that when presented with lists containing both cognates and false friends the cognate-facilitation effect disappeared in child second language learners suggesting that the cognate effect may be dependent on task, language experience, language proficiency, or a combination of these factors. The Bilingual Interactive Activation Pluss model (Dijkstra & Van Heuven, 2003. BIA+, see figure 1) explains such findings by proposing that input first goes through an identification system where lexical items are tagged for language membership. Lexical items thus feed activation not only to the lexico-semantic system but also to their respective language node resulting in one node receiving more activation. Cognate effects are explained by the system being language nonselective while bilinguals being able to recognise lexical items as belonging to the correct language is explained by the presence of the language nodes. Another part of lexical selection relates to resting activation levels which posit that all lexical items have a resting activation level which will increase or decrease over time with more or less usage respectively. Finally, the identification system feeds continuous activation to the task schema which contains specific processing steps for the task in question. That child second language learners did not display a cognate facilitation effect in lists containing both cognates and false friends can according to Brenders et al. (2011) be explained within the framework provided by the BIA+ model by assuming that how bilinguals resolve cross-lingual ambiguity is in part dependent on their level of proficiency, and that early L2 language learners have not yet learnt that cognate lexical decisions can be unambiguously mediated through their shared semantic representations.

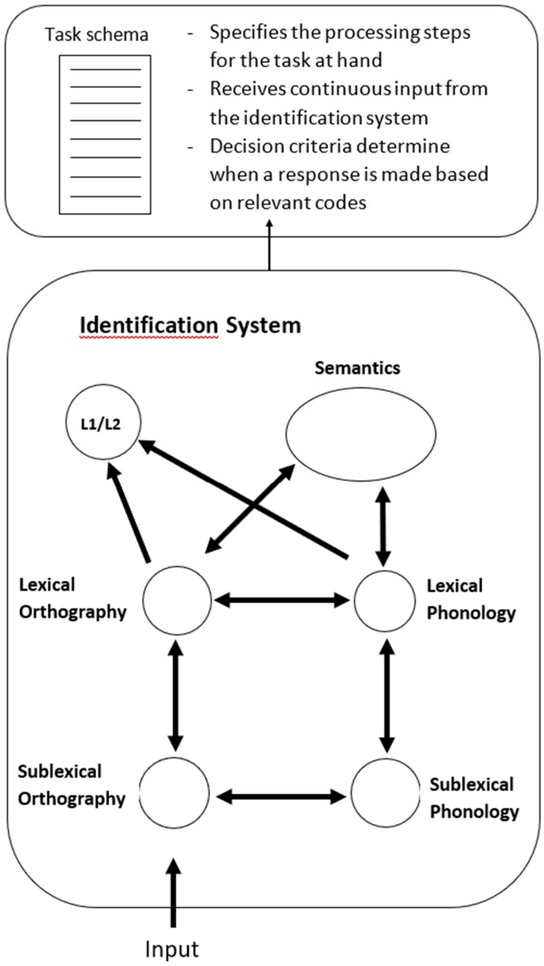

Figure 1: The BIA+ model (adapted from Dijkstra & van Heuven, 2003).

The issue of how bilinguals correctly distinguish their multiple languages is present in both production and perception. The BIA+ model only makes predictions for language perception and is not applicable to language production which is an equally important part of language. The question of how bilinguals ensure that they speak in the intended language is therefore still open. The Inhibitory Control Model or ICM (Green, 1998) differs from the BIA+ model in that it can be applied to both production and perception. In this model, conceptual activity feeds activation to the lexico-semantic system as well as the supervisory attentional system (SAS) which controls the activation of task schemas. Lemmas are tagged for language membership, and the activation of lemmas in the intended language feed activation to other lemmas in said language while also inhibiting lemmas in the unintended language or languages. Inhibition is thus according to this model a key part of bilingual language control (see figure 2).

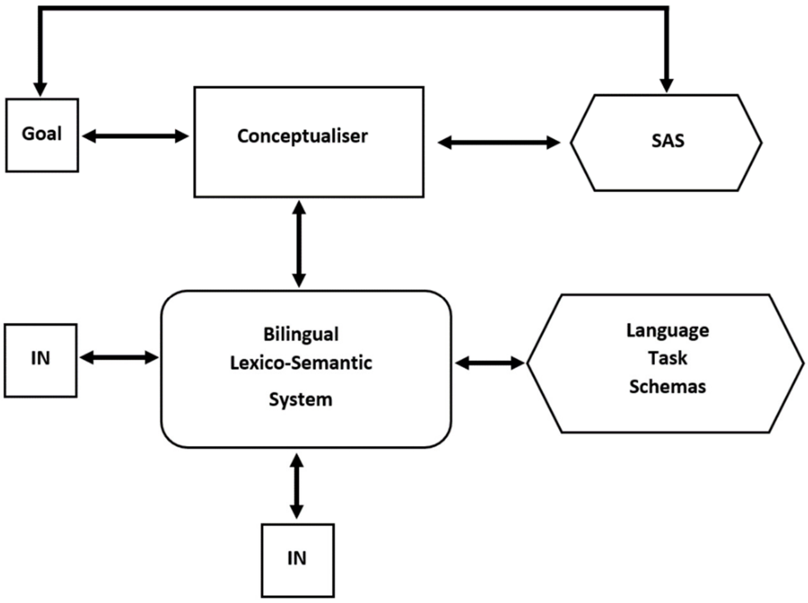

Figure 2: The ICM (Adapted from Green, 1998)

Inhibition is on this view a key part of how bilinguals choose lexical items, grammatical phrases, and syntactic structures in the correct language for a given situation. Key evidence for the presence of inhibition in bilinguals comes from language switching and translation studies which share a common theme in that language switching and translation both require bilinguals to access information from multiple languages over the course of the experiments. In translation studies, bilinguals are asked to make judgements of whether presented items are translation equivalents (e.g. Sunderman & Kroll, 2006). In switching studies, on the other hand, bilinguals are asked to produce a target item in one of their languages as telegraphed by language cue. This cue can be a coloured frame, a flag, and so forth (e.g. Guo, Liu, Misra, & Kroll, 2011; Misra, Guo, Bobb, & Kroll, 2012). Guo et al. (2011) reported a study investigating inhibition in bilingual word production using fMRI. Chinese-English bilinguals were asked to name pictures in blocked (i.e. single-language) and mixed (i.e. mixed-language) blocks. In the blocked condition, participants were told in advance which language to name pictures in for the entire block and thus only switched between blocks. In the mixed condition, participants switched between languages within each block. In the blocked condition, participants should be able to employ inhibition of the entire irrelevant language, so-called global inhibition, while in the mixed condition participants will presumably need to rely on local inhibition of individual lexical items (i.e. the competitor items from the irrelevant language). The results showed that in the mixed condition switching from the L1 to L2 or vice versa employed largely similar neural networks. This suggests that local inhibitory processes are employed for both directions of switching as local inhibition was taken to be more favourable in the mixed condition. The results further showed that switching from a blocked L2 block to a blocked L1 block involved areas of the brain thought to be involved in cognitive control to a significantly greater extent than when naming in the L1 first. This asymmetry is explained within the framework provided by the ICM as the more dominant L1 requires greater inhibition to allow lexical items from the less dominant L2 to be selected than vice versa. When naming pictures in the L2, the L1 will be under considerable inhibition. By contrast, when naming in the already dominant L1, the less dominant L2 will require considerably less inhibition to avoid conflict.

In a follow-up study using ERPs (Event Related Potentials), Misra, Guo, Bobb, & Kroll (2012) examined the inhibition of bilinguals' L1 during single-word production. The experiment differed from that reported by Guo et al. (2011) in that participants named pictures in each language for two blocks in a row rather than alternating between languages between each block. This manipulation was intended to allow inhibitory effects more time to build up and presumably solidify. The order of which language participants named in first was counterbalanced with half the participants naming the first two blocks in their L1, and the remaining participants instead naming in their L2 first. The task order only reached significance for the L2 (i.e. facilitation was only observed when naming in the L1 first). Participants who first named in their L2 displayed inhibitory effects in the third block (i.e. the first block in which they named in their L1). These inhibitory effects declined with time but still remained observable during the fourth block (i.e. the second block in which they named in their L1). This suggests that the degree of inhibition applied to the L1 to facilitate L2 production is significantly greater than for the reverse, and that it takes considerable time to undo this inhibition even after switching back to one's L1.

While the results obtained by Guo et al. (2011) and Misra et al. (2012) provide compelling evidence for the ICM and inhibition being a key part of bilingual language production it is important to point out that this may only be the case in certain (in this case experimental) situations, or that it may only be the case for a subset of bilinguals. Employing a switching paradigm in which participants named pictures, Costa & Santesteban (2004) investigated switch costs in bilingual language switching (i.e. the time it takes to switch between languages). Switching costs for L2 learners were in this study reported as being asymmetrical, meaning participants took significantly longer to switch from their L2 to their

L1 than vice versa. However, with highly-proficient Catalan-Spanish bilinguals this asymmetry was not observed. Furthermore, the absence of this asymmetry was also observed when participants named pictures in their far less dominant L3. Expanding on this observation, Costa, Santesteban, & Ivanova, (2006) examined switch costs in highly proficient L1/L2 bilinguals switching between L1, L2, L3, and L4. This study again reported no asymmetrical switch costs between any of the four languages which suggests that highly proficient L1/L2 bilinguals have found an alternate way of managing interlingual competition and that they are able to expand this method to new languages (i.e. L3 and beyond).

A critical model to account for the findings observed by Costa & Santesteban (2004) and Costa, Santesteban, & Ivanova (2006) is the Revised Hierarchical Model, or RHM shown in figure 3 below (Kroll & Stewart, 1994). Unlike the previous models reviewed in this thesis, the RHM aims to explain the links and connections between a bilingual's languages rather than the specific processes by which production or comprehension take place. The RHM is a more abstract model which nevertheless makes important predictions for both domains. The RHM suggests that there exists a direct link between one's L1 and conceptual information. Because of this it becomes necessary when learning an L2 to first translate from the L2 to the L1 in order to access this conceptual information. With time and increased proficiency, a weaker link is formed between the L2 and conceptual information meaning that it becomes possible to access conceptual information in the L2 without first translating through the L1. Therefore, the RHM suggests that the link from the L2 to the L1 is stronger than vice versa. This also means that translation from L1 to L2 requires conceptual mediation, but that translation in the opposite direction (i.e. from the L2 to L1) can proceed directly via the established lexical connections from L2 lexical items to their translation equivalents. Backward translation may not require conceptual mediation and will be faster than forward translation (which will be more likely to use conceptual information, or semantics). As the connections from L2 words to concepts become stronger with more use (and presumably increased relative balance between languages) the asymmetry observed in translation should decrease. It is therefore possible that bilinguals who have achieved this degree of balance between their L1 and L2 are able to extend this knowledge to their L3 and beyond thus enabling them to display a similar lack of asymmetry in any further languages that they learn.

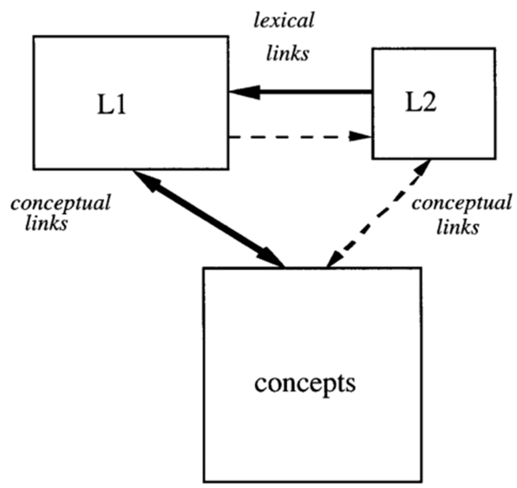

Figure 3: The RHM (from Kroll & Stewart, 1994)

3.1 Bilingual Sentence Planning

As has been discussed, bilinguals and monolinguals differ considerably when it comes to language production and perception. It is therefore of interest to examine whether bilinguals also differ from monolinguals when they plan utterances, and more specifically, if they differ in terms of planning scope and incrementality. The evidence reviewed for monolinguals provides robust evidence for incrementality during monolingual sentence production. However, incrementality can be used to refer to different strategies. Konopka, Meyer, & Forest (2018) report a series of eye-tracking experiments where the predictions of linear- and hierarchical incrementality are tested in L1 (Dutch) and L2 (English) sentence production. In short, linear incrementality means speakers plan on a concept-by-concept basis at the conceptual level (also known as the message level) and on a word-by-word basis at the lexical level with planning for a concept or lexical item only commencing once planning for the preceding item or items has been completed. In other words, incrementality proceeds from left to right one element at a time. By contrast, hierarchical incrementality posits that speakers first encode a larger preverbal message (i.e. a sort of "buffer") before initiating linguistic encoding. Konopka et al. (2018) point out that these are not mutually exclusive; it is fully possible that speakers prefer one form of incrementality in some situations but not in others. As has been discussed above, bilinguals' L2 tends to be weaker and less dominant than their L1 and their preferred form of incrementality may thus differ between languages.

The results showed that speakers' strategies were more consistent with linear incrementality in their L1 but that their strategies were more consistent with hierarchical incrementality in the L2 meaning speakers preferred to build up a "buffer" in their weaker L2 but not in the stronger L1. Analyses of sentence types showed that speakers were more syntactically flexible in their L1 than in their L2 which suggests that speakers are more biased towards a simpler structure (i.e. the active structure) in their weaker L2. This effect was modulated by vocabulary scores meaning speakers with larger vocabularies were more likely to produce passive structures in both languages. Furthermore, speech onset latencies were also modulated by vocabulary scores with larger vocabularies meaning faster onset times. These results suggest that speaker-specific factors may play an important role in bilingual sentence planning and production. The experiments also found that familiarity with agents facilitated onset latencies but did not affect speakers' preference to delay sentence onset in their weaker L2 in favour of a more thorough and broader planning strategy. Familiarity with verbs was shown to affect early sentence planning, unlike noun familiarity which did not. This is by Konopka et al. (2018) suggested to be because verbs provide information about the relations between referents and may thus decrease the costs of encoding a relational framework. It is possible that previewed verbs have a priming effect on early conceptual encoding while previewed nouns have no such effect.

The results reported by Konopka et al. (2018) are of particular interest to this thesis due to them highlighting the possibility that planning strategies may be highly dependent on speaker-specific factors such as linguistic experience with and proficiency in a given language, and that speakers may adopt different planning strategies for different situations. The finding that both generation of more complex passive structures and speech onset latencies were modulated by vocabulary scores is interesting as bilinguals have been shown to have significantly smaller vocabulary sizes in all of their languages, including their L1, when compared to native monolingual speakers of that language (e.g. Bialystok, Craik, & Luk, 2008) lending further credence to the possibility that bilingual and monolinguals differ in terms of sentence planning and incrementality.

4. The Bilingual Advantage and Disadvantage

Bilinguals have been shown to differ cognitively from monolinguals even when performing tasks that are not directly related to language. Bialystok, Craik, & Luk (2008) reported a study in which monolingual and bilingual participants performed tasks designed to test working memory (i.e. the ability to temporarily hold task-relevant information available for processing), lexical access, and executive control (i.e. the ability to manage and carry out tasks). The results showed that the monolingual and bilingual participant groups performed equally well on working memory tasks but that bilinguals performed better on tasks measuring executive control while monolinguals scored higher on tasks measuring lexical access and vocabulary size. In another study, Tao, Marzecová, Taft, Asanowicz, & Wodniecka (2011) showed that executive networks in bilinguals were more efficient than in monolinguals regardless of whether they were early or late bilinguals (i.e. at what point in life the bilinguals learnt their L2) which is directly related to their L2 age of acquisition. This pattern was present when controlling for non-verbal intelligence and socio-economic status which suggests that the source of this effect is related to bilingualism rather than being a side-effect of other factors related to socio-economic status (e.g. education, overall economic purchase power, and so forth).

While bilingualism does confer advantages Bialystok et al. (2008) also showed that bilinguals have smaller receptive vocabularies than monolinguals. This finding was replicated by Bialystok, Luk, Peets, & Yang (2009) in a study which analysed 1738 children (aged between 3 and 10). This difference in vocabulary scores was present despite all the bilingual children using their L2 (English) daily in school and despite the Children's L1s varying greatly. Furthermore, bilinguals have been reported to be at a disadvantage when it comes to word-finding as indicated by bilinguals consistently being shown to have more Tip-of-the-tongue states (ToTs) when producing common nouns than monolinguals (e.g. Gollan, Bonanni, & Montoya, 2005) though Gollan & Acenas (2004) found that this difference disappeared when the target words were cognates. However, there is an issue of the direction of causality when it comes to ToTs. That is, it is not inherently clear whether bilingualism causes an increased number of ToTs because it takes speakers down from a "knowing" state to a ToT state, or whether it helps them going from a "not knowing" state to a ToT state.

When discussing the bilingual disadvantage in lexical tasks there are two main hypotheses. First, the selection competition hypothesis (e.g. Green, 1998; Kroll, Bobb, & Wodniecka, 2006) states that the bilingual disadvantage in lexical tasks occurs mainly as a side-effect of selection competition (i.e. competition from the co-activated lexical items from other languages). This competition makes linguistic processing harder and more effortful than for monolinguals who do not have to manage interlingual competitors. On the other hand, the frequency lag or weaker links hypothesis (e.g. Prior & Gollan, 2011; Gollan, Montoya, Cera, & Sandoval, 2008) states that the bilingual disadvantage in lexical tasks is due to bilinguals effectively splitting their frequency of use between multiple languages. It is therefore impossible for any bilingual to achieve the same frequency of use as a matched monolingual in either of their languages simply because bilinguals must split their time between multiple languages. Because bilinguals use both their L1 and L2 less than matched monolinguals in either language; this explains why bilinguals have reduced accessibility of words in all their languages. Both hypotheses suggest that it is impossible for a bilingual to become "like a monolingual" in either of their languages, but rather that they can only at best approximate a monolingual's performance. For the selection competition account this is because bilinguals will presumably always experience some degree of interference from the non-intended language or languages. For the weaker links account this is because an amount of time, regardless of how small, will always be spent in a bilingual's non-native language or languages. On this account, balanced bilinguals may display a different pattern or magnitude of disadvantages because their time spent in each language is more evenly split than for an unbalanced bilingual who spends almost all their time speaking their L1. An unbalanced bilingual may therefore be at a much smaller disadvantage in their L1 at the cost of being at a much larger disadvantage in their L2 when compared to balanced bilinguals. Regardless, even a small amount of time spent using another language will over time result in a cumulative weaker-links effect.

An important point related to both bilingual advantages and disadvantages is that bilinguals differ greatly, not only from monolinguals, but also from one another. For example, bilinguals differ in which languages that make them bilingual, the similarities or differences between these languages, their balance between languages (or lack thereof), and in what way context they use their languages. It is therefore possible that differences between bilinguals play an important role in determining the size of bilingual advantages and disadvantages. Green & Abutalebi (2013) state that speech production and comprehension are both governed by control processes. The authors hypothesize that bilinguals not only increase cognitive control to achieve goals, but that the control mechanisms themselves adapt to recurrent contextual demands placed upon them. This is the *adaptive control hypothesis*. Green & Abutalebi (2013) point out that bilinguals are likely to differ greatly in terms of language context. That is, whether bilinguals use each of their languages in a single-language context (i.e. in isolation from one another, for example exclusively using one language at work and another at home), in a dual language context (i.e. switching between languages with different speakers but not switching within a single conversation), or in a dense code-switching context (i.e. interleaving elements from one's languages within utterances adapting words, grammar, morphology, or other elements). The hypothesis states that the control processes shown in figure 4 below adapt depending on the demands placed on them.

