How is bilingual's memory for visual scenes effected by the use of cognates and disfluencies? An eye tracking study.

A psycholinguistic-based study on how memory is affected by knowing a second language with the use of cognates and disfluencies.

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Table of Contents

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1. Introduction

1.1. Introduction and general structure

Bilinguals acquires the cognitive skill of handling two languages at once, as well as the advantage of having linguistic proficiency in two languages (Kroll, 2008). A study looking at the bilingual advantage of juggling two languages by Konopka (2019), found that bilinguals were affected differently by disfluencies than monolinguals. These findings led to this eye tracking study being conducted by testing bilinguals. The present study looks at how memory of bilinguals is affected by disfluencies and how disfluencies may affect bilingual memory, as well as how bilinguals are affected by cognates. The aim of the study is to see if bilinguals are affected by disfluencies in terms of memory and if bilinguals are affected by cognates. The study will have a null result when it comes to the memory test and the influence of cognates requires more data in order to find any significant results. However, bilinguals have a higher gaze duration when presented with a disfluency prior to the target word. These results are then discussed with earlier studies on similar aspects and future research is suggested. Another eye tracking study by Konopka (Internal report, 2019) found that disfluencies have a different effect on bilinguals than monolinguals. However, what the theoretical models have in common is that they are all trying to understand and demonstrate how the bilingual language process works. The present study will look at how the bilingual comprehension process of disfluencies affect memory. The use of cognates and noncognates is a method to see if the participants are affected by a stronger activated word according to the Cognate Facilitation Effect (Costa, Caramazza, & Sebastian-Galles, 2000) and nonselective language activation (Lagrou, Hartsuiker, & Duyck, 2013). To elaborate, a cognate word is, according to the Cognate Facilitation Effect and nonselective language activation, a word with twice the activation since the word gets activated from both the first and the second language of the bilingual speaker. The present study is interested in seeing how high proficient bilinguals behave compared to monolinguals.

In the following section, general aspects of bilingualism and the essential parameters used in bilingual research will be examined. Secondly, some of the current models of bilingual language processing (Costa et al., 2000; Dijkstra & van Heuven, 2002; Green, 1998; Green & Abutalebi, 2013; Kroll & Stewart, 1994) will be reviewed.

Thirdly, the memory of bilinguals will be discussed. Evidence of previous studies (Baddeley, Gathercole, & Papagno, 1998; Baddely & Hitch, 1974; Papagno, Valentine, & Baddeley, 1991), including Sampaio and Konopka's (2013) study on monolinguals and bilingual's memory on gist and surface form, suggest there is a difference between monolinguals' and bilinguals' memory. It proposes that the gist is easier to remember by monolinguals, while bilinguals remember the correct surface form. Then, I will deliberate on disfluency, before reviewing Norwegian-English bilinguals living in Norway, and how the Norwegian and English languages are in relation to each other by the use of cognates. Then in the introduction, I will look into how eye tracking has been used in bilingual language studies in the past (Konopka, 2019; Tanenhaus et al., 1995). Finally, I will explain the methodology employed, before the results are presented and the results are analysed in the discussion.

1.2. Bilingualism

There is a lot of evidence that being bilingual affects cognitive processes (Bialystok, 2001; Peal & Lambert, 1962). This study investigates bilingual speech processing and memory. A bilingual is a person who knows two languages. There are several ways of considering someone bilingual. For example, a bilingual person could be born into a family where two languages are spoken or speak a different language at home than at school. A bilingual could also be an early or late bilingual learning a second language as a young child or learning a second language later in life as an adult. In today's society, bilingualism can be interpreted in many different ways. We are often restricted in our ways of thinking of bilinguals as those who have had two or more languages since birth, such as those who grow up with parents speaking two or more different languages. However, in this study people who use two languages or more to communicate on a regular basis, in certain situations, or with particular people will be considered to be bilinguals. Therefore, in this study a bilingual will be defined as someone who can communicate in two languages. Research has found that bilinguals have both of their languages active during speech processes (Lagrou et al., 2013). Bilinguals can be affected by cognates since they are processed differently than non-cognates. Cognates are words that share meaning and form across different languages such as *klokke/clock*. This is further amplified by a systematic representation by Costa et al. (2000).