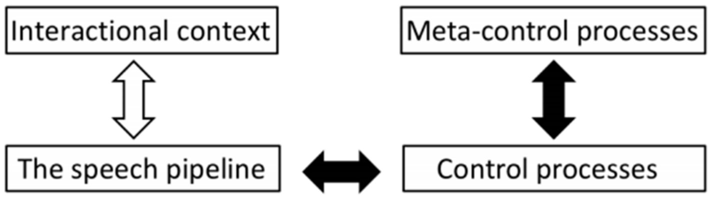

Figure 4: The adaptive control hypothesis (from Green & Abutalebi (2013). Filled arrows depict internal processes of control.

The adaptive control hypothesis posits that bilinguals in a dense code-switching language context are able to work in a different fashion to bilinguals in single- or dual language contexts. This is because the task schemas (e.g. the ICM, Green, 1988) in single- and dual language context bilinguals will compete with schemas from the unintended language or languages, while bilinguals in dense conde-switching contexts are instead able to use the different task schemas in a cooperative fashion rather than in a competitive one. This is, according to the adaptive control hypothesis, because the control processes underlying language use have adapted to the specific needs of dense code-switching. The adaptive control hypothesis further shows that bilingualism is a broad term which applies to a wide array of sub-groups, each of which is likely to differ in key areas. It is not at present clear which factors contribute to what areas of bilingual performance, but it is clear from the studies reviewed in this section that bilinguals do differ considerably and that this affects bilingual performance in experimental conditions. It is therefore paramount for studies to thoroughly examine and describe the bilinguals that they test.

5. Effects of Language Similarity

Bilinguals differ is in terms of which languages they know. However, because some languages have more in common than others it is possible that bilinguals differ in how they process languages depending on the relationship between their languages (e.g. Cui & Shen, 2017, Bialystok & Barac, 2012). In a series of three experiments, Cui & Shen (2017) investigated the effects of language similarity on speech production in bilinguals using a picture-word interference paradigm. Participants were shown a picture and a distractor word (which they had to ignore). In switching blocks, participants were also cued to which language they should perform the task in thus forcing participants to switch between their languages when cued. A second goal of these experiments was to investigate the effects of language proficiency on switching.

To recap, Costa & Santesteban (2004) reported a study in which highly proficient L1/L2 bilinguals did not display asymmetrical switching costs regardless of whether they were switching between their highly proficient L1 and L2 or their much weaker L3. Costa et al. (2006) reported a follow-up study in which this finding extended to participants' L4 as well. The first experiment reported by Cui & Shen (2017) examined bilinguals who switched between their highly proficient and similar L1 and L2 (i.e. Tibetan and Mandarin). Experiment 1 showed symmetrical switch costs. Experiment 2 used a similar paradigm, but participants instead switched between their L2 (Mandarin) and a weaker and dissimilar L3 (English). Experiment 2 showed a significant asymmetrical switch cost with participants taking longer to switch from their L3 (English) to L2 (Mandarin) than vice-versa. Experiment 3, again using the same paradigm, asked participants to switch between their native L1 (Tibetan) and their less proficient L3 (English). The results again showed an asymmetrical switch cost with participants taking longer to switch from their L3 to their L1 than vice-versa., the results obtained by Cui & Shen (2017) replicate those obtained by Costa et al. (2006) insofar as a highly proficient and similar L1 and L2 did not yield asymmetrical switch costs. However, Cui & Shen (2017) found asymmetrical switch costs when bilinguals were asked to switch from either of their highly proficient languages (i.e. the L1 and L2) into a weaker and dissimilar L3. Cui & Shen (2017) argue that this difference in results is likely due to Tibetan and Mandarin being more dissimilar to English than the languages used by Costa et al. (2006) are from one another (i.e. Spanish, Basque, English, Catalan, and French). Taken together, these results suggest that asymmetry in switching is at least to some extent modulated by language similarity, and that more dissimilar languages elicit asymmetrical switching costs when switching from a highly proficient L1 or L2 to a less proficient L3. It is therefore important to describe the similarities and dissimilarities between the languages of participants as language similarity (or the lack thereof) likely plays a role in bilingual performance.

6. Comparison between English and Norwegian

Languages are inherently different from one another. When spoken, languages may employ different phonemes, and the same allophone may belong to different phonemes in different languages. In writing, languages may employ different scripts, and both in spoken and written production; grammatical, syntactic, and morphological elements differ. However, while no two languages are the same it should be noted that some languages are more similar than others. It is therefore possible, as shown by Cui and Shen (2017), that such language similarities (or the lack thereof) influences aspects bilingual language production. This thesis will only compare and discuss areas of English and Norwegian that are relevant to the methodology and logic of the experiment reported herein.

6.1 Phonology

Both Norwegian and English are Germanic languages, with English being a doubly West Germanic language and Norwegian being a North Germanic language. It is therefore not be surprising that the two phoneme inventories of each language share several phonemes between them. In this comparison, English is represented by Received Pronunciation (RP), while Norwegian is represented by Urban East Norwegian (UEN).[1] In terms of phoneme inventories, the two languages are fairly similar with RP containing 23 consonant- and 20 vowel-phonemes (Roach, 2004) and UEN containing 24 consonant- and 24 vowel-phonemes (Kristoffersen, 2000). Consonant inventories are listed in Table 1 below.

[1] UEN is an unofficial standard of spoken Norwegian based on the standard writing of Norwegian Bokmål.

	Bilabial	Labio-dental	Dental	Alveolar	Post-alveolar	Palatal	Retroflex	Velar	Glottal
Plosive	p b			t d			ʈ ɖ	k g	
Nasal	m			n			ɳ	ŋ	
Trill					r				
Tap or Flap				ɾ			ɽ		
Fricative		f	θ ð	s z	ʃ ʒ		ʂ	ç	h
Affricate					tʃ dʒ				
Approximant		ʋ				j		w[2]	
Lateral Approximant				l			ɭ		

Table 1: Consonant Phonemes of RP and UEN. Consonants coloured blue are exclusive to RP, red consonants are exclusive to UEN, and black consonants are present in both phoneme inventories. Adapted from Kristoffersen (2000) and Roach (2004)

Norwegian UEN and English RP share 14 consonants as shown in Table 1 above. The two languages differ most noticeably in terms of retroflex consonants (where UEN has 6 and RP 0), postalveolar consonants (where RP has 5 and UEN 0), and dental consonants (where RP has 2 and UEN has 0). Beyond this the two languages are similar due to the considerable number of shared consonants. There is a greater difference in the vowel inventories of the two languages, starting with monophthongs as illustrated in Figure 5.

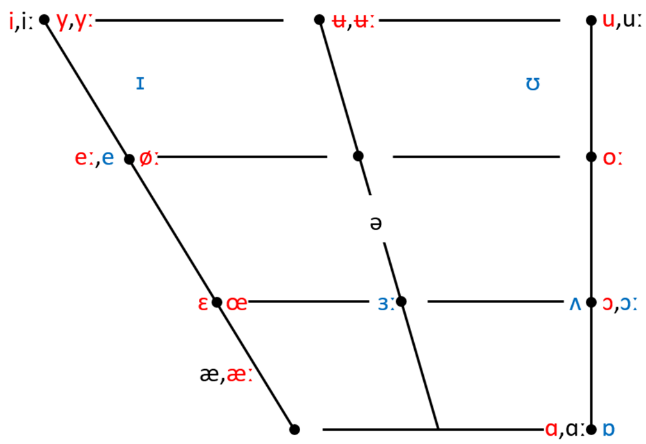

Figure 5: Monophthongs of UEN and RP. Adapted from Kristoffersen (2000) and Roach (2004). Black vowels are shared, red are exclusive to UEN, and blue are exclusive to RP.

RP and UEN share only five monophthongs. One clear difference is that some monophthongs of UEN are listed as both long and short in Figure 5. This is because these long/short contrasts can be used to differentiate between different phonemes in Norwegian UEN but not in English RP. This is not to say that the long/short contrast is not present in English RP, only that it is not phonemically contrastive. Finally, as illustrated in Table 2 below,

[2] [w] does exist in UEN but only as part of the common diphthong /æw/ which is its own phoneme. /w/ is therefore not a phoneme of UEN as it is not contrastive by itself.

Norwegian and English do not share any diphthongs. The transcriptions in Table 2 follow the same definition as Kristoffersen (2000) in that UEN diphthongs are transcribed as ending in a semivowel (i.e. [j] or [w]) rather than a full vowel.

Table 2:Diphthongs of UEN and RP. Adapted from Kristoffersen (2000) and Roach (2002)

RP	UEN
/eɪ/ /əʊ/ /ɔɪ/ /aɪ/ /aʊ/ /ɪə/ /ʊə/ /eə/	/æj/ /œj/ /ɔj/ /ʉ/ /ɑj/ /æw/

6.2 – Orthography

English and Norwegian use similar scripts with all 26 letters of the English alphabet also being present in the Norwegian alphabet. The only difference is that the Norwegian alphabet contains 29 letters, with the three additions being “Æ”, “Ø”, and “Å”.

6.3 - Morphology

A key difference between the two languages is that English verbs are conjugated according to the subject’s person within each tense. That is, English verbs must agree with the plurality and person of their subject. In Norwegian there is no such distinction and verbs are conjugated in the same way for each plurality and person within the same tense. This is shown in table 3.

Table 3: Examples of subject-verb agreement in English and its absence in Norwegian

<table>
<tr><th colspan="2"></th><th colspan="2">English</th><th colspan="2">Norwegian</th></tr>
<tr><th colspan="2">Infinitive</th><th>To open</th><th>To be</th><th>Å åpne</th><th>Å være</th></tr>
<tr><td rowspan="6">Present</td><td>I</td><td>Open</td><td><u>Am</u></td><td rowspan="6">Åpner</td><td rowspan="6">Er</td></tr>
<tr><td>You</td><td>Open</td><td>Are</td></tr>
<tr><td>He/She/It</td><td><u>Opens</u></td><td><u>Is</u></td></tr>
<tr><td>We</td><td>Open</td><td>Are</td></tr>
<tr><td>You</td><td>Open</td><td>Are</td></tr>
<tr><td>They</td><td>Open</td><td>Are</td></tr>
<tr><td rowspan="6">Past</td><td>I</td><td rowspan="6">Opened</td><td><u>Was</u></td><td rowspan="6">Åpnet</td><td rowspan="6">Var</td></tr>
<tr><td>You</td><td>Were</td></tr>
<tr><td>He/She/It</td><td><u>Was</u></td></tr>
<tr><td>We</td><td>Were</td></tr>
<tr><td>You</td><td>Were</td></tr>
<tr><td>They</td><td>Were</td></tr>
</table>

Norwegian and English also differ in how they treat nouns morphologically. This is largely because Norwegian nouns are assigned a grammatical gender meaning that all Norwegian nouns can be categorized as being masculine, feminine, or neuter.[3] In many languages with grammatical gender, such as Spanish and Greek, there are categories of nouns that are easier to recognise as belonging to a certain gender. In Norwegian this is generally not the case; with the notable exception of the definite singular inflection where nouns are assigned an inflectional suffix in accordance with their gender. However, for the remaining three inflections this is not the case. Note that it is possible to differentiate between genders of indefinite singular nouns only if they are paired with their indefinite article which in Norwegian corresponds to the noun's gender.

Table 4: Noun Inflections in English and Norwegian

Indef. SG.	Def. SG.	Indef. PL.	Def. PL
A Car **En** Bil (M)	The Car Bil**en**	Car**s** Bil**er**	The Cars Bil**ene**
A Bottle **Ei** Flaske (F)	The Bottle Flask**a**	Bottle**s** Flask**er**	The Bottles Flask**ene**
A Window **Et** Glass (N)	The Window Vindu**et**	Window**s** Vindu**er**	The Windows Vindu**ene**

By contrast, English nouns are not categorised by grammatical gender, and the indefinite article instead depends on the initial phoneme of the following noun rather than depending on grammatical gender as is the case in Norwegian. Furthermore, as can be seen in Table 4 above, Norwegian nouns are inflected by adding a suffix rather than by a separate article as is the case in English except in the indefinite plural inflection where nouns of both languages are assigned a suffix marker.

The final morphological difference that this thesis will examine is related to compound-words. A compound word is, loosely defined, a word which is created by adding two or more existing words together (e.g. headache). Such words are relatively rare in English but are by comparison extremely common in Norwegian. Moreover, compounding is more easily applied to create novel words in Norwegian than in English. For example, the English "*headache tablet*" would be a single compound in Norwegian (i.e. "*hodepinetablett*"). Thus,

[3] Some Norwegian dialects only have two grammatical genders. In such dialects, all feminine nouns are instead treated as masculine.

many concepts which are expressible through single words in English require compounds constructed of two or more words in Norwegian. Norwegian compounds always take on the grammatical gender and word-class of the right-most word in the compound.

7. Semantic Interference in Sentence Planning

The experiment reported in this thesis used an experimental paradigm like that used by Smith & Wheeldon (2004), and this study will therefore be described in some detail before describing the present experiment. Smith & Wheeldon (2004) reported four experiments in which they investigated whether the lemma access within the first phrase is serial (i.e. a lemma is only accessed after the preceding one(s) have been accessed) or parallel (i.e. temporal overlap between the access of lemmas). A related issue is whether the horizontal information flow is interactive (i.e. whether information generated from accessing one item can inform the access of another item) or modular (i.e. information is restricted to each item). The authors argue that there is observational evidence suggesting that horizontal information flow is interactive. For example, in example (1) below, which is taken from Ancient Greek, (adapted from Smith & Wheeldon, 2004) the sentence-final noun *"ανδρεια"* meaning "*courage*" is feminine. However, its corresponding definite article is the sentence initial "*η*". Thus, there is a second definite article (i.e. "*του*") and its corresponding masculine lexical noun (i.e. *"στρατιωτου"* meaning "*courage*") between the initial feminine indefinite article and the feminine lexical noun that the initial article's gender depends on.

(1) **η** του στρατιωτου **ανδρεια**
The (F) the (M) of the soldier (M) courage (F)
"The soldier's courage"

To test these hypotheses, Smith & Wheeldon (2004) used a modified version of the picture-word interference task, which in its standard version sees participant name pictures while ignoring a simultaneously displayed distractor word. The modified version used movements to elicit responses in a similar fashion to Smith & Wheeldon (1999). Experiment 1 had four conditions shown in examples (2)-(5) below. In Experiment 1, both related conditions yielded longer latencies than their unrelated counterparts with the difference in the same phrase conditions being stronger than in the different phrase conditions. This suggests that there was temporal overlap between the processing of the two nouns in both the same phrase and different phrase conditions (supporting a parallel view) but that the information flow within a phrase is stronger than between phrases.

(2) “[The saw and the axe] move down” (Same Phrase, Related)

(3) “[The saw and the cat] move down” (Same Phrase, Unrelated)

(4) “[The saw] moves towards the axe” (Different Phrase, Related)

(5) “[The saw] moves towards the cat” (Different Phrase, Unrelated)

Experiment 2 replicated the semantic interference effect obtained in Experiment 1 but using only same phrase conditions and thus similar picture movements suggesting that the result was not due to the visual display. Experiment 3 investigated whether phonological information can flow from one lexeme to another and provide facilitation by constructing same phrase stimuli which had either a begin overlap (e.g. “cat” and “cap” which overlap with the word-initial /k/) or end-overlap (e.g. “flag” and “bag” which overlap with the word-final /g/). Facilitation was found only for the end-overlap condition. Experiment 4 investigated whether there was temporal overlap between the planning of lexemes from different phrases by using a similar design to Experiment 3 but with different phrase stimuli instead. Neither overlap condition showed faciliatory effects and the experiment therefore did not provide evidence of temporal overlap in the activation of lexemes that fall within different phrases, nor did it provide evidence for phonological information being able to cross phrasal boundaries. Taken together, this suggests that there is no temporal overlap and no flow of phonological information between lexemes in different phrases. That semantic interference, while stronger in the same-phrase condition, was present in both conditions is by Smith & Wheeldon (2004) suggested to be due to participants accessing only conceptual information for lexical nouns that fell outside the first phrase, while lexical nouns within the first phrase were planned to the point of accessing both conceptual and lemma information. Thus, only conceptual information interfered when the lexical nouns fell within different phrases while both lemma and conceptual information interfered when the nouns fell within the same phrase which yielded the observed asymmetry.

8. The Current Study

8.1 Predictions

Participants should take longer when both lexical items fall within the same phrase than when they do not. This is because studies using similar paradigms have reliably produced this effect and there is no manipulation in the current experiment that should negate this (e.g. Allum & Wheeldon, 2009; Smith & Wheeldon, 1999, 2004; Wheeldon et al., 2013; Zhao, Alario, & Yang, 2014). What is novel is that this effect, if present, will replicate this pattern in bilinguals' L2 and provide further support for the functional phrase hypothesis of planning scope.

A second prediction is that there should be a semantic interference effect when target items are semantically related. Because semantic interference is a measure of word retrieval it is strongly expected that there will be a significant effect of semantic interference in the same phrase conditions. However, I also predict that participants will display a semantic interference effect when lexical items fall within different phrases as observed by Smith & Wheeldon (2004). This semantic interference effect is expected to be stronger in the same-phrase condition than in the different-phrase condition.

Third, participants should be faster to onset sentences that contain cognate words than those that contain non-cognate words. This is based on the observation in previous literature that participants consistently both recognise and produce cognates faster than non cognates (e.g. Costa & Santesteban, 2004; Lemhöfer & Dijkstra, 2004). This prediction is aided by the observation by Costa et al. (2000) that cognate effects during picture naming are stronger when naming in the L2 due to the stronger influence on the L1 on the L2 than vice-versa. This is because participants in the experiment reported in this thesis performed the task in their L2.

A final prediction is that these effects should be modulated by proficiency and language background. That is, participants who are more proficient in their L2 should display a smaller semantic interference effect as they should be likely to adopt a less-conservative scope of planning. Cognate effects should be modulated by relative L1/L2 proficiency, with participants who are more proficient in their L2compared to their L1 showing a smaller cognate effect due to the L1 being of less help than for participants who are comparably less proficient in their L2 compared to their L1.

8.2 Methodology

8.2.1 Participants

29 participants were recruited and were compensated monetarily for their participation. Participants had to be aged between 18 and 40 and be native speakers of Norwegian while also being reasonably fluent speakers of English. Furthermore, participants were required to have normal or corrected to normal vision as well as normal hearing, and none of the participants had a diagnosed language impairment (e.g. dyslexia, stuttering, etc.). The study was ethically approved by the Norwegian Centre for Research Data (NSD - Norsk senter for forskningsdata)[4] and participants gave informed written consent prior to testing.

8.2.2 Language Questionnaire

Prior to testing, participants filled in a modified Language Experience and Proficiency Questionnaire (LEAP-Q, Marian, Blumenfeld, & Kaushanskaya, 2007). The full questionnaire used in this study is provided in Appendix A. First, the order of questions was changed. Most notably, the screening portion of the questionnaire was administered prior to testing with the remaining portion of the questionnaire being administered following the vocabulary test and tip-of-the-tongue experiment (Mollestad Avila, 2019; Sunnset, 2019). Because the present experiment always followed at least one of the two tip-of-the-tongue experiments this meant that participants had always filled in the complete LEAP-Q prior to participating in the sentence production experiment reported in this thesis. The modified LEAP-Q only collected proficiency data for participants' L1 and L2 (i.e. Norwegian and English). Meaning that while participants were asked to list all their languages, we only collected detailed proficiency data for Norwegian and English. The modified LEAP-Q was also subject to several design-related modifications and paraphrases with the intention of making the questionnaire easier for participants to understand. This was done to better ensure the reliability of the collected data by removing as much ambiguity as possible. Finally, several novel questions were added; most of which as part of the dialect and accent section at the end of the questionnaire.