Many models have been proposed to explain bilingual speech processing. Among them are The Bilingual Interactive Activation (BIA) model (Dijkstra & van Heuven, 2002) that describes the bilingual language process. The model expands on the concept of non-selective language activation. The BIA model proposes how the bilingual language process occurs from having two languages active to the bilingual speech comprehension process where one of the languages gets inhibited. The Inhibitory Control Model (ICM), by Green (1998), portrays how language selection works. Green and Abutalebi (2013) specify how the language process happens from an interactional context to the metacontrol process in a bilingual mind. This is called the Adaptive Control Hypothesis (ACH).

The proficiency of bilinguals in each of their two languages could be one factor that affects language processing. The proficiency of bilinguals can be divided into different levels. Proficiency is also discussed when the bilingual acquired the second language, either as an adolescent or as an adult. Kroll and Stewart (1994) constructed the Revised Hierarchical Model (RHM) in order to give an indication on how the process of becoming bilingual occurs. Whilst the Hierarchical Model describes how proficiency is developed, bilingual benefits imply the advantages the bilingual obtains. Sampaio and Konopka (2013) study both the monolingual and the bilingual memory. The study examines how memory differs between monolinguals and bilinguals by the use of sentence memory and surface form. The bilingual memory gives an indication on how two languages affect the bilingual. The following section the concept of lexical activation is language nonselective is discussed.

1.2.1. Lexical activation is nonlanguage selective

Research suggests that a bilingual's languages are active during speech processing. This is called non-selective language activation (Lagrou et al., 2013). The non-selectivity works on not only the word level but on the phonological, semantic and syntactic levels of the language production and comprehension. Many studies have used a picture naming task to test this in spoken word production (Costa et al., 2000). In the process of choosing the correct word for an object, there is a cognitive process that needs to happen. Firstly, the object needs to be identified, secondly, the meaning needs to be understood, and thirdly, the meaning is placed upon an appropriate word with its specifically phonological associations to that word. By having both languages active, the bilingual process cognate words differently than non-cognate words.

1.2.2. What are cognates?

According to Sunderman and Schwartz (2008) cognate words share meaning and form in both languages, which speeds up the retrieval process. This is how Sunderman and Schwartz (2008) describes how language non-selective lexical access speeds up the retrieval process of cognates. By the measures mentioned above, cognates should be easier to access than non-cognates. The retrieval process is increased for cognates because of the similarities of cognate words, e.g., *klokke/clock*, and the bilingual can use the L1 and the L2 in order to access the word and its information faster. Noncognates, on the other hand, for example *speil/mirror* have no similarities. The bilingual will not be able to use both *mirror* and *speil* in order to retrieve the information in one language since the words are so different from each other. Cognates are, as mentioned earlier, words that share meaning and form across different languages. More specifically, cognates share aspects of pronunciation, spelling and meaning. An example of this is the word *hånd* in Norwegian which translates to *hand* in English. *Hånd/hand* share meaning and have similar aspects of sound and spelling. Sunderman and Schwartz (2008) mention two different concepts similar to cognates, such as false friends and partial cognates. Bilinguals can encounter L2 words which are very much like the form of an L1 word. However, not sharing the same meaning such as *mugg* in Norwegian meaning ‘mildew’ in English and not a *mug* for hot beverages. This concept is referred to as false friends. Another version of cognates is called partial cognates. These are words that share similar forms yet differ some in their meaning. For instance, *arm/arm* which in Norwegian and English is the section between the shoulder and the hand of a human being. Additionally, however, *arms* in English can also refer to weapons. In other terms, consequently, the difference between cognates and partial cognates is that partial cognates have a second meaning in L2. The study by Sunderman and Schwartz (2008) tested 21 Spanish-English bilinguals where they were asked to complete a visual lexical decision task. The task required the participants to determine if a word was an English word or a nonword. A nonword is a string of letters that follow English pronunciation and are orthographically legal to the English language. The study found that cognates were processed faster than noncognate control words, just as they initially hypothesized.

1.2.3. The Cognate Facilitation Effect

Costa et al. (2000) demonstrates a schematic representation of lexical access for cognate and noncognate words in Catalan-Spanish bilinguals. They present one for cognates (see Figure 1.1a.) and another for noncognates (see Figure 1.1b.). The models are for visual word recognition. Lexical access is explained with the use of nodes for the different levels of activation flow. It all starts with the concept, the idea of something. From that point, the semantic nodes for the corresponding meaning of the concept are activated which are represented with the thick lines in Figure 1.1a. and Figure 1.1b. These are the notes that directly correspond to the concept. Once the general meaning has been established, the next level that Costa et al. (2000) mention is the lexical nodes, which is the word level. This is where both languages of the bilingual become active. At the sub lexical level, the individual letters of the activated word are divided into different nodes, one node for each letter. For the sub lexical nodes that are represented by both languages, they become twice as active than those nodes that are only related to one of the two languages. This illustrates how a bilingual activates cognate words more efficiently since bilinguals get activation from two different semantically active languages.

The representation of lexical and sublexical access for noncognate (see Figure 1.1b.) words has the same levels and structures as mentioned above. At the top, the concept gets activated with the semantic nodes of the two languages the bilingual possesses. Thereafter, the word is present in both L1 and L2 each in their own lexical node. Since these are noncognates the words are quite different between the two languages. On the sub lexical level, where each note includes all the different letters presented by the word on the lexical level, there is only one node that is activated by both the first and the second language. All the other notes that are presented do only relate to one of the two languages. This shows that noncognate words have less activation across languages since the words are very different phonologically and lexically speaking. Cognate words, however, share aspects of spelling, meaning and pronunciation which facilitates activation. This leads us to the Bilingual Interactive Activation model which explains the bilingual language process.

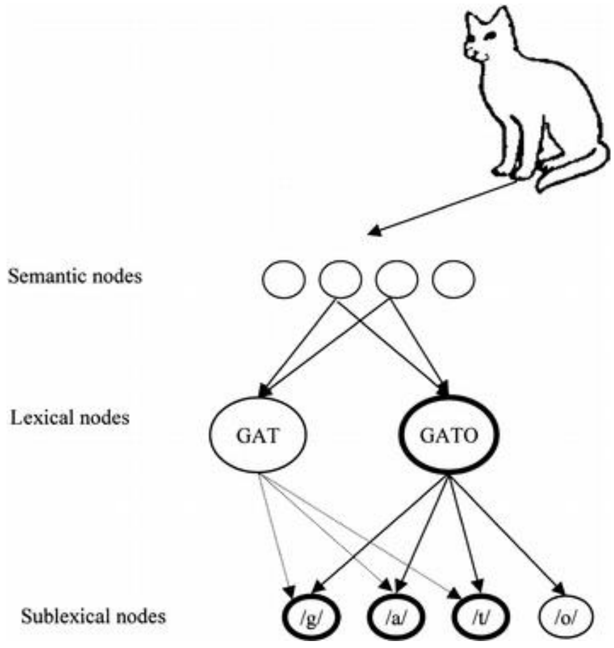


Figure 1.1a.: Model of the representation of lexical and sublexical access of cognates in Catalan-Spanish by Costa et al., (2000, p. 1285)