8.2.3 Materials

The experiment used 56 pictures and 56 words, of which 16 from each category were fillers and the remaining 40 were experimental items. Each experimental picture was paired with

[4] NSD Reference Code: 158894

one of two words in each condition (one semantically related and one unrelated) which resulted in a total of four conditions, one related same phrase (1A, 2A), one related different phrase (1B, 2B), one unrelated same phrase (1C, 2C), and one unrelated different phrase (1D, 2D)

1)

A) A **Zebra** goes above a Hyena

B) A **Zebra** and a Hyena go down

C) A **Zebra** goes above an Alarm

D) A **Zebra** and an Alarm go down

2)

A) A **Fork** goes below a Plate

B) A **Fork** and a Plate go up

C) A **Fork** goes below a Rabbit

D) A **Fork** and a Rabbit go up

Each word was used four times, twice in the semantically unrelated conditions and twice in the related conditions meaning that there was a total of 40 experimental pictures and 40 words, with each item appearing four times, once in each individual condition. Thus, there were a total of 160 experimental sets (i.e. picture-word pairings). The experimental picture-names and words were controlled for syllable-length, phonemic length, and frequency using the CELEX corpus for English words and the "*Norwegian Web as Corpus*" (NoWaC) for Norwegian words (see Appendix B).

When creating the related condition, each picture and word was controlled to share the living trait, while in the unrelated condition the picture and word were controlled to be of opposite living-states. The picture and word pairings were controlled to ensure that there was as little phonological overlap as possible. Of the 40 pictures and 40 words, half were cognates and half were non-cognates. Cognate status was constant within sets meaning that cognate pictures always occurred with cognate words, and that non-cognate pictures always occurred with non-cognate words (see Appendix C for the full list of experimental pairings).

To create the same- and different phrase conditions the movements of the pictures and words were manipulated. In the same phrase condition both the experimental picture and word moved up or down simultaneously which resulted in a target-sentence in which both experimental items fell within the same phrase (1B, 1D, 2B, 2D). By contrast, in the different phrase condition, only the picture moved up or down with the word remaining immobile (1A, 1C, 2A, 2C). The movement-direction of the same-phrase and different-phrase conditions for each experimental picture-word pairing always contrasted; thus, as shown in (1) and (2) above, if the same-phrase condition went down, the different-phrase condition would go above and vice versa. This was done to minimize the chance of participants associating a particular item with one specific movement direction.

To keep the comparability between English and Norwegian as large as possible, the target sentences were designed to be as comparable in the two languages as possible. In Norwegian, the definite is formed by adding a suffix (-*en* for the masculine genus) to the end of the word rather than by adding a separate definite article before the noun to be modified (underlined in example 3A and 3B) as mentioned in section 5.3 above. Furthermore, the verb "to move" is reflexive in Norwegian (bold in example 3A and 3B) meaning that "*å bevege seg*" literally translates as "*to move oneself*".

3)

A) <u>The</u> Zebra **moves** below <u>the</u> Hyena

B) Zebra<u>en</u> **beveger seg** under Hyen<u>en</u>

To account for these differences the indefinite "a/an" was used in place of the definite "the" as the indefinite article is more similar between the two languages (though Norwegian has three indefinite articles; "en/ei/et", one for each grammatical gender). Additionally, the verb "to go" was chosen instead of "to move" due to the former not being reflexive in Norwegian. Thus, the complexity of the sentences in both languages should remain relatively similar as illustrated by the sentences in example (4) below.

4)

A) **A** Zebra <u>goes</u> below **a** Hyena

B) **En** Zebra <u>går</u> under **en** Hyene

The filler-items consisted of 16 pictures and 16 words. Of the fillers, half from each category were cognates, with the other half being non-cognates. Half the fillers from each cognate-category were living with the remaining half being non-living. The filler trials displayed either a picture or a word by itself in one of the two experimental screen-positions (with screen positions being balanced across fillers). Each filler-item defined its own filler set, and each filler set contained one trial in which the filler moved to the left (5A), one in which it moved to the right (5B), one in which there was no movement (5C), and one in which the screen was empty (5D). This resulted in a total of 128 filler-items (see Appendix D for a complete list)

5)

A) A Crown goes left

B) A Crown goes right

C) There is a Crown

D) There is nothing on screen

The goal of the filler-items was to provide syntactic variation as well as create some uncertainty as to which position pictures and words would occur in in the subsequent trial as well as uncertainty pertaining to movement.

8.2.4 Design

The experiment used a mixed design. Each picture-word pairing used either a same- or different phrase structure (see 1 and 2 above). The picture-name and its paired word were either semantically related or unrelated, and each picture-name and word was either a cognate or a non-cognate. All three conditions were within-subject manipulations with phrase structure and relatedness being were within-item manipulations and cognate status being a between-items manipulation. In other words, each subject (i.e. participant) saw every condition. Phrasal structure and relatedness manipulations occurred within each item (i.e. picture-word pairing), and cognate-status manipulations only occurred between each picture-word pairing as cognate-status is constant unlike semantic relatedness and phrasal structure

Half the experimental items were cognates and half were non-cognates. Within each cognate category both the relatedness of the items and the phrasal structure (i.e. same phrase or different phrase) varied. This resulted in a total of 160 experimental trials with each experimental picture occurring four times. Four experimental blocks were created, each containing one condition from each experimental and filler set (see Appendix E). This resulted in there being 72 trials in each block (40 experimental and 32 fillers). Each experimental picture occurred once in each of its four conditions across the four blocks, and each experimental picture only occurred once within a block. This meant that within each experimental block there were 10 items from each of the four experimental conditions, with half being cognates and the remaining half being non-cognates. A similar distribution was ensured for the fillers with one filler-item from each filler-set being present in each experimental block.

Each experimental block always began with a filler-trial, and each block had a pause in the middle. The order of experimental trials within each block was pseudorandomised with the following constraints: no more than four experimental trials occurred in a row without a filler in-between; no more than three experimental trials of the same relatedness or cognate category occurred consecutively between or across fillers; and experimental trials of the same phrase-type never occurred consecutively (i.e. a same phrase trial was always preceded by a different phrase trial and vice-versa) between or across fillers (this was done to minimise the risk of structural priming effects). The four experimental blocks were rotated to create four lists which were balanced across participants so that one fourth of the participants completed list 1, one fourth of the participants completed list 2, and so forth.[5] All participants saw the same practice block (see Appendix E) consisting of 50 practice trials spread across two sub-blocks of 25 trials each prior to completing the four experimental blocks.

8.2.5 Apparatus

Participants were seated in a sound-attenuated booth, approximately 60 cm the monitor. Participant responses were recorded with a Sennheiser GSP350 headset, and the stimuli was presented using the Presentation software. The experiment used a simple amplitude-based voice-key.

[5] Because there was an uneven number of participants (i.e. 29) and an even number of blocks (i.e. 4) this resulted in 8 participants completing List 1 while 7 participants completed lists 2, 3, and 4.

8.2.6 Procedure

Prior to the experiment all participants had undergone a tip of the tongue (ToT) experiment (see Mollestad Avila, 2019; Sunnset, 2019) participants filled in a modified Language Experience and Proficiency Questionnaire (LEAP-Q) questionnaire prior to testing (see Appendix A). When filling in the LEAP-Q, participants were accompanied by an experimenter to avoid differences in interpretations of the questions thus ensuring more reliable data. Participants also completed a synonym/antonym vocabulary test (see Appendix F) where they were presented with a word and asked to name which of four alternatives were a synonym or antonym of the presented item. All target-items were low-frequency and an experimenter again supervised the participants.

For the experiment, participants were tested individually with the experimenter seated next to them for the two practice blocks, and behind them during the eight experimental blocks. The pictures and words always appeared in the same two positions in the centre of the screen (see figure 6 and 7) with the pictures always appearing in the left-most position. Participants were instructed to describe the scenes in a left-to-right manner using specific sentence structures.

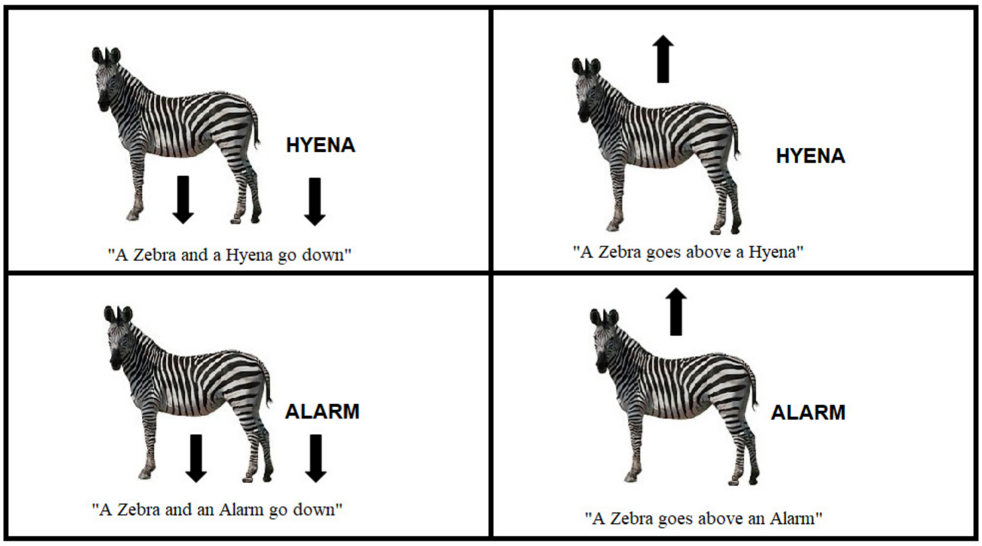

Figure 6: An example experimental picture-word pairing in its four conditions

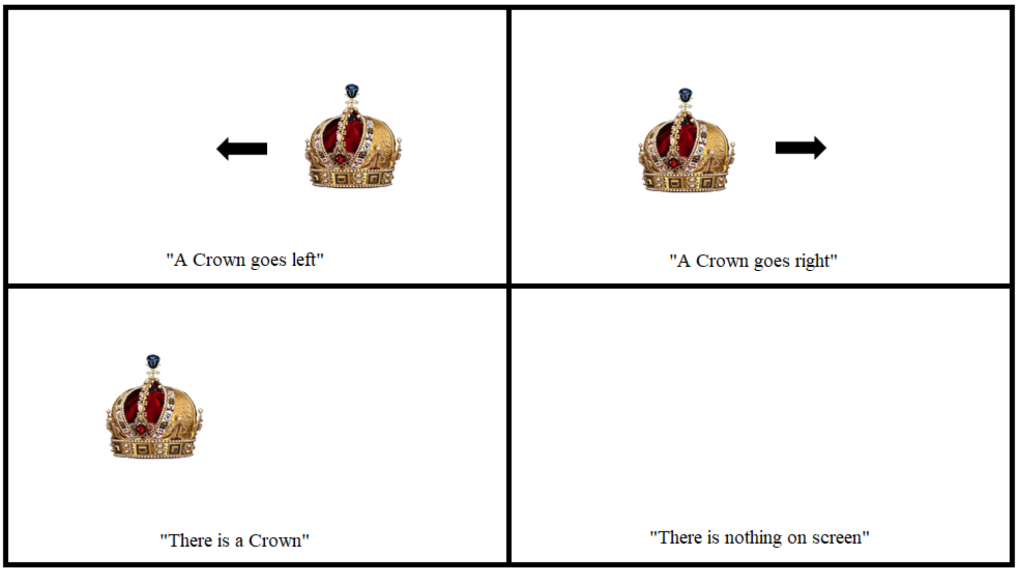

Figure 7: An example picture filler-item in its four conditions.

The experiment was conducted exclusively in English, meaning that participants were both instructed and spoken to in English. This was done to, as far as is possible, reduce cross-language disruption. Participants were told that they would be shown scenes on the screen and that they would be required to describe them. Prior to the testing phase, participants were trained to describe the scenes in the appropriate manner. That is, participants were asked to describe the scenes from left to right using the appropriate language (see figure 6 and 7) and were told to be as fast, fluent, and accurate as possible. On the computer, participants first saw two practice sub-blocks of 25 items each (50 items in total). Of the 50 practice items, 34 were similar to the experimental items while 16 were filler-like (4 items from each filler-condition). The 50 practice items were made using the experimental items with every experimental picture and word appearing once in the practice trial thus familiarising participants with the experimental picture names. The practice trial was experimenter-timed meaning that the next trial would only commence when the experimenter had pressed the enter key on the keyboard. During this trial, participants were corrected on picture-names and given general feedback and corrections about fluency, syntax, and movement.

After the practice trial participants were shown a white screen with "*start of experiment*" written on it. They were told to press the enter key when ready. After every 36 trials there was a pause screen which required the participant to press the enter key to proceed. Every trial began with a blank screen for 1000ms followed by a fixation cross being displayed on-screen for 500ms. When the fixation cross first appeared, there was an auditory "beep" to notify participants that a trial was about to appear on screen. When the fixation cross disappeared, participants were shown another blank screen for 500ms. The voice-key was armed once the trial appeared on-screen (i.e. after 2000ms) with movement (if any) commencing immediately once the items appeared on-screen. When participants started speaking there was a 500ms timeout meaning that the trial would end once 500ms passed from the offset of speech. There was a 3000ms no-reply timeout, meaning that if no reply was detected within 3000ms of the trial first being displayed it would be logged as no reply and the next trial would commence instead. The time at which every trial first appeared was logged in milliseconds, as were the times of participant speech onset and offset. Participant reaction times were calculated by subtracting trial appearance time from participant voice-onset time. This procedure was repeated for each trial.

9. Results

9.1 Participants

All 29 participants (23 female and 6 male; 25 right-handed) reported Norwegian as being the culture with which they identified the most. All but one participant reported Norway as being their country of birth, and all participants currently resided in Norway. 27 participants reported Norwegian as their most dominant and English as their second-most dominant language with the remaining two participants reporting English as their most dominant and Norwegian as their second-most dominant language. Furthermore, all but one participant reported having acquired Norwegian before English (with the remaining participant reporting having acquired English first and Norwegian second). 23 participants reported having once been better in one of their languages of whom five reported having become less fluent in English and one in Norwegian. Participants were aged between 19 and 36 (M=23.6) and had between 14 and 22 years of education (M=16.4). On the vocabulary scores participants knew between 3 and 27 English targets (M=14.1) and between 4 and 28 Norwegian targets (M=14.1) out of 40 possible in each language. The participants were recruited from the University of Agder student population and the greater Kristiansand area.

Participants also reported their overall language use, proficiency, and exposure as is summed up in Table 5 below. As can be seen, participants were generally more proficient in Norwegian than in English and participants reported using Norwegian more often than English except for reading where participants on average spent more time reading in English than in Norwegian. Most participants also reported having spent more time in a country or family where Norwegian was predominantly spoken. Participants reported having been recently exposed (i.e. over the past month or so) to Norwegian more than English when interacting with friends and family, but otherwise reported being more exposed to English. On average, participants reported being younger when first being exposed to and when attaining fluency in Norwegian than in English. Similarly, participants reported factors like family and friend interactions as being more important to acquiring Norwegian than in English with the pattern shifting for formal means of learning (e.g. the contribution of schooling) and media-based exposure (e.g. watching TV or streaming). Overall, participants reported Norwegian intruding into English either by accident or by code-switching as happening more often than vice-versa.

Measures	Norwegian		English	
	M	Range	M	Range
Self-Reported Proficiency[A]				
Speaking (general fluency)	9.4	8-10	7.9	4-10
Pronunciation (accent)	9.4	7-10	7.4	3-10
Reading	8.9	4-10	7.8	3-10
Writing	8.0	3-10	7.2	2-10
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
Spoken Language Immersion (years)[6]				
Country	22.3	16-30	1.1	0-16.5
Family	23.2	19-32.7	2.0	0-32.7
Language Use (per cent)				
Exposure	55.7	30-85	42.2	14-70
Time spent speaking	74.7	10-99	24.3	1-90
Time spent reading	42.2	5-94	57	5-95
Language Choice	80.1	40-100	19.3	0-60
Recent Language Exposure[B]				
Interacting with friends	8.4	3-10	3.1	0-7
Interacting with family	9.0	1-10	1.2	0-9
Reading	3.7	0-10	7.6	2-10
Self-instruction	0.4	0-7	1.0	0-10
Watching TV/Streaming	2.6	0-10	8.1	3-10
Listening to music/media	2.2	0-10	8.0	3-10
Contribution to Language Learning[C]				
Interaction (friends/colleagues)	6.5	0-10	5.6	0-10
Interaction (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
Watching TV/streaming	3.6	0-10	7.2	3-10
Listening to music/media	2.3	0-10	6.5	1-10
Age milestones				
Started hearing regularly	**N/A[7]**		6.4	0-14
Became fluent (speaking)	4.4	1-10	12.6	6-20
Started learning (reading)	1.1	3-10	7.3	4-10
Became fluent (reading)	2.6	5-20	11.6	6-20
English Accent				
Norwegian accent perceived by self[D]			2.8	0-9
Identified by others[E]			5.4	0-10
Important to have a good English accent[F]			7.4	0-10
Effort put into improving own accent[G]			5.1	0-10
Ability to imitate foreign accents[H]			4.2	0-9
Important to speak grammatically correct[I]			8.1	5-10
Attention to others' pronunciation[I]			7.5	1-10
Want to improve own pronunciation[I]			8.0	0-10
Want a native-like accent[I]			8.5	0-10
Pronunciation is NOT important[I]			2.4	0-10
Norwegian Dialect				
Important to speak own dialect[F]	5.6	0-10		
Regional rating of own dialect[J]	5.4	0-9		
Modifies own dialect[K]	4.7	0-10		
Language intrusion[E]				
By accident	3.1	0-8	1.4	0-4
On purpose	4.3	0-10	1.8	0-10

Table 5: Participant self-reported measures

[A]Range: 0 (none) – 10 (perfect), [B]Range: 0 (never) – 10 (almost always), [C]Range: 0 (not a contributor) – 10 (most important contributor), [D]Range: 0 (none) – 10 (pervasive), [E]Range: 0 (never) – 10 (always), [F]Range: 0 (not at all) – 10 (extremely important), [G]Range: 0 (no effort) – 10 (constant effort), [H]Range: 0 (extremely poor) – 10 (extremely good), [I]Range: 0 (very strongly disagree) – 10 (very strongly agree), [J]Range: 0 (not at all) – 10 (very much), [K]Range: 0 (not at all) – 10 (totally).

9.2 Leap-Q data

Inclusion of data. All non-numerical, descriptive values were removed. This resulted in 77 remaining variables with which a 77x77 correlation matrix was created. All variables correlated >0.3 with at least one other variable. 7 variables that correlated >0.8 with another were considered too closely related and were removed (see Appendix G).

The remaining 70 variables were entered into a parallel analysis which resulted in 8 factors being identified (see figure 3 below) which together accounted for 67% of the total variance. These 8 factors and their variables are listed and named in table 6. The variables of each factor were examined, and their commonalities were identified. Based on this an underlying, shared, theme was identified, and a name for each factor was then chosen. The factors are listed in order of variance accounted for.

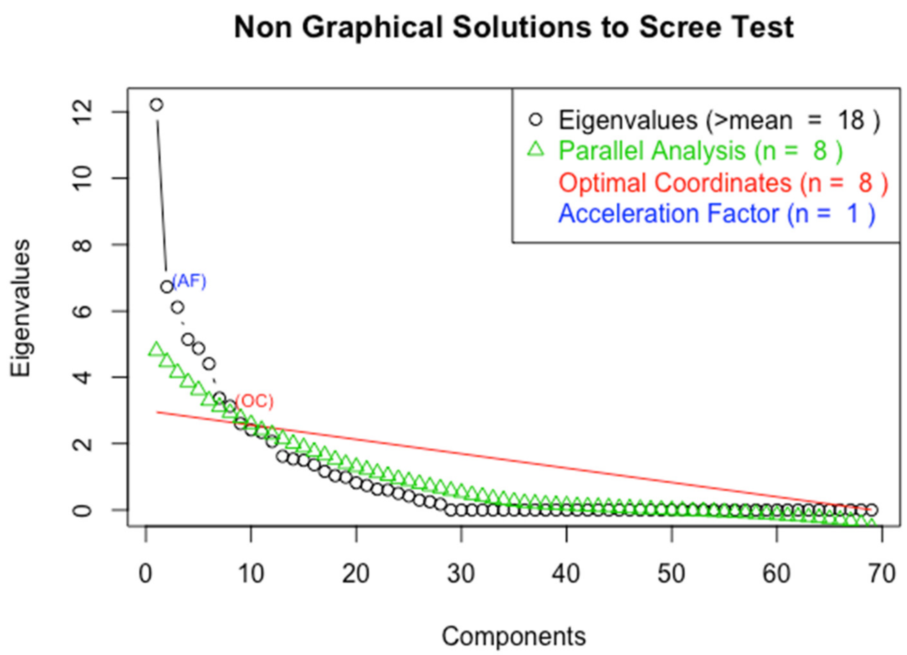

Figure 8: Optimal number of factors identified by parallel analysis.