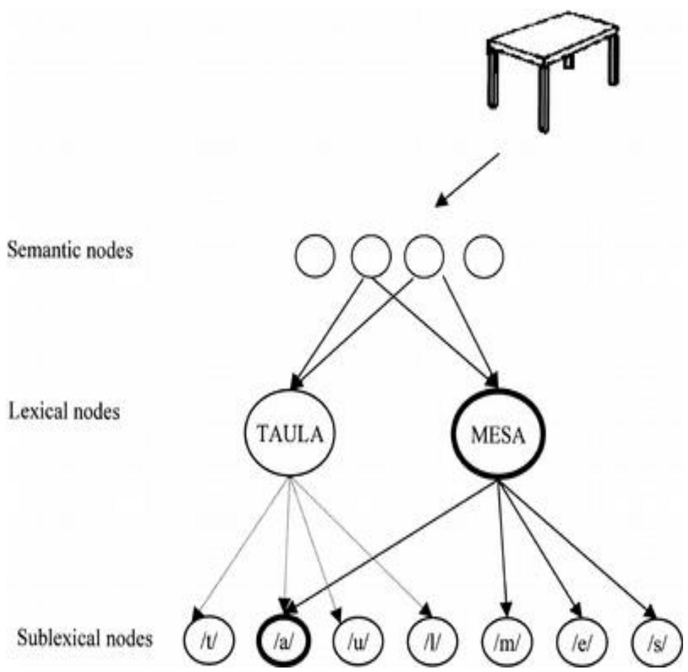


Figure 1.1b.: Model of the representation of lexical and sublexical access of noncognates in Catalan-Spanish by Costa et al. (2000, p. 1286)