[6] Participants reported four of the immersion questions as being confusing or ambiguous and these are therefore not included in this table. These are marked with an asterisk in Appendix A.

[7] All participants were native speakers of Norwegian and uniformly reported the age at which they started hearing Norwegian regularly as 0.

Table 6: Factors identified by factor analysis. Original names of variables are listed in Appendix H

Factor 1 – English Fluency	*Loading values*	**Factor 2 – N**orwegian Informal Learning	*Loading values*	**Factor 3 –** Norwegian Proficiency	*Loading values*	**Factor 4 – L**ater English Fluency	*Loading values*
ENG – Time spent reading	0.81	NOR – Current exposure, self-instruction	0.84	NOR – Proficiency, writing	0.90	ENG – Age became fluent, speaking	0.82
ENG – Proficiency, reading	0.79	NOR – Learning from music	0.83	NOR – Proficiency, reading	0.89	Time lived in Norway	0.70
ENG – Current exposure, reading	0.78	NOR – Current exposure, music	0.80	NOR – Proficiency, spelling	0.84	ENG – Age started hearing	0.69
ENG – Proficiency, speaking	0.76	NOR – Learning from TV/streaming	0.77	NOR – Proficiency, vocabulary	0.72	ENG – Age became fluent, reading	0.68
ENG – Proficiency, grammar	0.71	NOR – Current exposure, TV/streaming	0.71	NOR – Proficiency, speaking	0.68	ENG – Age started reading	0.57
ENG – Overall exposure (% time)	0.70	NOR – Learning from self-instruction	0.69	NOR – Proficiency, grammar	0.49	ENG – Others identify non-native accent ENG –	0.34
ENG – Overall speaking (% time)	0.70	NOR – Current Exposure, reading	0.60	NOR – Proficiency, pronouncing	0.43	Self-rated Norwegian accent	0.32
ENG – Proficiency, writing	0.67	ENG – Learning from self-instruction	0.41	Time lived in Norway	0.42	ENG – Want to improve own pronunciation	0.30
ENG – Current exposure, interacting with friends	0.61	ENG – Learning from TV/streaming	0.40	NOR – Likely to modify own dialect	0.41	ENG – Attention to others' pronunciation	-0.44
ENG – Learning from reading	0.56	ENG – Learning from music	0.40	ENG – Proficiency, writing	0.40	ENG – Exposure, Interacting with family	-0.54
ENG – Choose to speak (% time)	0.53	NOR – Learning from school	0.36	ENG – Proficiency, grammar	0.35	NOR – Intentionally mix in English	-0.58
ENG – Learning from interacting with friends	0.51	ENG – Age started reading	0.35	ENG – Learning from music	-0.37	ENG – Learn from interacting with family	-0.67
ENG – Important to speak grammatically correct	0.49	NOR – Learning from reading	0.34	NOR – Regional rating of own dialect	-0.38	ENG – Intentionally mix in Norwegian	-0.69
ENG – Important to have a good accent	0.46	NOR – Time exposed to other dialect	0.33	NOR – Accidentally mix in English	-0.45		
NOR – Age became fluent, speaking	0.46	ENG – Learning from school	0.32				
ENG – Current exposure, music	0.43	ENG – Current exposure, self-instruction	0.32				
ENG – Current exposure, self-instruction	0.42						
ENG – Current exposure, TV/Streaming	0.40						
NOR – Age became fluent, reading	0.33						
NOR – Regional rating of own dialect	-0.34						
ENG – Want a native-like accent	-0.40						
NOR – Current exposure, interacting with friends	-0.44						
ENG – Learning from school	-0.50						
NOR – Current exposure, reading	-0.60						
ENG – Self-rated Norwegian accent	-0.75						
NOR – Time spent reading	-0.82						
Proportion Variance	0.15	Proportion Variance	0.09	Proportion Variance	0.09	Proportion Variance	0.08
Cumulative Variance	0.15	Cumulative Variance	0.24	Cumulative Variance	0.32	Cumulative Variance	0.41

Factor 5 – Improve English Pronunciation	*Loading values*	**Factor 6 –** Language Competition	*Loading values*	**Factor 7** – Mixed Language Exposure	*Loading values*	**Factor 8 –** Later Norwegian Fluency	*Loading values*
ENG – Want to improve own pronunciation	0.75	ENG – Accidentally mix in Norwegian	0.65	NOR – Speaking own dialect is important	0.75	NOR – Age started reading	0.82
Identify with Norwegian culture	0.68	ENG – Age started reading	0.58	ENG – Others identify non-native accent	0.59	NOR – Age became fluent, reading	0.68
ENG – Important to have a good English accent	0.69	NOR – Accidentally mix in English	0.51	NOR – Overall exposure, friends	0.45	NOR – Proficiency, speaking	0.49
ENG – Effort put into improving own accent	0.57	NOR – Likely to modify own dialect	0.45	NOR – Learn from school	0.44	Age	0.48
ENG – Want to have native-like accent	0.50	ENG – Age became fluent, reading	0.40	ENG – Overall exposure, TV/Streaming	0.39	NOR – Proficiency, pronouncing	0.46
NOR – Proficiency, pronunciation	0.45	ENG – Want native-like accent	0.39	ENG – Attention to others' pronunciation	0.38	ENG – Age started hearing	0.36
ENG – Important to speak grammatically correct	0.33	NOR – Learning from family	0.39	ENG – Important to speak grammatically correct	0.35	NOR – Age became fluent, speaking	0.31
ENG – Current exposure, TV/Streaming	0.32	ENG – Overall exposure, music	0.33	ENG – Learning from school	0.33	NOR – Overall exposure, music	-0.30
ENG – Learning from TV/Streaming	0.30	ENG – Learn from interacting with friends	0.31	NOR – Overall exposure, TV/Streaming	0.32	ENG – Attention to others' pronunciation	-0.31
ENG – Notice how others pronounce things	0.33	NOR – Regional rating of own dialect	-0.43	NOR – Learning from reading	0.31	ENG – Learning from reading	-0.32
NOR – Learning from reading	-0.35	ENG – Overall speaking (% time)	-0.43	NOR – Learning from interacting with family	-0.40	NOR – Proficiency, grammar	-0.33
ENG – Learning from interacting with friends	-0.43	ENG – Overall exposure, self-instruction	-0.54	ENG – Choose to speak (% time)	-0.46	NOR – Likely to modify own dialect	-0.41
NOR – Time exposed to other dialect	-0.44	NOR – Age became fluent, speaking	-0.57	ENG – Speaking (% time)	-0.48	NOR – Learning from reading	-0.44
Age	-0.59	ENG – Learn from self-instruction	-0.57	NOR – Learning from interacting with friends	-0.52	NOR – Time exposed to other dialect	-0.63
ENG – Own pronunciation NOT important	-0.72			ENG – Overall exposure, interacting with friends	-0.56		
Proportion Variance	0.07	Proportion Variance	0.07	Proportion Variance	0.06	Proportion Variance	0.06
Cumulative Variance	0.48	Cumulative Variance	0.55	Cumulative Variance	0.61	Cumulative Variance	0.67

The first factor's positive loading variables predominantly featured measures of English exposure and proficiency. The top positive loading factors were overall time spent reading in English, overall proficiency in reading English, current exposure to English through reading, and proficiency in speaking English. The negative loading values included predominantly Norwegian variables, or English variables which reflected Norwegian dominance, such as self-rated Norwegian accent when speaking English. This factor was therefore taken as being a measure of *English fluency*.

The second factor had no negative loading variables, but heavily featured Norwegian variables among its positive loading variables. The top positive loading values came from current exposure to Norwegian through self-instruction, the contribution of music to learning Norwegian, current exposure to Norwegian through music, learning Norwegian through TV or streaming, and current exposure to Norwegian through TV or streaming. Because this factor heavily featured informal means of learning Norwegian (with learning Norwegian from school having the sixth lowest loading value), as well as variables for exposure to Norwegian through such informal media, this factor was taken as a measure of *Norwegian informal learning*.

The third factor's seven most positive loading values were all related to Norwegian proficiency, with the eighth variable being the amount of time lived in Norway. English measures of proficiency were at the bottom of the positive loading values, while the negative loading variables included self-rated frequency of accidentally mixing English into Norwegian and the contribution of music to learning English. This factor was therefore taken as being a measure of *Norwegian Proficiency*.

The fourth factor's top positive loading values came from variables related to age of English initial exposure through hearing or reading, or age of attaining fluency in speaking or reading English (i.e. participants were older when they first became exposed to English in this way, and when they attained fluency in this form of English). Furthermore, the second-most positive loading value was the variable for time lived in Norway, while the lower positive loading values included the frequency of others identifying the participants' non-native accent, the self-rated presence of a Norwegian accent when speaking English, and wanting to improve their own English pronunciation. The negative loading values included variables for overall exposure to English through interacting with family members as well as the contribution of such interactions to one's learning of English. This factor was therefore taken as being a measure of *Later English Fluency*.

The fifth factor's positive loading values included variables pertaining to English pronunciation and accent such as wanting to improve one's own pronunciation in English, how important one feels it is to have a good English pronunciation, the amount of effort put into improving one's English accent, and how much one wants to have a native-line English accent. The strongest negative loading value for this factor came from not viewing it as important to have a good English pronunciation. This factor was because of this seen as being a measure of wanting to *improve English pronunciation*.

The sixth factor contained positive and negative loading values from both languages related to proficiency, age of first exposure, and age of fluency. This dichotomy was prevalent in both the positive and negative loading values. Thus, because neither language was clearly more represented than the other this was taken as being a measure of *language competition*.

Similarly, to the sixth factor, the seventh factor contained a very mixed set of positive and negative loading values from both Norwegian and English. The seventh factor predominantly contained variables related to exposure among its positive loading values; such as exposure to Norwegian through interacting with friends, exposure to English through TV or streaming, as well as the contribution of school in learning both languages. This factor was therefore seen as being more oriented towards some form of language exposure. Crucially, overall time spent speaking in English, and overall time one chooses to speak in English when conversing with someone who is equally proficient in all of one's languages both yielded negative loading values. This factor was therefore taken as not being a measure of anything within one language, but instead as being a measure of *mixed language exposure*.

The eight factor's strongest positive loading values mostly reflected variables related to age meaning that participants were older when they achieved a certain milestone. These milestones included the age at which participants first started reading Norwegian, the age at which they became fluent readers of Norwegian, and the age at which they became fluent speakers of Norwegian. The negative loading values predominantly reflected Norwegian variables such as time spent exposed to another dialect than one's own, and the contribution of reading to one's learning of Norwegian. This factor was therefore taken as being a measure of *later Norwegian fluency* on account of the prevalence of age-related variables among the positive loading values, as well as its overall reversed similarity to the fourth factor.

9.3 Experimental Results

Reaction Times (RTs) and error rates (ERs) were analysed. Of the 29 participants; 2 were excluded due to high ERs on the experimental items (above 50%). This left 27 participants with 160 experimental items comprised of 20 from each of the eight experimental conditions. This yielded a total of 4230 experimental items, 540 from each of the experimental conditions, all of which were used in the error analyses. For the RT analyses incorrect responses were removed resulting 1066 items (24,7% of the data) being excluded. Additionally, trials with RTs higher or lower than 2.5 SDs of the mean per participant per condition were excluded resulting in an additional 95 items or 2,9% being excluded. This left 3159 experimental items for the RT analyses (between 392 and 425 trials per condition).

The RT data was analysed using a linear mixed-effect regression (lmer) model followed by post-hoc pairwise comparisons for further investigation of interactions. A significant main effect of semantic relatedness (p<.001) was found meaning that participants were slower to initiate sentences with semantically related words (967ms) than with semantically unrelated words (929ms) across all conditions. Furthermore, a significant main effect of phrase type was found across all conditions (p=.007) meaning that participants were slower to initiate speech for sentences in the same phrase conditions (964ms) than for sentences in the different phrase conditions (931ms). While participants were faster to initiate speech for sentences containing cognate words (938ms) than for sentences containing non-cognate words (958ms) this effect did not reach significance (p=.295).

There was a significant interaction (p=.015) between semantic relatedness and initial phrase type meaning that the semantic interference effect was larger when both items were in the same phrase (54ms, p<.001) than when the items were in different phrases (22ms, p=.064). There was no significant interaction between relatedness and cognate status (p=.404) and there was no significant interaction between cognate status and phrase type (p=.660). Finally, the 3-way interaction between phrase type, relatedness, and cognate status was not significant (p=.594).

The ERs were analysed using a general linear mixed-effect regression (glmer) model. All incorrect responses were coded as 1 regardless of error-type, and all correct responses were coded as 0. There was a significant main effect of phrase type (p=.001) meaning that overall participants produced significantly more errors in the different phrase conditions (27.2%) than in the same phrase conditions (22.1%). The main effect of semantic relatedness was not significant (p=.873) meaning that participants produced a similar amount of errors in the related (24.6%) compared to the unrelated (24.8%) conditions. The main effect of cognate-status was also not significant (p=.952) meaning that participants made a similar amount of errors in both the cognate (24.9%) and non-cognate (24.8%) conditions. There were no significant interactions in the ER analyses. RT and ER data is shown in Figure 9.

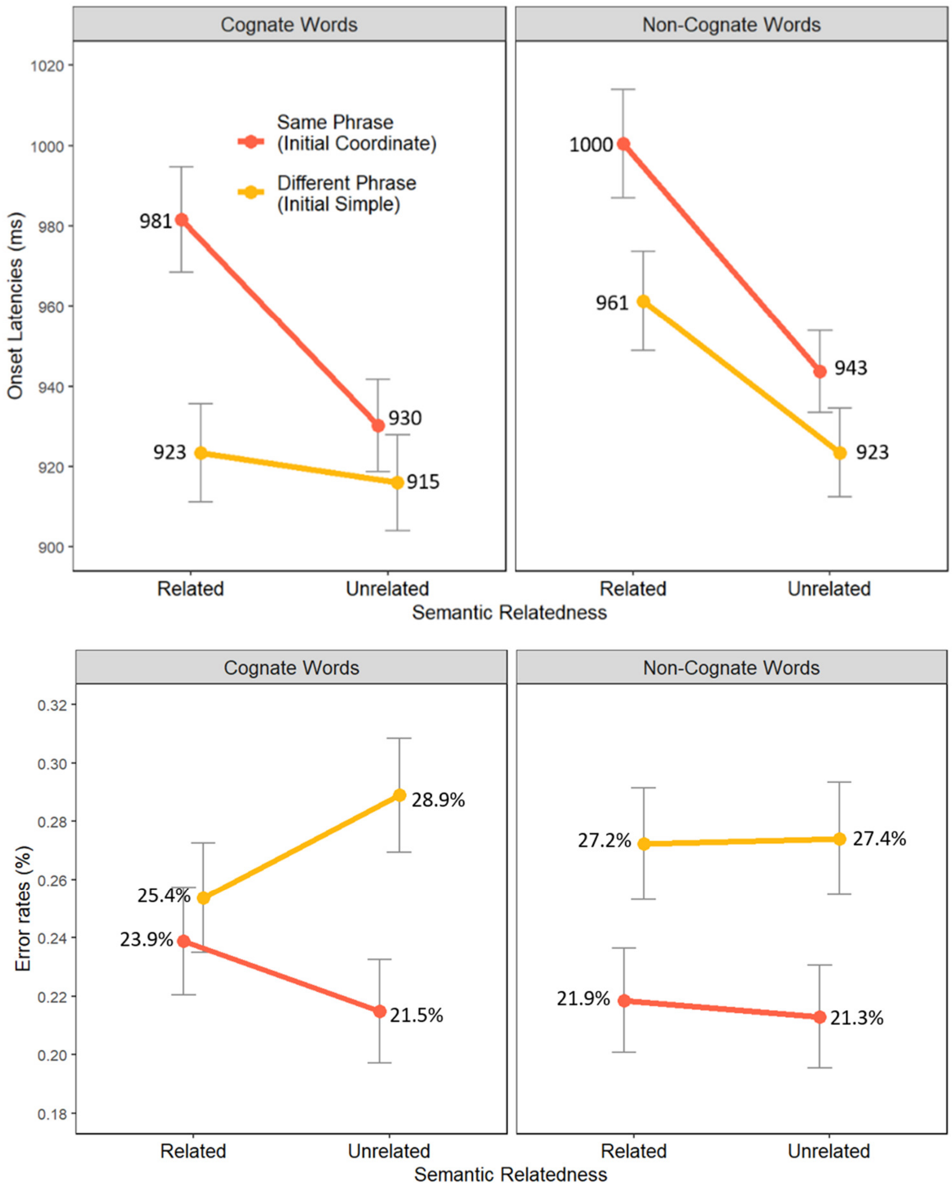

Figure 9: Participant overall RTs and ERs across all conditions.

9.4 Prediction Effects

For each participant we calculated five measures, namely phrase effect (i.e. whether an item was in the same phrase or different condition), cognate effect, overall semantic interference (i.e. whether items were semantically related or not), same-phrase semantic interference effect (i.e. whether items in the same-phrase conditions were semantically related or not) and different-phrase semantic interference effect. The phrase effect was calculated by subtracting RTs for trials in the different-phrase conditions from trials in the same-phrase conditions. The cognate effect was calculated by subtracting RTs for trials in the cognate conditions from trials in the non-cognate conditions. The overall semantic interference effect was calculated by subtracting the RTs for trials containing unrelated words from the RTs for trials containing semantically related words. The measures for same-phrase and different-phrase semantic interference effects were calculated in the same manner as the overall semantic interference effect but with same- and different-phrase condition constraints respectively. Figure 10 shows the effects for all individual participants, and as can be seen there was considerable variability both in terms of overall speed, accuracy, and the direction of the effects themselves. It is therefore of interest to see which characteristics of the participants relate to their performance.

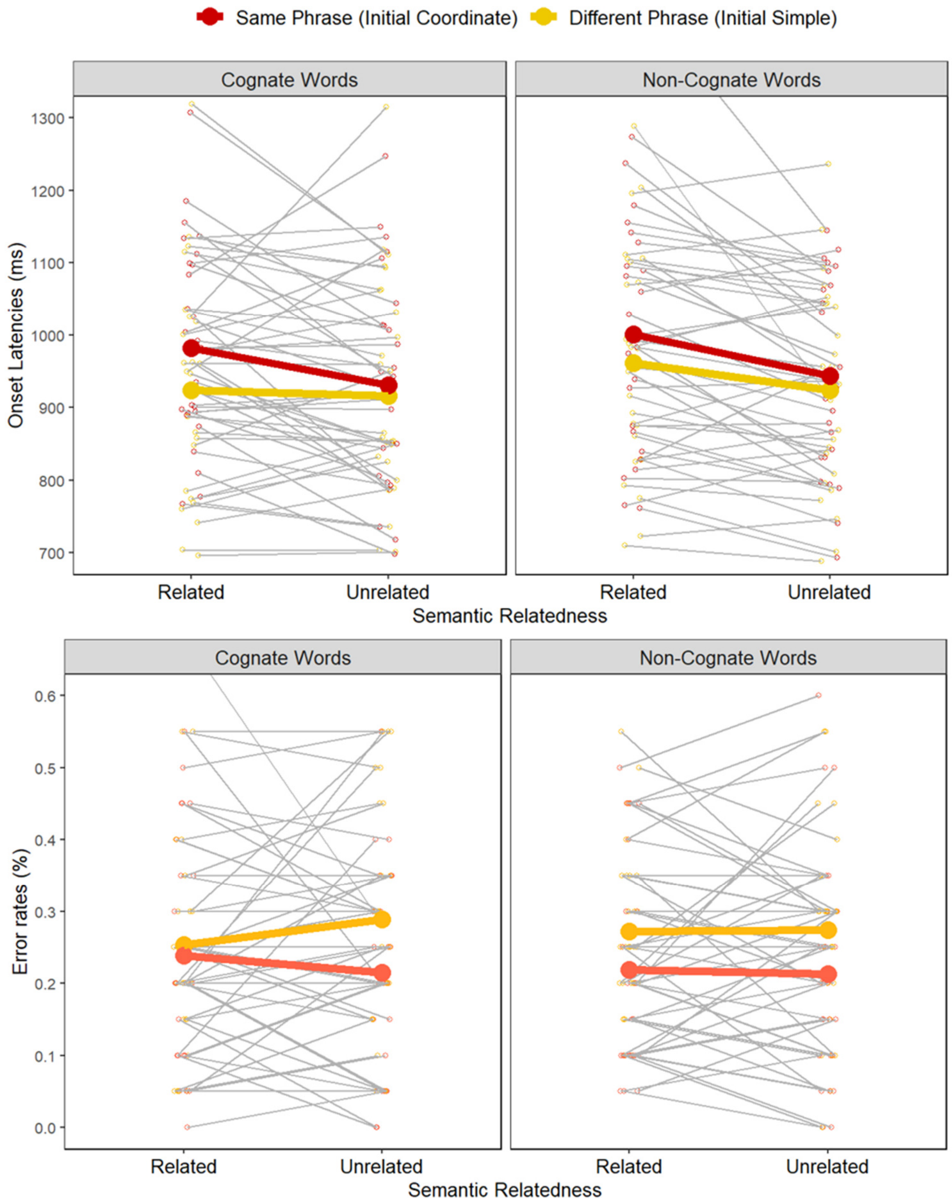

Figure 10: Participants' individual effects in the RT and ER data with the means coloured and in bold.

Linear multiple regression analyses were conducted to look for possible prediction effects on the five experimental effects, namely phrase effect, cognate effect, overall semantic interference effect, same-phrase semantic interference effect, and different-phrase semantic interference effect by the participants' vocabulary scores and the factors yielded by the factor analysis. This revealed significant effects on same-phrase semantic interference effect by three factors summarised in table 7. Vocabulary scores in both languages and the relative difference between scores in English and Norwegian were also tested for predictionary effects but neither reached significance. The only significant predictionary effects are thus listed in table 7.

Table 7: Significant prediction effects on SP semantic interference effect

Factor	t-value	p-value
1 – English fluency	t=2.289	p=0.0370
4 – Later English fluency	t=2.174	p=0.0461
5 – Improve English Pronunciation	t=-2.485	p=0.0252

10. Discussion

The purpose of this experiment was to investigate planning scope in bilinguals operating in their L2 with respect to the functional phrase hypothesis both in terms of lexical and structural scope. The experiment further investigated the effects of cognate status and semantic relatedness on scope and how bilingual language profile relates to the effects of initial phrase-size, semantic interference, and cognate effect. To investigate these issues the experiment used a picture-word interference and movement paradigm like that previously used by Smith & Wheeldon (2004). This design enabled the manipulation of cognate status, semantic relatedness, and initial phrase-size in the experiment stimuli. Consistent with the predictions and with previous studies participants took significantly longer to onset sentences with longer initial phrases suggesting that part of the planning process was constrained by initial phrase size (e.g. Allum & Wheeldon, 2009, 2007, Smith & Wheeldon, 1999, 2004; Wheeldon, Ohlson, Ashby, & Gator, 2013; Zhao, Alario, & Yang, 2014).

An effect of semantic interference was observed in both phrase conditions with the effect being significantly larger in the same-phrase conditions. This finding is in-line with the predictions for this experiment and are also consistent with the results reported by Smith & Wheeldon (2004). It is, however, not inherently clear why the present experiment differs in this regard from Hardy, Wheeldon, & Segaert (in prep.) who when using a similar paradigm investigating scope in younger and older English monolinguals found that young monolinguals displayed no significant difference in semantic interference effect between phrasal conditions, and that older monolinguals showed a significantly larger semantic interference effect in the different-phrase condition (i.e. the opposite direction of what was found in this experiment). It is here first important to note that participants in the MA project reported in this thesis were aged between 19 and 36, and that it is thus most relevant to compare their results to the younger monolingual group tested by Hardy et al. (in prep.) where the semantic interference effect did not differ significantly between phrasal conditions. This suggests that the bilinguals tested in this study differed in their lexical planning strategies from their monolingual counterparts. It may be that bilinguals are constrained by a phrasal scope of low-level lexical processing due to adopting a more constrained planning strategy when working in their less dominant L2 (as was the case in this experiment). This may have led bilinguals to adopt a strategy like that suggested by Smith & Wheeldon (2004) where bilinguals only access the conceptual information for lexical nouns outside the first phrase prior to speech-onset. On this view, the semantic interference effect should be present but significantly smaller in the different-phrase condition, as was observed in this experiment, because the second lexical noun in the different phrase conditions has only been planned to the point of accessing conceptual information. By contrast, the first lexical noun which is located within the first phrase has been processed to the point of accessing lemma level information. Such a strategy entails that the activation level of the noun placed within the first phrase will be considerably higher than that of its semantically related counterpart when it is located outside of the initial phrase. This may in turn allow the more strongly activated competitor to suppress part of the semantic interference effect due to its higher level of activation.

The magnitude of semantic interference in the same phrase conditions was modulated by three measures of participants' bilingual profile. Overall English fluency (factor 1) correlated positively meaning that participants who rated themselves as being more fluent in English experienced a larger semantic interference effect in the same phrase condition. Similarly, participants experienced a larger semantic interference effect in the same phrase conditions when they reported having attained English fluency at a later age (factor 4). Wanting to improve one's English pronunciation (factor 5) correlated negatively with same phrase semantic interference meaning that participants who felt a stronger desire to improve their pronunciation of English experienced a smaller semantic interference effect. This implies that more fluent bilinguals experience a smaller semantic interference effect.

That overall English fluency and later English fluency correlated positively with the same-phrase semantic interference effect can be explained by participants with greater fluency experiencing stronger competition due to their L2 lexical nodes presumably being stronger when compared to those belonging to their L1 thus yielding a stronger competition. It is less clear on this account why participants who had attained English fluency at a later age experienced a stronger semantic interference. More curious still is the observation that participants who reported wanting to improve their pronunciation of English experienced a smaller same-phrase semantic interference effect. Further research is required to better understand the nature of these predictionary effects.

It is also not inherently clear why these predictionary effects were only significant in the same-phrase conditions. One possible explanation is that participants only accessed conceptual information for semantic competitors falling outside of the initial phrase resulting in conceptual competition when competitors fell within different phrases. Thus, lemma-level semantic competition only occurred when the two lexical nouns fell within the same phrase. The predictionary effects only reaching significance in the same-phrase conditions can on this view be explained by these aspects of bilingual profile not affecting bilinguals at the conceptual-level but that their effects are instead tied to the lemma-level. This account explains why the predictionary effects only were significant in the same-phrase conditions; the lack of lemma-level semantic competition in the different-phrase conditions meant that the necessary lemma-level information for these effects to arise had not been retrieved yielding the observed asymmetry in predictionary effects.

Of interest, and in contrast to the predictions, is the lack of a significant effect of cognate status. It was expected that cognate-status would yield a faciliatory effect similar to those observed in previous bilingual production experiments (e.g. Costa et al., 2000). The absence of a cognate effect is particularly surprising as participants were working in their less dominant L2. However, unlike previous experiments, this experiment had a relatively small participant-pool of 29 participants. Moreover, a considerable portion of the data was lost due to incorrect responses (i.e. 24.7%). Thus, an already small data-pool due to the small number of participants was reduced further by high error-rates. It is therefore possible that the trend towards participants being faster to onset speech for sentences containing cognate-items would have reached significance given more power causing the predicted cognate-effect to emerge. Participants experienced a stronger semantic interference effect when the competitors were Norwegian/English cognates than when they were not, though this interaction did not reach significance. It is again possible that added power would cause this interaction to become significant. The interaction between cognate status and phrase type did also not reach significance which suggests that participants did not adjust their planning scope depending on the cognate-status of lexical items. It is possible, however, that if added power uncovers a cognate effect this interaction will become significant.

It is also surprising that only three aspects of bilingual language profile displayed significant predictionary effects on participant performance, and that all three predictors affected a single condition. It is not inherently obvious why this is the case, but it remains possible that this is similarly to the lack of a cognate effect due to the lack of participants and high error rates and thus an overall lack of power. For example, in a study by Marian, Blumenfeld, & Kaushanskaya (2007) verifying the reliability of the LEAP-Q questionnaire used factor analysis to describe bilingual language profile. 60 participants were tested in the study by Marian et al. (2007). It is possible that effects of vocabulary size in either language, difference in vocabulary size between languages, or any of the factors identified by factor analysis would have exerted significant predictionary effects on participant performance given more data and power.

Error rates were significantly higher in the different-phrase conditions than in the same-phrase conditions. This pattern is in the opposite direction to what was observed in the reaction time data. That is, participants were faster to onset speech for sentences in the different-phrase conditions, but they also produced significantly more errors in this condition. By contrast, participants were significantly less error-prone in the same-phrase condition which also took them longer to onset. This suggests that there may have been a speed-accuracy trade-off where participants delayed speech-onset in the more complex condition in favour of adopting a more thorough planning strategy to avoid making errors. Beyond this, error rates were stable across conditions with no further significant effects or interactions. It is difficult to explain why this is, but it is possible that further significant effects would emerge given more power.

Further research on this topic should be conducted on larger participant groups to better differentiate between actual null results and effects that do not emerge solely due to a lack of power. On a similar note, L2 speakers should be trained more thoroughly on target structures to reduce overall error rates. Furthermore, future research on bilingual sentence scope should test participants in both their L1 and L2 to investigate in what ways, if any, bilinguals differ in their planning strategies between their languages. It would also be relevant to compare bilinguals to a monolingual control group as this would enable researchers to further investigate how bilinguals differ significantly from monolinguals in their planning strategies as is suggested by the results reported by this experiment. Such research should also take care to gather detailed language-background information about bilinguals in both their languages as it seems clear that bilingual profile does exert an effect on bilingual performance, though the exact nature and locus of this effect requires more research to determine. It would also be relevant to have participants undergo objective measures of fluency as this would allow for investigating the effects of subjective and objective measures on performance in both languages.

In sum, the present experiment provides further evidence for a phrasal scope of planning. For lexical scope, the present experiment provides evidence that participants do retrieve lexical nouns beyond the first phrase, as indicated by the presence of a semantic interference effect in both phrasal conditions, implying that lexical scope is not constrained by the initial phrase. Importantly, this experiment suggests that lexical processing of items beyond the first phrase is less thorough suggesting a phrasal scope of low-level processing, particularly of lemma-level information. It is therefore possible that low-level processing is constrained by a phrasal scope while higher-level conceptual processing is not. The experiment also suggests that bilingual language profile does exert predictionary effects on performance thus implying that bilingual language profiles are an important tool in investigating the effects of bilingualism on performance. That is, the present experiment provides evidence in support of bilinguals not only differing significantly from one another, but that these differences manifest as observable effects on performance.

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Appendices

Appendix A: Modified LEAP-Q

Participant number: | **Date of testing:**

SCREENING QUESTIONNAIRE

Experimenter: Ask participant the following questions and fill in the yellow boxes with their responses.

1 What is your age? (in years)

2 What is your gender?

3 Are you a native speaker of Norwegian?

4 Is Norwegian the only language you speak at home (aside from perhaps English)? *If no, please specify other home language*

5 Are you a reasonably good speaker of English?

6 Do you have normal vision or vision that is corrected to normal with glasses or contact lenses?

7 Can you confirm that you have no language impairments such as dyslexia, stuttering etc.?

8 Do you have normal hearing or hearing that is corrected to normal?

9 Are you left or right handed?

10 What is country of birth?

11 What is your current country of residence?

12 How many years of education do you have?

13 What is the highest education level you have? (Select from the drop-down options)

If other, please specify

2. LANGUAGE BACKGROUND

Participant: please answer these questions below about the different languages you speak.
Please fill in your responses in the appropriate yellow boxes, and ask the experimenter if you have any questions.

Q1 Please list all the languages you speak in order of DOMINANCE (up to 5).

1
2

3	
4	
5	

Q2 Please list all the languages you speak in order of ACQUISITION (up to 5).

1	
2	
3	
4	
5	

Q3 Please list what percentage of the time you are on average exposed to each language (e.g. exposure in terms of talking, listening, and reading, including TV, films and music).

(All your answers should add up to 100%)

	Language	**%**
1		
2		
3		
4		
5		
	Total:	0

Please make sure your answer adds up to 100%

Q4 Please list what percentage of the time you spend speaking each language.

(All your answers should add up to 100%)

	Language	**%**
1		

2		
3		
4		
5		
	Total:	0

Please make sure your answer adds up to 100%

Q5 Please list what percent of time you typically spend reading in each language.

(All your answers should add up to 100%)

	Language	**%**
1		
2		
3		
4		
5		
	Total:	0

Please make sure your answer adds up to 100%

Q6 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.

(All your answers should add up to 100%)

	Language	**%**
1		
2		
3		
4		
5		
	Total:	0

Please make sure your answer adds up to 100%

Q7 What cultures do you identify with (e.g., Norwegian, British, American, etc)? Please list each culture below (up to 5) and use the scale from 0-10 to rate the degree of identification, whereby 0 = no identification, 5 = moderate identification, 10 = complete identification.

	Culture	Identification
1		
2		
3		
4		
5		

Q8 Do you feel that you were once better in one of your languages and that you have become less fluent?

If yes, which one?

And at what age did you become less fluent?

Q9 In which language do you usually do the following tasks?

Task	Language
Simple maths (count, add)	
Dream	
Express anger or affection	
Talk to yourself	

3. NORWEGIAN AND ENGLISH PROFICIENCY

Participant: please answer these questions below about your experience with Norwegian and English.

Please fill in your responses in the appropriate yellow boxes, and ask the experimenter if you have any questions.

Q1 Please list the number of years and months you have spent in each language environment.

	Norwegian		**English**	
	Years	Months	Years	Months
A country where this language is spoken				
A family where this language is spoken				
A school where this language is spoken ALL of the time*				
A school where this language is spoken SOME of the time*				
A workplace where this language is spoken ALL of the time*				
A workplace where this language is spoken SOME of the time*				

Q2 Please rate how much the following factors contributed to your learning of each language on a scale of 0-10 whereby 0 = not a contributor, 5 = moderate contributor and 10 = most important contributor.

	Norwegian	**English**
Interacting with friends / colleagues		
Interacting with family		
Reading (e.g., books, magazines, online material)		
School and education		
Self-instruction (e.g., language learning videos or apps)		
Watching TV / streaming		
Listening to music/media		

Q3 Please rate to what extent you are currently (e.g. in the last month or so) exposed to each language on a scale of 0-10 whereby 0 = never, 5 = half of the time and 10 = almost always.

	Norwegian	**English**
Interacting with friends		

Interacting with family		
Reading (e.g., books, magazines, online material)		
Self-instruction (e.g., language learning videos or apps)		
Watching TV / streaming		
Listening to music/media		

Q4

Please rate your level of proficiency in the following aspects of each language on a scale of 0-10 whereby: 0 = none; 1 = very low; 2 = low; 4 = slightly less than adequate; 5 = adequate; 6 = slightly more than adequate; 7 = good; 8 = very good; 9 = excellent; 10 = perfect.

	Norwegian	**English**
Speaking (general fluency)		
Pronunciation (accent)		
Reading		
Writing		
Grammar		
Vocabulary		
Spelling		

Q5

Please list the AGE (in years) you were when the following occurred for each language.

	Norwegian	**English**
Started hearing this language on a regular basis		
Became fluent in speaking this language		
Started learning to read in this language		
Became fluent in reading this language		

4. DIALECT AND ACCENT

Please answer these questions below about your Norwegian dialect and your accent when speaking English.
Please fill in your responses in the appropriate yellow boxes, and ask the experimenter if you have any questions.

Q1 Which dialect of Norwegian do you speak?

Q2 How important is speaking your own dialect for you on a scale of 0-10 (whereby 0 = not at all, 5 = moderately important, 10 = extremely important)?

Q3 To what extent would you say you modify your own dialect when speaking to a person with a different dialect on a scale of 0-10 (whereby 0 = not at all, 5 = moderately, 10 = totally)?

Q4 Have you lived in an environment where you have been exposed to other dialects than your own for a longer period of time (e.g. moving to a different city in Norway or living with someone who speaks another dialect)?

If yes, which dialect? *And for how long (in years)?*

Q5 In your opinion how strongly regional is your spoken Norwegian on a scale of 0-10 (whereby 0 = not at all, 5 = moderately, 10 = very much)?

Q6 What kind of accent do you think your spoken English has (e.g., British / American / other / none in particular)?

Q7	In your view, how much of a Norwegian accent do you have when you speak English on a scale of 0-10? Whereby 0 = none, 1 = almost none, 2 = very light, 3 = light, 4 = some, 5 = moderate, 6 = considerable, 7 = heavy, 8 = very heavy, 9 = extremely heavy, 10 = pervasive.
Q8	To what extent do you think others identify you as a non-native speaker based on your ACCENT when speaking English on a scale of 0-10 (whereby 0 = never, 5 = half of the time 10 = always)?
Q9	How important is it for you to have a good accent when speaking English on a scale of 0-10 (whereby 0 = not at all, 5 = moderately important, 10 = extremely important)?
Q10	How much effort have you put into improving your accent when speaking English on a scale of 0-10 (whereby 0 = no effort at all, 5 = moderate effort, 10 = constant effort)?
Q11	How would you rate your ability to imitate foreign accents and dialects on a scale on a scale of 0-10 (whereby 0 = extremely poor, 5 = moderate, 10 = extremely good)?
Q12	Please rate the degree to which you agree with the following statements on a scale of 0-10 (whereby 0 = very strongly disagree, 10 = very strongly agree)?

Statement	**Rating**

It is important to me to speak grammatically correct English	
I pay attention to how people pronounce words and sounds	
I want to improve my pronunciation of English	
If it were possible I would like to pronounce English like a native speaker	
Pronunciation is not important to me because it does not affect how well I can communicate	

Q13 Are there any sounds in the English language you find difficult to pronounce?

If yes, which one(s)? (Write down the letter representing the sound or a word that contains the sound (capitalize the sound).

Q14 Have you noticed any English speech sounds that are difficult for other Norwegians when speaking English?

If yes, which one(s)? (Write down the letter representing the sound or a word that contains the sound (capitalize the sound).

Q15 When you are speaking do you ever find yourself accidentally mixing words or sentences from Norwegian and English?

(a) If yes, how often does English accidentally intrude in your Norwegian on a scale of 0-10 (whereby 0 = never, 5 = half of the time, 10 = all of the time)?

(b) And how often does Norwegian accidentally intrude into your English on a scale of 0-10 (whereby 0 = never, 5 = half of the time, 10 = all of the time)?

Q16 When you are speaking with a person who also knows both Norwegian and English do you ever find yourself intentionally mixing words or sentences from Norwegian and English?

(a) If yes, how often do you intentionally use English words when speaking Norwegian on a scale of 0-10 (whereby 0 = never, 5 = half of the time, 10 = all of the time)?