1.2.4. The Bilingual Interactive Activation model

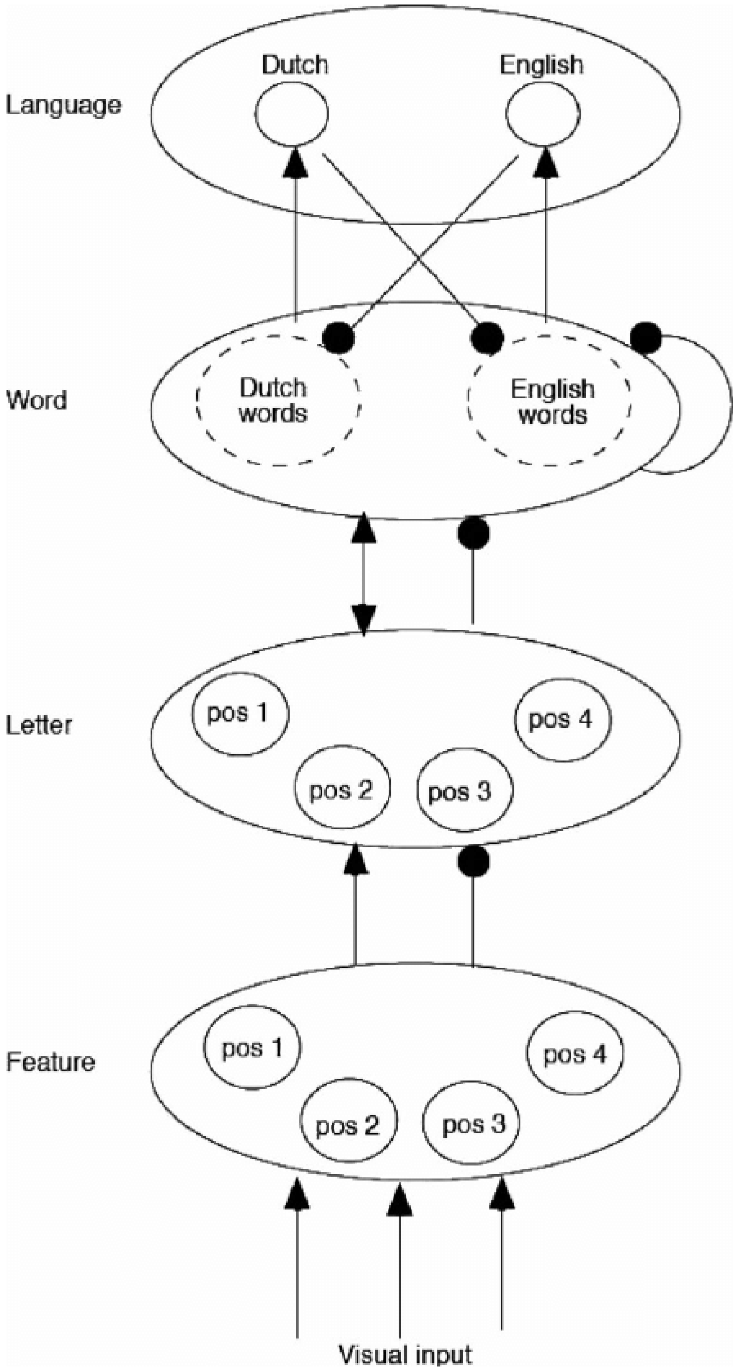


Figure 1.2: The BIA model by Dijkstra and van Heuven (2002, p. 177)

The Bilingual Interactive Activation model (Dijkstra & van Heuven, 2002) is for visual word recognition. The model starts with the visual input (see Figure 1.2.) where the person first finds the features of a word and links this to one of the languages the person knows. Both words are activated if the word shares features or letters, then the bilingual chooses the appropriate language. Whilst having input either written or orally, the input may change language mid-sentence and the bilingual can still follow because lexical access is language nonselective and both languages are therefore always active. Language change mid-sentence is called code switching. An example of that can be *han var helt dreamy* 'he was very dreamy' where the sentence is said in a Norwegian setting and 'dreamy' describes the person with an English word. From there, words and concepts not of interest for the specific input, are inhibited. At the last level, everything surrounding the relevant concept itself is activated, e.g., the concept pig, the fact that this can be bought in different pieces in the supermarket, and everything related to pigs happening on farm gets activated, as well as syntactic, phonological and semantic information. (Dijkstra & van Heuven, 2002)

The Bilingual Interactive Activation model investigates how language activation is nonselective (Dijkstra & van Heuven, 2002). The model describes the process of bilingual word recognition and starts with the neighbourhood features of the visual input. Inhibition is a part of the nonselective language activation process, where in each step more and more words are inhibited from being activated. At the word level the languages become more apparent, and the words are separated into L1 and L2 words. At the top level the languages get separated before the correct word in the correct language is activated.

1.2.5. Non language selective, comprehension and inhibition

Kroll et al. (2015) propose that inhibition takes a greater part in the comprehension and production process of a bilingual. Since lexical access is non language selective, all languages are always active in a receiver's bilingual brain. So, then when the bilingual is speaking or listening there is a competition process in accessing the correct language. Thereafter, the process of inhibition happens, where the bilingual must inhibit the irrelevant language. With both languages active at the same time, cognates might be easier to understand and retrieve the appropriate information for, since they are linked to both the active languages of the bilingual.

1.2.6. Inhibitory control model

Figure 1.3. depicts the inhibitory control model (Green, 1998) and how language selection during speech works (see Figure 1.3.). Green (1998) explains his model from the lexical semantic system where there is both direct input and output as well as links to more dense levels, such as the language task schemas, the conceptualizer, supervisory attentional system (SAS) and goal. Some of these can be linked to the cognate facilitation model by Costa et al. (2000) such as the goal of what the bilingual wants to understand or communicate with others. The same goes for conceptualizer since this may be the same as the concept or the mental lexicon where one collects the languages as well as all information about them and all other lexical information. The conceptualizer links directly to the bilingual lexical semantic system. There is also the superior system in place for attention such as monitoring the performance of schemas in correlation with task goals. Within the bilingual lexico-semantic system the innovation takes place which helps inhibit unrelated information or languages to the current situation. The next section will look at the Adaptive control Hypothesis which involves a meta-control level.