(b) And how often do you intentionally use Norwegian words when speaking English on a scale of 0-10 (whereby 0 = never, 5 = half of the time, 10 = all of the time)?

END OF QUESTIONNAIRE - THANK YOU FOR YOUR TIME!

Appendix B: Controlled Factors

	Cognate Pictures										Living	Cognate Related Words									
	English	CELEX	O	P	S	Norwegian	NoWaC	O	P	S		English	CELEX	O	P	S	Norwegian	NoWaC	O	P	S
1	Frog	4.4	4	4	1	Frosk	1.2	5	5	1	Yes	Gecko	0	5	4	2	Gekko	0.7	5	4	2
2	Bell	39.3	4	3	1	Bjelle	1.1	6	5	2	No	Drum	8.7	4	4	1	Tromme	1.9	6	5	2
3	Bread	74.1	5	4	1	Brød	19.6	4	3	1	No	Cake	21.4	4	3	1	Kake	8.1	4	4	1
4	Bus	64.5	3	3	1	Buss	21.6	4	3	1	No	Helicopter	10.6	10	10	4	Helikopter	8.2	10	10	4
5	Cat	41.3	3	3	1	Katt	19.3	4	3	1	Yes	Tiger	8.8	5	4	2	Tiger	9.2	5	5	2
6	Clock	35.6	5	4	1	Klokke	4.0	5	5	2	No	Alarm	21.2	5	4	2	Alarm	7.0	5	5	2
7	Cow	22.5	3	2	1	Ku	6.6	2	2	1	Yes	Horse	84.8	5	4	1	Hest	45.9	4	4	1
8	Crab	5.4	4	4	1	Krabbe	2.4	6	5	2	Yes	Oyster	3.6	6	4	2	Østers	0.2	6	5	2
9	Fish	174.6	4	3	1	Fisk	74.7	4	4	1	Yes	Eel	4.4	3	2	1	Ål	0.0	2	2	1
10	Foot	116.6	4	3	1	Fot	15.6	3	3	1	Yes	Arm	106.0	3	2	1	Arm	8.7	3	2	1
11	Giraffe	1.2	7	5	2	Sjiraff	0.1	7	5	2	Yes	Elephant	12.6	8	7	3	Elefant	1.6	7	7	3
12	Goat	11.7	4	3	1	Geit	1.7	4	3	1	Yes	Hen	5.6	3	3	1	Høne	1.5	4	4	2
13	Hammer	12.6	6	4	2	Hammer	8.0	6	5	2	No	Axe	5.6	3	3	1	Øks	0.2	3	3	1
14	Knife	36.9	5	3	1	Kniv	7.4	4	4	1	No	Bowl	29.3	4	3	1	Bolle	3.4	5	4	2
15	Moon	53.1	4	3	1	Måne	2.0	4	4	2	No	Star	53.2	4	3	1	Stjerne	13.2	7	6	2
16	Skirt	20.9	5	4	1	Skjørt	28.8	6	3	1	No	Vest	4.9	4	4	1	Vest	38.5	4	4	1
17	Sun	153.3	3	3	1	Sol	35.4	3	3	1	No	Planet	25.0	6	5	2	Planet	11.3	6	5	2
18	Trumpet	4.9	7	7	2	Trompet	1.4	7	7	2	No	Piano	26.0	5	5	2	Piano	6.8	5	5	2
19	Whale	6.3	5	3	1	Hval	2.5	4	3	1	Yes	Dolphin	1.3	7	6	2	Delfin	0.4	6	6	2
20	Zebra	1.3	5	5	2	Sebra	0.4	5	5	2	Yes	Hyena	1.3	5	5	3	Hyene	0.1	5	5	3
	Averages	**44.0**	**4.5**	**3.7**	**1.2**		**12.7**	**4.7**	**4.0**	**1.4**		**Averages**	**21.7**	**5.0**	**4.3**	**1.7**		**8.4**	**5.1**	**4.8**	**1.9**

	Non-Cognate Pictures											Non-Cognate Related Words									
	English	CELEX	O	P	S	Norwegian	NoWaC	O	P	S	Living	English	CELEX	O	P	S	Norwegian	NoWaC	O	P	S
21	Barn	10.4	4	3	1	Låve	0.9	4	4	2	No	Cabin	27.1	5	5	2	Hytte	17.4	5	4	2
22	Car	276.2	3	2	1	Bil	98.6	3	3	1	No	Train	79.0	5	4	1	Tog	19.6	3	3	1
23	Chair	104.9	5	2	1	Stol	8.9	4	4	1	No	Cradle	5.1	6	5	2	Vugge	1.4	5	4	2
24	Coat	52.4	4	3	1	Frakk	0.9	5	4	1	No	Sweater	11.0	6	5	2	Genser	4.6	6	6	2
25	Dog	71.7	3	3	1	Hund	76.5	4	3	1	Yes	Rabbit	10.8	6	5	2	Kanin	5.4	5	5	2
26	Envelope	18.8	8	7	3	Konvolutt	1.5	9	8	3	No	Letter	121.0	6	5	2	Brev	56.2	4	4	1
27	Flower	27.7	6	4	2	Blomst	4.7	6	6	1	Yes	Branch	53.7	6	5	1	Gren	2.3	4	4	1
28	Fork	13.6	4	3	1	Gaffel	1.4	6	5	2	No	Plate	36.7	5	4	1	Tallerken	1.8	9	8	3
29	Fox	13.7	3	4	1	Rev	9.4	3	3	1	Yes	Badger	3.7	6	4	2	Grevling	0.7	8	7	2
30	Jug	8.5	3	3	1	Mugge	0.4	5	4	2	No	Pot	24.8	3	3	1	Gryte	1.6	5	5	2
31	Leaf	15.5	4	3	1	Blad	21.9	4	4	1	Yes	Seed	27.8	4	3	1	Frø	5.9	3	3	1
32	Lobster	2.0	7	6	2	Hummer	3.0	6	5	2	Yes	Shrimp	1.3	6	5	1	Reke	2.2	4	4	2
33	Owl	3.0	3	2	1	Ugle	1.4	4	4	2	Yes	Pigeon	4.1	6	5	2	Due	6.7	3	3	2
34	Pig	17.9	3	3	1	Gris	5.3	4	4	1	Yes	Sheep	40.1	5	3	1	Sau	7.3	3	2	1
35	Snake	14.6	5	4	1	Slange	3.4	6	5	2	Yes	Lizard	1.8	6	5	2	Øgle	0.0	4	4	2
36	Spider	4.1	6	5	2	Edderkopp	1.0	9	7	3	Yes	Ant	3.9	3	3	1	Maur	1.9	4	3	1
37	Squirrel	3.5	8	7	2	Ekorn	1.1	5	5	2	Yes	Ferret	1.8	6	5	2	Ilder	0.5	5	5	2
38	Table	203.6	5	5	2	Bord	16.4	4	3	1	No	Cupboard	15.1	8	5	2	Skap	6.8	4	4	1
39	Tap	20.5	3	3	1	Spring	2.9	6	5	1	No	Shower	17.3	6	3	2	Dusj	7.6	4	3	1
40	Tie	35.5	3	2	1	Slips	2.1	5	5	1	No	Glove	4.6	5	4	1	Hanske	1.5	6	6	2
	Averages	**47.8**	**4.5**	**3.7**	**1.4**		**13.1**	**5.1**	**4.6**	**1.6**		**Averages**	**24.5**	**5.5**	**4.3**	**1.6**		**7.6**	**4.7**	**4.4**	**1.7**

Appendix C: Experimental Picture-Word Pairings

Cognate Related Pairs		Cognate Unrelated Pairs		Non-Cognate Related Pairs		Non-Cognate Unrelated Pairs	
Pictures	**Words**	**Pictures**	**Words**	**Pictures**	**Words**	**Pictures**	**Words**
Bell**	Drum	Bell**	Arm	Dog	Rabbit	Dog	Plate
bread	cake	Bread	Hen	Pig	Sheep	Pig	Cupboard
Bus	Helicopter	Bus	Horse	Flower	Branch	Flower	Glove
Cat	Tiger	Cat**	Vest	Owl	Pigeon	Owl	Pot
Clock	Alarm	Clock**	Hyena	Spider	Ant	Spider	Cabin
Cow	Horse	Cow**	helicopter	Tie	Glove	Tie	Branch
Crab	Oyster	Crab**	planet	Fork	Plate	Fork	Rabbit
Fish	Eel	Fish**	Axe	Squirrel	Ferret	Squirrel	Train
Foot	Arm	Foot	Drum	Jug*	Pot	Jug*	Pigeon
Frog	Gecko	Frog	Star	Barn	Cabin	Barn	Ant
Giraffe	Elephant	Giraffe	Piano	Table	Cupboard	Table	Sheep
Goat	Hen	Goat	cake	Tap	Shower	Tap	Badger
Hammer	Axe	Hammer	Eel	Car	Train	Car	Ferret
Knife	Bowl	Knife	Dolphin	Fox*	Badger	Fox*	Shower
Moon	Star	Moon	Gecko	Chair	Cradle	Chair	Seed
Skirt	Vest	Skirt**	Tiger	Envelope	Letter	Envelope	Lizard
Sun	planet	Sun	Oyster	Snake	Lizard**	Snake	Letter
Trumpet	Piano	Trumpet	Elephant	Leaf	Seed	Leaf	Cradle
Whale	Dolphin	Whale	Bowl	Lobster	Shrimp	Lobster	Sweater
Zebra	Hyena	Zebra	Alarm	Coat	Sweater	Coat	Shrimp

Appendix D: Filler List

Movement	Sentence	Cog	Living	Stimuli
Left	A Mouse goes left.	Cog	Living	Mouse
Right	A Mouse goes right.	Cog	Living	Mouse
None	There is a Mouse	Cog	Living	Mouse
Empty	There is nothing on screen	Cog	Living	Mouse
Left	A Policeman goes left.	Cog	Living	Policeman
Right	A Policeman goes right.	Cog	Living	Policeman
None	There is a Policeman	Cog	Living	Policeman
Empty	There is nothing on screen	Cog	Living	Policeman
Left	A Wasp goes left.	Cog	Living	Wasp
Right	A Wasp goes right.	Cog	Living	Wasp
None	There is a Wasp	Cog	Living	Wasp
Empty	There is nothing on screen	Cog	Living	Wasp
Left	A Dinosaur goes left.	Cog	Living	Dinosaur
Right	A Dinosaur goes right.	Cog	Living	Dinosaur
None	There is a Dinosaur	Cog	Living	Dinosaur
Empty	There is nothing on screen	Cog	Living	Dinosaur
Left	A Tent goes left.	Cog	Non-Living	Tent
Right	A Tent goes right.	Cog	Non-Living	Tent
None	There is a Tent	Cog	Non-Living	Tent
Empty	There is nothing on screen	Cog	Non-Living	Tent
Left	A Pen goes left.	Cog	Non-Living	Pen
Right	A Pen goes right.	Cog	Non-Living	Pen
None	There is a Pen	Cog	Non-Living	Pen
Empty	There is nothing on screen	Cog	Non-Living	Pen
Left	A Ring goes left.	Cog	Non-Living	Ring
Right	A Ring goes right.	Cog	Non-Living	Ring
None	There is a Ring	Cog	Non-Living	Ring
Empty	There is nothing on screen	Cog	Non-Living	Ring
Left	A Crown goes left.	Cog	Non-Living	Crown
Right	A Crown goes right.	Cog	Non-Living	Crown
None	There is a Crown	Cog	Non-Living	Crown
Empty	There is nothing on screen	Cog	Non-Living	Crown
Left	A Strawberry goes left.	No_Cog	Living	Strawberry
Right	A Strawberry goes right.	No_Cog	Living	Strawberry
None	There is a Strawberry	No_Cog	Living	Strawberry
Empty	There is nothing on screen	No_Cog	Living	Strawberry
Left	A Deer goes left.	No_Cog	Living	Deer
Right	A Deer goes right.	No_Cog	Living	Deer
None	There is a Deer	No_Cog	Living	Deer
Empty	There is nothing on screen	No_Cog	Living	Deer
Left	A Seagull goes left.	No_Cog	Living	Seagull
Right	A Seagull goes right.	No_Cog	Living	Seagull
None	There is a Seagull	No_Cog	Living	Seagull

Empty	There is nothing on screen	No_Cog	Living	Seagull
Left	A Turkey goes left.	No_Cog	Living	Turkey
Right	A Turkey goes right.	No_Cog	Living	Turkey
None	There is a Turkey	No_Cog	Living	Turkey
Empty	There is nothing on screen	No_Cog	Living	Turkey
Left	A Mirror goes left.	No_Cog	Non-Living	Mirror
Right	A Mirror goes right.	No_Cog	Non-Living	Mirror
None	There is a Mirror	No_Cog	Non-Living	Mirror
Empty	There is nothing on screen	No_Cog	Non-Living	Mirror
Left	A Button goes left.	No_Cog	Non-Living	Button
Right	A Button goes right.	No_Cog	Non-Living	Button
None	There is a Button	No_Cog	Non-Living	Button
Empty	There is nothing on screen	No_Cog	Non-Living	Button
Left	A Key goes left.	No_Cog	Non-Living	Key
Right	A Key goes right.	No_Cog	Non-Living	Key
None	There is a Key	No_Cog	Non-Living	Key
Empty	There is nothing on screen	No_Cog	Non-Living	Key
Left	A Ladder goes left.	No_Cog	Non-Living	Ladder
Right	A Ladder goes right.	No_Cog	Non-Living	Ladder
None	There is a Ladder	No_Cog	Non-Living	Ladder
Empty	There is nothing on screen	No_Cog	Non-Living	Ladder
Left	A Ape goes left.	Cog	Living	Ape
Right	A Ape goes right.	Cog	Living	Ape
None	There is a Ape	Cog	Living	Ape
Empty	There is nothing on screen	Cog	Living	Ape
Left	A Crocodile goes left.	Cog	Living	Crocodile
Right	A Crocodile goes right.	Cog	Living	Crocodile
None	There is a Crocodile	Cog	Living	Crocodile
Empty	There is nothing on screen	Cog	Living	Crocodile
Left	A Swan goes left.	Cog	Living	Swan
Right	A Swan goes right.	Cog	Living	Swan
None	There is a Swan	Cog	Living	Swan
Empty	There is nothing on screen	Cog	Living	Swan
Left	A Lung goes left.	Cog	Living	Lung
Right	A Lung goes right.	Cog	Living	Lung
None	There is a Lung	Cog	Living	Lung
Empty	There is nothing on screen	Cog	Living	Lung
Left	A Lamp goes left.	Cog	Non-Living	Lamp
Right	A Lamp goes right.	Cog	Non-Living	Lamp
None	There is a Lamp	Cog	Non-Living	Lamp
Empty	There is nothing on screen	Cog	Non-Living	Lamp
Left	A Bubble goes left.	Cog	Non-Living	Bubble
Right	A Bubble goes right.	Cog	Non-Living	Bubble
None	There is a Bubble	Cog	Non-Living	Bubble
Empty	There is nothing on screen	Cog	Non-Living	Bubble
Left	A Balcony goes left.	Cog	Non-Living	Balcony

Right	A Balcony goes right.	Cog	Non-Living	Balcony
None	There is a Balcony	Cog	Non-Living	Balcony
Empty	There is nothing on screen	Cog	Non-Living	Balcony
Left	A Flag goes left.	Cog	Non-Living	Flag
Right	A Flag goes right.	Cog	Non-Living	Flag
None	There is a Flag	Cog	Non-Living	Flag
Empty	There is nothing on screen	Cog	Non-Living	Flag
Left	A Mosquito goes left.	No_Cog	Living	Mosquito
Right	A Mosquito goes right.	No_Cog	Living	Mosquito
None	There is a Mosquito	No_Cog	Living	Mosquito
Empty	There is nothing on screen	No_Cog	Living	Mosquito
Left	A Maggot goes left.	No_Cog	Living	Maggot
Right	A Maggot goes right.	No_Cog	Living	Maggot
None	There is a Maggot	No_Cog	Living	Maggot
Empty	There is nothing on screen	No_Cog	Living	Maggot
Left	A Butterfly goes left.	No_Cog	Living	Butterfly
Right	A Butterfly goes right.	No_Cog	Living	Butterfly
None	There is a Butterfly	No_Cog	Living	Butterfly
Empty	There is nothing on screen	No_Cog	Living	Butterfly
Left	A Mushroom goes left.	No_Cog	Living	Mushroom
Right	A Mushroom goes right.	No_Cog	Living	Mushroom
None	There is a Mushroom	No_Cog	Living	Mushroom
Empty	There is nothing on screen	No_Cog	Living	Mushroom
Left	A Newspaper goes left.	No_Cog	Non-Living	Newspaper
Right	A Newspaper goes right.	No_Cog	Non-Living	Newspaper
None	There is a Newspaper	No_Cog	Non-Living	Newspaper
Empty	There is nothing on screen	No_Cog	Non-Living	Newspaper
Left	A Mountain goes left.	No_Cog	Non-Living	Mountain
Right	A Mountain goes right.	No_Cog	Non-Living	Mountain
None	There is a Mountain	No_Cog	Non-Living	Mountain
Empty	There is nothing on screen	No_Cog	Non-Living	Mountain
Left	A Computer goes left.	No_Cog	Non-Living	Computer
Right	A Computer goes right.	No_Cog	Non-Living	Computer
None	There is a Computer	No_Cog	Non-Living	Computer
Empty	There is nothing on screen	No_Cog	Non-Living	Computer
Left	A Carpet goes left.	No_Cog	Non-Living	Carpet
Right	A Carpet goes right.	No_Cog	Non-Living	Carpet
None	There is a Carpet	No_Cog	Non-Living	Carpet
Empty	There is nothing on screen	No_Cog	Non-Living	Carpet

Appendix E: Experimental Blocks

Sentence	Cognate	Related	Phrase	Picture	Word
Practice Block 1					
A Spider goes Below a Oyster	No_Cog	Practice	Practice	Spider	Oyster
A Tie goes Below a Piano	No_Cog	Practice	Practice	Tie	Piano
A Helicopter goes Left	Cog	Practice	Practice		Helicopter
A Tap and a Seed go Down	No_Cog	Practice	Practice	Tap	Seed
A Chair and a Shower go Up	No_Cog	Practice	Practice	Chair	Shower
There is a Lobster	No_Cog	Practice	Practice	Lobster	
There is a Hen	Cog	Practice	Practice		Hen
There is a Zebra	Cog	Practice	Practice	Zebra	
A Envelope and a Star go Up	No_Cog	Practice	Practice	Envelope	Star
A Whale and a Drum go Down	Cog	Practice	Practice	Whale	Drum
A Cow and a Dolphin go Up	Cog	Practice	Practice	Cow	Dolphin
There is Nothing on Screen	N/A	Practice	Practice		
There is Nothing on Screen	N/A	Practice	Practice		
There is a Vest	No_Cog	Practice	Practice		Vest
A Leaf goes Right	No_Cog	Practice	Practice	Leaf	
There is Nothing on Screen	N/A	Practice	Practice		
A Dog goes Above a Horse	No_Cog	Practice	Practice	Dog	Horse
A Car and a Sheep go Down	No_Cog	Practice	Practice	Car	Sheep
A Jug and a Gecko go Down	No_Cog	Practice	Practice	Jug	Gecko
A Goat and a Elephant go Down	Cog	Practice	Practice	Goat	Elephant
A Bus goes Left	Cog	Practice	Practice	Bus	
A Fox and a Shrimp go Down	No_Cog	Practice	Practice	Fox	Shrimp
A Cat and a Cupboard go Up	Cog	Practice	Practice	Cat	Cupboard
A Frog goes Above a Alarm	Cog	Practice	Practice	Frog	Alarm
A Coat goes Below a Train	No_Cog	Practice	Practice	Coat	Train
PAUSE					
Practice Block 2					
A Barn and a Pot go Up	No_Cog	Practice	Practice	Barn	Pot
A Giraffe goes Below a Badger	Cog	Practice	Practice	Giraffe	Badger
A Pig goes Above a Hyena	No_Cog	Practice	Practice	Pig	Hyena
A Snake and a Sweater go Up	No_Cog	Practice	Practice	Snake	Sweater
A Clock and a Ferret go Down	Cog	Practice	Practice	Clock	Ferret
A Fish goes Above a Ant	Cog	Practice	Practice	Fish	Ant
A Glove goes Right	No_Cog	Practice	Practice		Glove
A Flower goes Above a Letter	No_Cog	Practice	Practice	Flower	Letter
A Table and a Rabbit go Up	No_Cog	Practice	Practice	Table	Rabbit
A Plate goes Left	No_Cog	Practice	Practice		Plate
A Moon goes Above a Arm	Cog	Practice	Practice	Moon	Arm
A Trumpet goes Below a Cabin	Cog	Practice	Practice	Trumpet	Cabin
A Hammer goes Below a Bowl	Cog	Practice	Practice	Hammer	Bowl
A Squirrel goes Below a Planet	No_Cog	Practice	Practice	Squirrel	Planet
A Sun goes Below a Branch	Cog	Practice	Practice	Sun	Branch
There is Nothing on Screen	N/A	Practice	Practice		