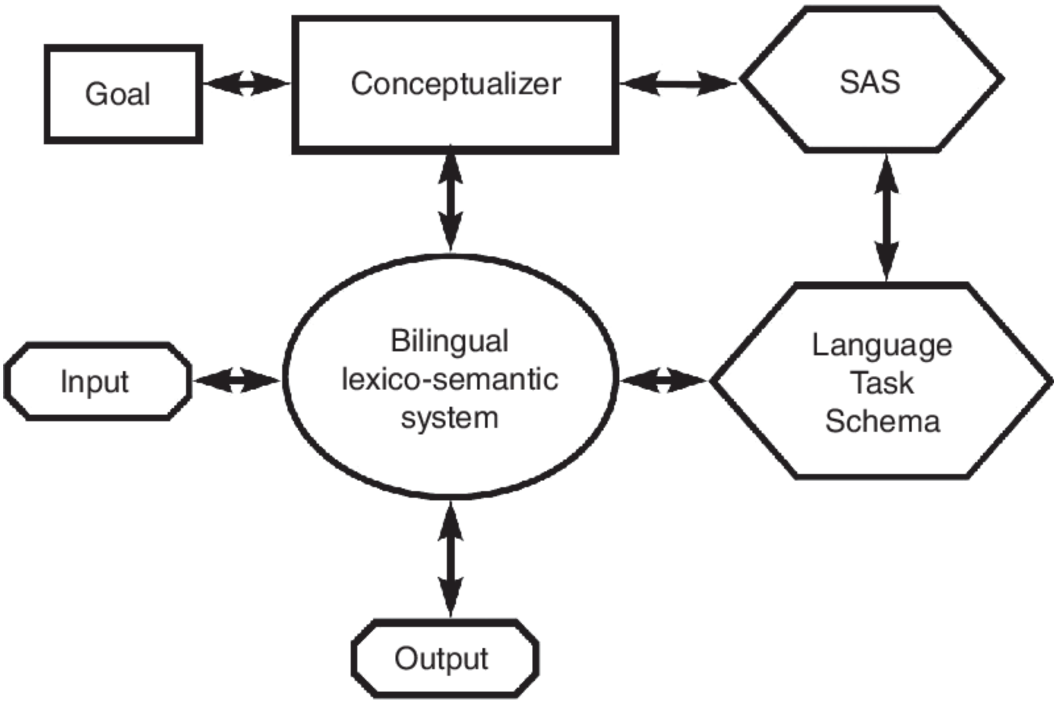


Figure 1.3: The inhibitory control model by Green (1998, p. 69)

1.2.7. Adaptive control hypothesis

Bilinguals need to choose which language they want to use for the sake of conveying speech in order to be understood in the specific setting. Choosing the language might be difficult for the bilingual and the choice is often decided by the context which the language is going to be used in e.g., what languages the listeners speak (Green & Abutalebi, 2013). Green and Abutalebi (2013) propose a model (see Figure 1.4.) to describe the control process that bilinguals use, called the adaptive control hypothesis. The process contains four steps. The first step named 'interactional context' is where the bilingual needs to choose the correct language for the specific situation. There are different situations that bilinguals can be in. Green and Abutalebi (2013) divide bilinguals into three groups of different settings. The first one being a single language context where bilinguals only use one of their languages and inhibits the other language to emerge. An example of this might be if an older person never learned a second language the bilingual communicating with them needs to strictly continuously use the older person's only language.

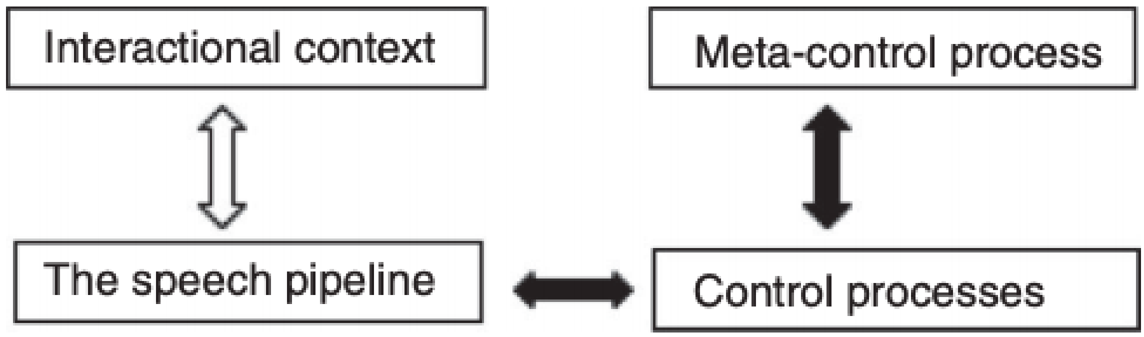
The second context for a bilingual is a dual-language context where both languages are used in the same setting (Green & Abutalebi, 2013). E.g., a group of people are talking and within the group there are different first languages. They all use either their first, second or third language to communicate. However, during the duration of the conversation different people exit and enter. Therefore, the lingua franca of the group changes in order for all people present to be understood and included in the conversation. The third context for bilinguals is, according to Green and Abutalebi (2013), a dense code switching context. These are situations where both L1 and L2 are used intermixed in speech. The language can change mid-utterance and words can be intermixed between the languages. An example of this could be *Har du shavet i dag* 'did you *shave* today'*?* where the English word *shave* is used and with the Norwegian present perfect tense suffix [-et] and the correct tonal pattern for a Norwegian verb. This is likely how most Norwegian-English bilinguals use their languages (Green & Abutalebi, 2013).