A Bell goes Left	No_Cog	Practice	Practice	Bell	
A Bread and a Cradle go Up	Cog	Practice	Practice	Bread	Cradle
A Tiger goes Right	Cog	Practice	Practice		Tiger
A Skirt and a Cake go Up	Cog	Practice	Practice	Skirt	Cake
A Knife and a Eel go Down	Cog	Practice	Practice	Knife	Eel
A Crab goes Above a Axe	Cog	Practice	Practice	Crab	Axe
A Owl goes Above a Lizard	No_Cog	Practice	Practice	Owl	Lizard
A Foot goes Right	Cog	Practice	Practice	Foot	
A Fork goes Below a Pigeon	No_Cog	Practice	Practice	Fork	Pigeon
PAUSE					
Experimental Block 1					
There is nothing on screen	Cog	Filler	Filler	N/A	Balcony
A Car and a Train go Up	NoCog	Rel	Same	Car	Train
A Chair goes Below a Cradle	NoCog	Rel	Diff	Chair	Cradle
A Dinosaur goes right.	Cog	Filler	Filler	Dinosaur	N/A
A Dog and a Plate go Up	NoCog	UnRel	Same	Dog	Plate
A Ape goes left.	Cog	Filler	Filler	N/A	Ape
A Foot goes Above a Drum	Cog	UnRel	Diff	Foot	Drum
A Newspaper goes right.	No_Cog	Filler	Filler	N/A	Newspaper
A Clock and a Alarm go Down	Cog	Rel	Same	Clock	Alarm
There is a Mushroom	No_Cog	Filler	Filler	N/A	Mushroom
A Knife goes Above a Bowl	Cog	Rel	Diff	Knife	Bowl
A Snake and a Letter go Up	NoCog	UnRel	Same	Snake	Letter
There is a Seagull	No_Cog	Filler	Filler	Seagull	N/A
A Table goes Below a Sheep	NoCog	UnRel	Diff	Table	Sheep
There is a Pen	Cog	Filler	Filler	Pen	N/A
A Skirt and a Vest go Up	Cog	Rel	Same	Skirt	Vest
A Leaf goes Above a Seed	NoCog	Rel	Diff	Leaf	Seed
There is nothing on screen	No_Cog	Filler	Filler	N/A	Maggot
A Bell and a Arm go Down	Cog	UnRel	Same	Bell	Arm
A Lung goes right.	Cog	Filler	Filler	N/A	Lung
A Zebra goes Below a Hyena	Cog	Rel	Diff	Zebra	Hyena
A Squirrel and a Train go Down	NoCog	UnRel	Same	Squirrel	Train
There is nothing on screen	Cog	Filler	Filler	Ring	N/A
A Flower goes Below a Glove	NoCog	UnRel	Diff	Flower	Glove
There is a Turkey	No_Cog	Filler	Filler	Turkey	N/A
A Frog and a Gecko go Up	Cog	Rel	Same	Frog	Gecko
There is nothing on screen	No_Cog	Filler	Filler	Strawberry	N/A
A Fish goes Above a Axe	Cog	UnRel	Diff	Fish	Axe
A Wasp goes right.	Cog	Filler	Filler	Wasp	N/A
A Owl and a Pigeon go Down	NoCog	Rel	Same	Owl	Pigeon
There is nothing on screen	No_Cog	Filler	Filler	N/A	Mosquito
A Lobster goes Below a Sweater	NoCog	UnRel	Diff	Lobster	Sweater
A Crab and a Planet go Down	Cog	UnRel	Same	Crab	Planet
There is a Lamp	Cog	Filler	Filler	N/A	Lamp
A Hammer goes Above a Axe	Cog	Rel	Diff	Hammer	Axe

There is a Bubble	Cog	Filler	Filler	N/A	Bubble
PAUSE					
There is nothing on screen	No_Cog	Filler	Filler	Deer	N/A
A Bus and a Helicopter go Up	Cog	Rel	Same	Bus	Helicopter
There is a Butterfly	No_Cog	Filler	Filler	N/A	Butterfly
A Pig goes Above a Sheep	NoCog	Rel	Diff	Pig	Sheep
A Policeman goes left.	Cog	Filler	Filler	Policeman	N/A
A Giraffe and a Piano go Up	Cog	UnRel	Same	Giraffe	Piano
A Mirror goes right.	No_Cog	Filler	Filler	Mirror	N/A
A Bread goes Above a Hen	Cog	UnRel	Diff	Bread	Hen
A Spider and a Ant go Up	NoCog	Rel	Same	Spider	Ant
A Carpet goes left.	No_Cog	Filler	Filler	N/A	Carpet
A Sun goes Below a Oyster	Cog	UnRel	Diff	Sun	Oyster
There is nothing on screen	Cog	Filler	Filler	Crown	N/A
A Envelope and a Lizard go Down	NoCog	UnRel	Same	Envelope	Lizard
A Moon goes Below a Star	Cog	Rel	Diff	Moon	Star
A Swan goes right.	Cog	Filler	Filler	N/A	Swan
A Coat and a Sweater go Down	NoCog	Rel	Same	Coat	Sweater
A Button goes right.	No_Cog	Filler	Filler	Button	N/A
A Cat goes Below a Tiger	Cog	Rel	Diff	Cat	Tiger
A Whale and a Bowl go Up	Cog	UnRel	Same	Whale	Bowl
A Computer goes left.	No_Cog	Filler	Filler	N/A	Computer
A Fox goes Above a Shower	NoCog	UnRel	Diff	Fox	Shower
There is nothing on screen	Cog	Filler	Filler	N/A	Flag
A Jug and a Pigeon go Up	NoCog	UnRel	Same	Jug	Pigeon
A Mountain goes right.	No_Cog	Filler	Filler	N/A	Mountain
A Fork goes Below a Plate	NoCog	Rel	Diff	Fork	Plate
A Crocodile goes left.	Cog	Filler	Filler	N/A	Crocodile
A Cow and a Helicopter go Down	Cog	UnRel	Same	Cow	Helicopter
A Mouse goes left.	Cog	Filler	Filler	Mouse	N/A
A Tie goes Above a Branch	NoCog	UnRel	Diff	Tie	Branch
A Tap and a Shower go Down	NoCog	Rel	Same	Tap	Shower
A Key goes left.	No_Cog	Filler	Filler	Key	N/A
A Goat goes Below a Cake	Cog	UnRel	Diff	Goat	Cake
There is a Tent	Cog	Filler	Filler	Tent	N/A
A Trumpet and a Piano go Down	Cog	Rel	Same	Trumpet	Piano
A Ladder goes left.	No_Cog	Filler	Filler	Ladder	N/A
A Barn goes Above a Cabin	NoCog	Rel	Diff	Barn	Cabin
PAUSE					
Experimental Block 2					
There is nothing on screen	No_Cog	Filler	Filler	Turkey	N/A
A Squirrel goes Above a Train	NoCog	UnRel	Diff	Squirrel	Train
A Tie and a Branch go Down	NoCog	UnRel	Same	Tie	Branch
A Computer goes right.	No_Cog	Filler	Filler	N/A	Computer
A Clock goes Above a Alarm	Cog	Rel	Diff	Clock	Alarm
There is nothing on screen	Cog	Filler	Filler	N/A	Bubble

A Barn and a Cabin go Down	NoCog	Rel	Same	Barn	Cabin
A Bell goes Above a Arm	Cog	UnRel	Diff	Bell	Arm
A Hammer and a Axe go Down	Cog	Rel	Same	Hammer	Axe
There is a Mirror	No_Cog	Filler	Filler	Mirror	N/A
A Jug goes Below a Pigeon	NoCog	UnRel	Diff	Jug	Pigeon
A Zebra and a Hyena go Up	Cog	Rel	Same	Zebra	Hyena
A Key goes right.	No_Cog	Filler	Filler	Key	N/A
There is a Lung	Cog	Filler	Filler	N/A	Lung
A Frog goes Below a Gecko	Cog	Rel	Diff	Frog	Gecko
There is a Newspaper	No_Cog	Filler	Filler	N/A	Newspaper
A Table and a Sheep go Up	NoCog	UnRel	Same	Table	Sheep
A Crocodile goes right.	Cog	Filler	Filler	N/A	Crocodile
A Bus goes Below a Helicopter	Cog	Rel	Diff	Bus	Helicopter
A Policeman goes right.	Cog	Filler	Filler	Policeman	N/A
A Fox and a Shower go Down	NoCog	UnRel	Same	Fox	Shower
A Mouse goes right.	Cog	Filler	Filler	Mouse	N/A
A Skirt goes Below a Vest	Cog	Rel	Diff	Skirt	Vest
A Bread and a Hen go Down	Cog	UnRel	Same	Bread	Hen
A Ring goes left.	Cog	Filler	Filler	Ring	N/A
A Tap goes Above a Shower	NoCog	Rel	Diff	Tap	Shower
A Moon and a Star go Up	Cog	Rel	Same	Moon	Star
There is a Swan	Cog	Filler	Filler	N/A	Swan
A Flag goes left.	Cog	Filler	Filler	N/A	Flag
A Giraffe goes Below a Piano	Cog	UnRel	Diff	Giraffe	Piano
A Knife and a Bowl go Down	Cog	Rel	Same	Knife	Bowl
There is a Wasp	Cog	Filler	Filler	Wasp	N/A
A Dog goes Below a Plate	NoCog	UnRel	Diff	Dog	Plate
A Maggot goes left.	No_Cog	Filler	Filler	N/A	Maggot
A Goat and a Cake go Up	Cog	UnRel	Same	Goat	Cake
A Mosquito goes left.	No_Cog	Filler	Filler	N/A	Mosquito
		PAUSE			
There is nothing on screen	No_Cog	Filler	Filler	N/A	Butterfly
A Car goes Below a Train	NoCog	Rel	Diff	Car	Train
A Sun and a Oyster go Up	Cog	UnRel	Same	Sun	Oyster
A Strawberry goes left.	No_Cog	Filler	Filler	Strawberry	N/A
A Trumpet goes Above a Piano	Cog	Rel	Diff	Trumpet	Piano
There is nothing on screen	Cog	Filler	Filler	Tent	N/A
A Foot and a Drum go Down	Cog	UnRel	Same	Foot	Drum
A Crab goes Above a Planet	Cog	UnRel	Diff	Crab	Planet
There is nothing on screen	No_Cog	Filler	Filler	N/A	Mushroom
A Leaf and a Seed go Down	NoCog	Rel	Same	Leaf	Seed
There is nothing on screen	No_Cog	Filler	Filler	Seagull	N/A
A Spider goes Below a Ant	NoCog	Rel	Diff	Spider	Ant
A Ape goes right.	Cog	Filler	Filler	N/A	Ape
A Cat and a Tiger go Up	Cog	Rel	Same	Cat	Tiger
A Ladder goes right.	No_Cog	Filler	Filler	Ladder	N/A

A Envelope goes Above a Lizard	NoCog	UnRel	Diff	Envelope	Lizard
A Pig and a Sheep go Down	NoCog	Rel	Same	Pig	Sheep
A Crown goes left.	Cog	Filler	Filler	Crown	N/A
A Cow goes Above a Helicopter	Cog	UnRel	Diff	Cow	Helicopter
A Fork and a Plate go Up	NoCog	Rel	Same	Fork	Plate
A Deer goes left.	No_Cog	Filler	Filler	Deer	N/A
A Whale goes Below a Bowl	Cog	UnRel	Diff	Whale	Bowl
A Chair and a Cradle go Up	NoCog	Rel	Same	Chair	Cradle
A Coat goes Above a Sweater	NoCog	Rel	Diff	Coat	Sweater
There is nothing on screen	Cog	Filler	Filler	Pen	N/A
A Carpet goes right.	No_Cog	Filler	Filler	N/A	Carpet
There is a Mountain	No_Cog	Filler	Filler	N/A	Mountain
A Fish and a Axe go Down	Cog	UnRel	Same	Fish	Axe
A Snake goes Below a Letter	NoCog	UnRel	Diff	Snake	Letter
There is a Dinosaur	Cog	Filler	Filler	Dinosaur	N/A
A Lobster and a Sweater go Up	NoCog	UnRel	Same	Lobster	Sweater
There is nothing on screen	Cog	Filler	Filler	N/A	Lamp
A Owl goes Above a Pigeon	NoCog	Rel	Diff	Owl	Pigeon
There is a Button	No_Cog	Filler	Filler	Button	N/A
A Balcony goes left.	Cog	Filler	Filler	N/A	Balcony
A Flower and a Glove go Up	NoCog	UnRel	Same	Flower	Glove

PAUSE

Experimental Block 3

A Bubble goes left.	Cog	Filler	Filler	N/A	Bubble
A Fork goes Below a Rabbit	NoCog	UnRel	Diff	Fork	Rabbit
A Spider and a Cabin go Up	NoCog	UnRel	Same	Spider	Cabin
There is a Mouse	Cog	Filler	Filler	Mouse	N/A
There is nothing on screen	No_Cog	Filler	Filler	N/A	Mountain
A Flower goes Below a Branch	NoCog	Rel	Diff	Flower	Branch
A Frog and a Star go Up	Cog	UnRel	Same	Frog	Star
There is a Key	No_Cog	Filler	Filler	Key	N/A
A Table goes Below a Cupboard	NoCog	Rel	Diff	Table	Cupboard
A Whale and a Dolphin go Up	Cog	Rel	Same	Whale	Dolphin
A Pig goes Above a Cupboard	NoCog	UnRel	Diff	Pig	Cupboard
A Bus and a Horse go Up	Cog	UnRel	Same	Bus	Horse
There is nothing on screen	Cog	Filler	Filler	N/A	Swan
There is nothing on screen	Cog	Filler	Filler	Wasp	N/A
A Barn goes Above a Ant	NoCog	UnRel	Diff	Barn	Ant
A Ring goes right.	Cog	Filler	Filler	Ring	N/A
A Squirrel and a Ferret go Down	NoCog	Rel	Same	Squirrel	Ferret
There is nothing on screen	No_Cog	Filler	Filler	Mirror	N/A
A Tie goes Above a Glove	NoCog	Rel	Diff	Tie	Glove
A Trumpet and a Elephant go Down	Cog	UnRel	Same	Trumpet	Elephant
There is a Ape	Cog	Filler	Filler	N/A	Ape
A Flag goes right.	Cog	Filler	Filler	N/A	Flag
A Butterfly goes left.	No_Cog	Filler	Filler	N/A	Butterfly

A Bread goes Above a Cake	Cog	Rel	Diff	Bread	Cake
A Jug and a Pot go Up	NoCog	Rel	Same	Jug	Pot
There is nothing on screen	Cog	Filler	Filler	N/A	Lung
A Hammer goes Above a Eel	Cog	UnRel	Diff	Hammer	Eel
A Car and a Ferret go Up	NoCog	UnRel	Same	Car	Ferret
There is a Computer	No_Cog	Filler	Filler	N/A	Computer
A Goat goes Below a Hen	Cog	Rel	Diff	Goat	Hen
A Balcony goes right.	Cog	Filler	Filler	N/A	Balcony
A Tap and a Badger go Down	NoCog	UnRel	Same	Tap	Badger
A Foot goes Above a Arm	Cog	Rel	Diff	Foot	Arm
A Pen goes left.	Cog	Filler	Filler	Pen	N/A
A Owl and a Pot go Down	NoCog	UnRel	Same	Owl	Pot
A Deer goes right.	No_Cog	Filler	Filler	Deer	N/A
			PAUSE		
A Mushroom goes left.	No_Cog	Filler	Filler	N/A	Mushroom
A Sun goes Below a Planet	Cog	Rel	Diff	Sun	Planet
A Dog and a Rabbit go Up	NoCog	Rel	Same	Dog	Rabbit
A Strawberry goes right.	No_Cog	Filler	Filler	Strawberry	N/A
A Fish goes Above a Eel	Cog	Rel	Diff	Fish	Eel
A Skirt and a Tiger go Up	Cog	UnRel	Same	Skirt	Tiger
A Maggot goes right.	No_Cog	Filler	Filler	N/A	Maggot
A Leaf goes Above a Cradle	NoCog	UnRel	Diff	Leaf	Cradle
A Seagull goes left.	No_Cog	Filler	Filler	Seagull	N/A
A Snake and a Lizard go Up	NoCog	Rel	Same	Snake	Lizard
A Knife goes Above a Dolphin	Cog	UnRel	Diff	Knife	Dolphin
A Cow and a Horse go Down	Cog	Rel	Same	Cow	Horse
There is nothing on screen	No_Cog	Filler	Filler	N/A	Newspaper
A Mosquito goes right.	No_Cog	Filler	Filler	N/A	Mosquito
There is a Policeman	Cog	Filler	Filler	Policeman	N/A
A Cat goes Below a Vest	Cog	UnRel	Diff	Cat	Vest
A Clock and a Hyena go Down	Cog	UnRel	Same	Clock	Hyena
A Lobster goes Below a Shrimp	NoCog	Rel	Diff	Lobster	Shrimp
There is a Ladder	No_Cog	Filler	Filler	Ladder	N/A
A Envelope and a Letter go Down	NoCog	Rel	Same	Envelope	Letter
A Crown goes right.	Cog	Filler	Filler	Crown	N/A
A Moon goes Below a Gecko	Cog	UnRel	Diff	Moon	Gecko
A Crab and a Oyster go Down	Cog	Rel	Same	Crab	Oyster
There is nothing on screen	Cog	Filler	Filler	Dinosaur	N/A
A Lamp goes left.	Cog	Filler	Filler	N/A	Lamp
A Chair goes Below a Seed	NoCog	UnRel	Diff	Chair	Seed
There is a Crocodile	Cog	Filler	Filler	N/A	Crocodile
A Giraffe and a Elephant go Up	Cog	Rel	Same	Giraffe	Elephant
A Tent goes left.	Cog	Filler	Filler	Tent	N/A
A Fox goes Above a Badger	NoCog	Rel	Diff	Fox	Badger
A Bell and a Drum go Down	Cog	Rel	Same	Bell	Drum
There is a Carpet	No_Cog	Filler	Filler	N/A	Carpet

A Zebra goes Below a Alarm	Cog	UnRel	Diff	Zebra	Alarm
A Turkey goes left.	No_Cog	Filler	Filler	Turkey	N/A
There is nothing on screen	No_Cog	Filler	Filler	Button	N/A
A Coat and a Shrimp go Down	NoCog	UnRel	Same	Coat	Shrimp
			PAUSE		
			Experimental Block 4		
A Lung goes left.	Cog	Filler	Filler	N/A	Lung
A Hammer and a Eel go Down	Cog	UnRel	Same	Hammer	Eel
There is a Crown	Cog	Filler	Filler	Crown	N/A
There is a Deer	No_Cog	Filler	Filler	Deer	N/A
A Tap goes Above a Badger	NoCog	UnRel	Diff	Tap	Badger
There is nothing on screen	No_Cog	Filler	Filler	N/A	Computer
A Table and a Cupboard go Up	NoCog	Rel	Same	Table	Cupboard
A Bubble goes right.	Cog	Filler	Filler	N/A	Bubble
A Mountain goes left.	No_Cog	Filler	Filler	N/A	Mountain
A Skirt goes Below a Tiger	Cog	UnRel	Diff	Skirt	Tiger
A Sun and a Planet go Up	Cog	Rel	Same	Sun	Planet
There is a Maggot	No_Cog	Filler	Filler	N/A	Maggot
A Owl goes Above a Pot	NoCog	UnRel	Diff	Owl	Pot
A Pen goes right.	Cog	Filler	Filler	Pen	N/A
A Leaf and a Cradle go Down	NoCog	UnRel	Same	Leaf	Cradle
There is nothing on screen	No_Cog	Filler	Filler	Ladder	N/A
A Crab goes Above a Oyster	Cog	Rel	Diff	Crab	Oyster
A Lobster and a Shrimp go Up	NoCog	Rel	Same	Lobster	Shrimp
A Button goes left.	No_Cog	Filler	Filler	Button	N/A
A Envelope goes Above a Letter	NoCog	Rel	Diff	Envelope	Letter
A Seagull goes right.	No_Cog	Filler	Filler	Seagull	N/A
A Barn and a Ant go Down	NoCog	UnRel	Same	Barn	Ant
A Giraffe goes Below a Elephant	Cog	Rel	Diff	Giraffe	Elephant
A Wasp goes left.	Cog	Filler	Filler	Wasp	N/A
A Moon and a Gecko go Up	Cog	UnRel	Same	Moon	Gecko
A Cow goes Above a Horse	Cog	Rel	Diff	Cow	Horse
A Bread and a Cake go Down	Cog	Rel	Same	Bread	Cake
A Lamp goes right.	Cog	Filler	Filler	N/A	Lamp
A Snake goes Below a Lizard	NoCog	Rel	Diff	Snake	Lizard
A Tie and a Glove go Down	NoCog	Rel	Same	Tie	Glove
A Turkey goes right.	No_Cog	Filler	Filler	Turkey	N/A
A Coat goes Above a Shrimp	NoCog	UnRel	Diff	Coat	Shrimp
A Goat and a Hen go Up	Cog	Rel	Same	Goat	Hen
There is a Ring	Cog	Filler	Filler	Ring	N/A
A Squirrel goes Above a Ferret	NoCog	Rel	Diff	Squirrel	Ferret
There is a Flag	Cog	Filler	Filler	N/A	Flag
			PAUSE		
There is nothing on screen	Cog	Filler	Filler	N/A	Ape
A Flower and a Branch go Up	NoCog	Rel	Same	Flower	Branch
There is nothing on screen	Cog	Filler	Filler	Mouse	N/A

There is a Balcony	Cog	Filler	Filler	N/A	Balcony
A Bell goes Above a Drum	Cog	Rel	Diff	Bell	Drum
A Fork and a Rabbit go Up	NoCog	UnRel	Same	Fork	Rabbit
There is a Strawberry	No_Cog	Filler	Filler	Strawberry	N/A
A Trumpet goes Above a Elephant	Cog	UnRel	Diff	Trumpet	Elephant
A Knife and a Dolphin go Down	Cog	UnRel	Same	Knife	Dolphin
There is a Mosquito	No_Cog	Filler	Filler	N/A	Mosquito
A Whale goes Below a Dolphin	Cog	Rel	Diff	Whale	Dolphin
A Fox and a Badger go Down	NoCog	Rel	Same	Fox	Badger
A Mushroom goes right.	No_Cog	Filler	Filler	N/A	Mushroom
A Clock goes Above a Hyena	Cog	UnRel	Diff	Clock	Hyena
A Chair and a Seed go Up	NoCog	UnRel	Same	Chair	Seed
A Butterfly goes right.	No_Cog	Filler	Filler	N/A	Butterfly
There is nothing on screen	Cog	Filler	Filler	Policeman	N/A
There is nothing on screen	No_Cog	Filler	Filler	N/A	Carpet
A Spider goes Below a Cabin	NoCog	UnRel	Diff	Spider	Cabin
A Foot and a Arm go Down	Cog	Rel	Same	Foot	Arm
A Tent goes right.	Cog	Filler	Filler	Tent	N/A
A Car goes Below a Ferret	NoCog	UnRel	Diff	Car	Ferret
A Fish and a Eel go Down	Cog	Rel	Same	Fish	Eel
A Dinosaur goes left.	Cog	Filler	Filler	Dinosaur	N/A
A Bus goes Below a Horse	Cog	UnRel	Diff	Bus	Horse
A Mirror goes left.	No_Cog	Filler	Filler	Mirror	N/A
A Cat and a Vest go Up	Cog	UnRel	Same	Cat	Vest
A Dog goes Below a Rabbit	NoCog	Rel	Diff	Dog	Rabbit
There is nothing on screen	No_Cog	Filler	Filler	Key	N/A
A Pig and a Cupboard go Down	NoCog	UnRel	Same	Pig	Cupboard
A Jug goes Below a Pot	NoCog	Rel	Diff	Jug	Pot
There is nothing on screen	Cog	Filler	Filler	N/A	Crocodile
A Newspaper goes left.	No_Cog	Filler	Filler	N/A	Newspaper
A Zebra and a Alarm go Up	Cog	UnRel	Same	Zebra	Alarm
A Swan goes left.	Cog	Filler	Filler	N/A	Swan
A Frog goes Below a Star	Cog	UnRel	Diff	Frog	Star

End of Experiment

Appendix F: Vocabulary Test

English Synonyms					
Item	**Word**	**Correct**	**Foil A**	**Foil B**	**Foil C**
1	caprice	whim	cattle	brute	lounge
2	baffle	confuse	hide	warp	bully
3	ponderous	unwieldy	useless	supportive	thoughtful
4	banter	chatting	whispering	denial	beating
5	garish	tasteless	spiky	green	bland
6	sequin	bead	stamp	sledge	order
7	loquacious	talkative	broad	roomy	marshy
8	covet	desire	pad	cradle	cave
9	acumen	cleverness	blame	spicy	wealth
10	drench	soak	raise	erase	flatten
11	abide	endure	inhabit	crave	depart
12	vocation	occupation	holiday	pronunciation	vocabulary
13	gulch	crevasse	swallow	shed	dislike
14	cogitate	ponder	achieve	succeed	enquire
15	vexatious	effortful	engaging	horrifying	priceless
16	peril	danger	shiny	delight	shelter
17	feral	savage	hungry	impartial	ugly
18	ludicrous	ridiculous	developed	nasty	certain
19	brisk	energetic	disposable	section	stern
20	truculent	defiant	delicious	juicy	tardy

English Antonyms					
Item	**Word**	**Correct**	**Foil A**	**Foil B**	**Foil C**
1	concerned	uncaring	scarce	misleading	understanding
2	timorous	fearless	forestry	funny	emotive
3	disdain	admire	unload	misfortune	huge
4	acerbic	sweet	itchy	loud	beautiful
5	nonplus	enlighten	subtract	gain	disadvantage
6	surfeit	lack	southern	excess	fake
7	vicious	gentle	slippery	fierce	disobedient
8	saunter	rush	fry	punish	daydream
9	slipshod	careful	difficult	clumsy	footwear
10	umbrage	delight	dungeon	demanding	appeal
11	strenuous	effortless	arduous	smooth	tricky
12	divulge	conceal	purchase	disclose	smuggle
13	loathe	cherish	rejoice	kindle	undress
14	querulous	agreeable	feathered	blatant	squeaky
15	forgo	acquire	precede	journey	disappear
16	conquer	surrender	demand	retain	release
17	hovel	palace	float	cloudy	stairwell

18	adversity	advantage	delay	grudge	persevere
19	alacrity	slowness	annoyance	fog	ingenuity
20	penury	wealth	dispatch	cunning	famine

Norwegian Synonyms

Item	Word	Correct	FoilA	FoilB	FoilC
1	lektyre	lesestoff	leker	hytte	husdyr
2	ufortrøden	uforstyrrelig	uforbederlig	ufokusert	fornøden
3	noksagt	dumrian	ferdigstilt	selvdyrker	påstand
4	lemfeldig	forsiktig	uberegnelig	langsom	frimodig
5	febrilsk	hektisk	illevarslende	tilstrekkelig	varmblodig
6	brudulje	slagsmål	ekteskap	floke	etterligning
7	fjetre	lamme	røpe	legere	finne
8	vankelmodig	ubestemt	nådeløs	mangelfull	hyklersk
9	attrå	begjære	fornærme	avslå	trampe
10	kryste	klemme	brodere	savne	forfølge
11	amper	hissig	skyldig	travel	fyldig
12	smektende	lengtende	spinkel	smakfull	buktende
13	maroder	utmattet	blodtørstig	spenstig	hevngjerrig
14	trettekjær	kranglete	grådig	kresen	svak
15	fadese	tabbe	utside	krig	vegring
16	mulkt	bot	dystert	sveiv	svalt
17	atal	plagsom	sløv	dyktig	hvass
18	vansmekte	lide	gnage	avsky	forgifte
19	sondre	skille	undersøke	forske	vise
20	omkalfatre	endevende	oppfatte	omkomme	omlegge

Norwegian Antonyms

Item	Word	Correct	Foil A	Foil B	Foil C
1	lapidarisk	pratesyk	usann	kortfattet	fremmed
2	distré	oppmerksom	utakknemlig	motsatt	fordelt
3	sjofel	hyggelig	annerledes	lumpen	skjærende
4	vanvidd	fornuft	ordstrid	viktighet	velklang
5	armod	rikdom	avsporing	elendighet	bopel
6	overflod	fattigdom	omskifte	flom	vrede
7	avertere	skjule	tirre	kunngjøre	forstyrre
8	nennsom	voldsom	sparsom	virksom	strevsom
9	ødsle	spare	hevde	nære	tvile
10	bebreide	berømme	beleire	betvile	betenke
11	uaffisert	påvirket	redigert	offentlig	merkelig
12	besynderlig	alminnelig	snevert	omfattende	anerkjent
13	ublu	rimelig	skjør	freidig	skral
14	hovmod	ydmykhet	angst	avskjed	tilregnelighet
15	anfektelse	visshet	forhindring	åpenbaring	straff

16	petimeter	slask	lekmann	tommestokk	skritt-teller
17	avferdige	godta	avslutte	forhindre	testamentere
18	bifalle	avvise	tilta	snuble	erobre
19	fetere	overse	pine	ernære	flytte
20	nidkjær	slurvete	trassig	selvopptatt	streng

Appendix G: Removed Variables

Removed Variable	Correlated >0.8 with
ENG – Proficiency, speaking	ENG – Proficiency, pronouncing, ENG – Proficiency, reading
ENG – Proficiency, pronouncing	ENG – Proficiency, speaking, ENG – Proficiency, reading
ENG – Proficiency, reading	ENG – Proficiency, speaking, ENG – Proficiency, pronouncing, ENG – Proficiency, Writing, ENG – Proficiency, Vocabulary
ENG – Proficiency, writing	ENG – Proficiency, reading, ENG – Proficiency, spelling
ENG – Proficiency, vocabulary	ENG – Proficiency, reading, ENG – Proficiency, spelling
ENG – Self-reported Norwegian accent	ENG – Proficiency, pronouncing
NOR – Overall exposure	ENG – Overall Exposure
NOR – Overall speaking (% time)	ENG – Overall speaking (% time)
NOR – Choose to speak (% time)	ENG – Choose to speak (% time)
NOR – Overall exposure, interacting with family	ENG – Overall exposure, interacting with family

Appendix H: Original Variable Names

Factor RC1 – English Fluency	*Loading values*	**Factor RC3** Norwegian Informal Learning	*Loading values*	**Factor RC2** Norwegian Proficiency	*Loading values*	**Factor RC5** Later English Fluency	*Loading values*
Q5b_Read_Eng	0.81	**Q3d_Expos_SelfInstruct_Nor**	0.84	**Q5e_Prof_Writing_Nor**	0.90	**Q5f_FluentSpeaking_Age_Eng**	0.82
Q4n_Prof_Vocab_Eng	0.79	**Q2g_Contrib_Music_Nor**	0.83	**Q4c_Prof_Reading_Nor**	0.89	**Q1a_Country_Nor**	0.70
Q3i_Expos_Reading_Eng	0.78	**Q3f_Expos_Music_Nor**	0.80	**Q4g_Prof_Spelling_Nor**	0.84	**Q5e_StartHearing_Age_Eng**	0.69
Q4h_Prof_Speaking_Eng	0.76	**Q2f_Contrib_TV_Nor**	0.77	**Q4f_Prof_Vocab_Nor**	0.72	**Q5h_FluentReading_Age_Eng**	0.68
Q4l_Prof_Grammar_Eng	0.71	**Q3e_Expos_TV_Nor**	0.71	**Q4a_Prof_Speak_Nor**	0.68	**Q5g_StartReading_Age_Eng**	0.57
Q3b_Exposure_Eng	0.70	**Q2e_Contrib_SelfInstruct_Nor**	0.69	**Q4e_Prof_Grammar_Nor**	0.49	**Q8_Accent_NonNative_Obviou**	0.34
Q4b_Speaking_Eng	0.70	**Q3c_Expos_Reading_Nor**	0.60	**Q4b_Prof_Pronoucing_Nor**	0.43	**Q7_Heavy_NorsktoEng_Accent**	0.32
Q4k_Prof_Writing_Eng	0.67	Q2l_Contrib_SelfInstruct_Eng	0.41	**Q1a_Country_Nor**	0.42	**Q12c_Improve_Pronounciation**	0.30
Q3g_Expos_InteractFriend_Eng	0.61	Q2m_Contrib_TV_Eng	0.40	Q3_Dialect_Modify	0.41	Q16b_Intentional_SubIn_Nor	-0.69
Q2j_Contrib_Reading_Eng	0.56	Q2n_Contrib_Music_Eng	0.40	**Q4k_Prof_Writing_Eng**	0.40	Q2i_Contrib_InteractFamily_Eng1	-0.67
Q6b_Choice_Eng	0.53	**Q2d_Contrib_School_Nor**	0.36	**Q4l_Prof_Grammar_Eng**	0.35	Q16a_Intentional_SubIn_Eng	-0.58
Q2h_Contrib_InteractFriend_Eng	0.51	Q5g_StartReading_Age_Eng	0.35	Q15a_Accident_Mix_Words_Freq	-0.45	Q3h_Expos_InteractFamily_Eng	-0.54
Q12a_Grammar_Correct_Eng	0.49	**Q2c_Contrib_Reading_Nor**	0.34	**Q5_Regional_Rating**	-0.38	**Q12b_Attention_Pronounciation**	-0.44
Q9_Import_Good_EngAccent	0.46	**Q4b_Other_Dialect_Length**	0.33	Q2n_Contrib_Music_Eng	-0.37		
Q5b_FluentSpeaking_Age_Nor	0.46	Q2k_Contrib_School_Eng	0.32				
Q3l_Expos_Music_Eng	0.43	Q3j_Expos_SelfInstruct_Eng	0.32				
Q3j_Expos_SelfInstruct_Eng	0.42						
Q3k_Expos_TV_Eng	0.40						
Q5d_FluentReading_Age_Nor	0.33						
Q5a_Read_Nor	-0.82						
Q7_Heavy_NorsktoEng_Accent	-0.75						
Q3c_Expos_Reading_Nor	-0.60						
Q2k_Contrib_School_Eng	-0.50						
Q12d_Want_Like_Native_Eng	-0.40						
Q5_Regional_Rating	-0.34						
Q3a_Expos_InteractFriend_Nor	-0.44						
Proportion Variance	0.15	Proportion Variance	0.09	Proportion Variance	0.09	Proportion Variance	0.08
Cumulative Variance	0.15	Cumulative Variance	0.24	Cumulative Variance	0.32	Cumulative Variance	0.41

Factor RC4 Improve English Pronunciation	*Loading values*	**Factor RC6** Norwegian Dominance?	*Loading values*	**Factor RC8** – Norwegian Language Exposure?	*Loading values*	**Factor RC7** Late Norwegian Fluency	*Loading values*
Q12c_Improve_Pronounciation	0.75	**Q15b_Accident_Nor_Intrude_Eng**	0.65	**Q2_Dialect_Important**	0.75	**Q5c_StartReading_Age_Nor**	0.82
Q7f_Ident_Cult_Nor	0.68	**Q5g_StartReading_Age_Eng**	0.58	**Q8_Accent_NonNative_Obvious**	0.59	**Q5d_FluentReading_Age_Nor**	0.68
Q9_Import_Good_EngAccent	0.69	**Q15a_Accident_Mix_Words_Freq**	0.51	**Q3a_Expos_InteractFriend_Nor**	0.45	**Q4a_Prof_Speak_Nor**	0.49
Q10_Effort_Improv_EngAccent	0.57	**Q3_Dialect_Modify**	0.45	**Q2d_Contrib_School_Nor**	0.44	Age	0.48
Q12d_Want_Like_Native_Eng	0.50	**Q5h_FluentReading_Age_Eng**	0.40	**Q3k_Expos_TV_Eng**	0.39	**Q4b_Prof_Pronoucing_Nor**	0.46
Q4b_Prof_Pronoucing_Nor	0.45	**Q12d_Want_Like_Native_Eng**	0.39	**Q12b_Attention_Pronounciation**	0.38	**Q5e_StartHearing_Age_Eng**	0.36
Q12a_Grammar_Correct_Eng	0.33	**Q2b_Contrib_InteractFamily_Nor**	0.39	**Q12a_Grammar_Correct_Eng**	0.35	**Q5b_FluentSpeaking_Age_Nor**	0.31
Q3k_Expos_TV_Eng	0.32	**Q3l_Expos_Music_Eng**	0.33	**Q2k_Contrib_School_Eng**	0.33	**Q4b_Other_Dialect_Length**	-0.63
Q2m_Contrib_TV_Eng	0.30	**Q2h_Contrib_InteractFriend_Eng**	0.31	**Q3e_Expos_TV_Nor**	0.32	**Q2c_Contrib_Reading_Nor**	-0.44
Q12b_Attention_Pronounciation	0.33	**Q2l_Contrib_SelfInstruct_Eng**	-0.57	**Q2c_Contrib_Reading_Nor**	0.31	**Q3_Dialect_Modify**	-0.41
Q12e_Pronounce_NOT_import	-0.72	**Q5b_FluentSpeaking_Age_Nor ***	-0.57	**Q3g_Expos_InteractFriend_Eng**	-0.56	**Q4e_Prof_Grammar_Nor**	-0.33
Age	-0.59	**Q3j_Expos_SelfInstruct_Eng**	-0.54	**Q2a_Contrib_InteractFriend_Nor**	-0.52	**Q2j_Contrib_Reading_Eng**	-0.32
Q4b_Other_Dialect_Length	-0.44	**Q4b_Speaking_Eng**	-0.43	**Q4b_Speaking_Eng**	-0.48	**Q12b_Attention_Pronounciation**	-0.31
Q2h_Contrib_InteractFriend_Eng	-0.43	**Q5_Regional_Rating**	-0.43	**Q6b_Choice_Eng**	-0.46	**Q3f_Expos_Music_Nor**	-0.30
Q2c_Contrib_Reading_Nor	-0.35			**Q2b_Contrib_InteractFamily_Nor**	-0.40		
Proportion Variance	0.07	Proportion Variance	0.07	Proportion Variance	0.06	Proportion Variance	0.06
Cumulative Variance	0.48	Cumulative Variance	0.55	Cumulative Variance	0.61	Cumulative Variance	0.67