The three language contexts require different degrees of executive control, for example, the single-language context provides the bilingual with benefits as inhibition of the suppressed language, as well as goal maintenance, because the bilingual only needs to focus on speaking one language (Green & Abutalebi, 2013). A bilingual in a dual-language context has the same benefits as bilinguals in a single-language context. Other benefits included by a dual-language context can be salient cue detection meaning that they have to focus on a new person entering the conversation. The bilingual has to suppress the languages not spoken at the time, and disengage from the task they are engaged in, in order to produce a sentence in another language. This is because the new person entering the group does not know what has been said earlier in the conversation. Therefore, the bilingual has to adjust and remember what information the new person might need in order to follow the track of the conversation. This is called task disagreement. The bilinguals have to re-engage the new language process, also called task engagement. The third context benefits only by opportunistic planning and does not develop the two other contexts provided. Opportunistic planning is making use of the structures that occur when the bilingual needs them. The adaptive control hypothesis helps explain how bilinguals adapt to the situations that they are exposed to. It is the context of interaction that decides the adaptive response for bilingual speakers.

The second part of the adaptive control hypothesis by Green and Abutalebi (2013) is the speech pipeline. The process of speech can, according to the hypothesis, be divided into three sections. The first section being a generation of a message that the bilingual speaker wants to convey. As a part of the generation the bilingual speaker needs to attend to the syntactic parts of a sentence, e.g., an agent, an object and an action in order to make a complete sentence. Also included at this stage is time, e.g., if the message happened in the past, the speaker needs to use the past tense. The focus of the sentence must also be addressed, e.g., what does the speaker want their listener to focus on and place the intonation accordingly. Lastly, the speaker needs to consider the mood of the sentence, if it should be a statement or a question for the specific sentence. The second stage of the speech pipeline process is the grammatical encoding as a part of the language system. In this section the speaker needs to select the best words for the specific message the speaker wants to convey. The words must also have some syntactic structure that places the words in a correct order. The third and final stage is phonological encoding. This is where the phonetics of the chosen words are accessed. This process is the same for both monolinguals and bilinguals. However, bilinguals also need to choose the correct language which can happen at different stages depending on which research is being followed. Therefore, for bilinguals, all the processes above can help make the bilingual speech process more challenging.

The third part of the adaptive control hypothesis is the control process. This is where the process of controlling the language representations in working memory takes place to make sure that the goal of communication is reached. The control processes can have insight into both conversational, dialog tasks and tasks demanding specific control, such as for dense code switchers, where the freedom to use either language contexts to the fluent performance. If the bilinguals have to limit themselves to only one language, they might not seem as fluent. Single-language and dual-language contexts have a better fluency of one language when bilinguals only use one of their languages, since they are used to only applying one language to communicate with at a time. Green and Abutalebi (2013) found that bilinguals have a better proficiency in inhibition tasks when they are more used to a dual-language context, than both single-language and dense code-switching contexts. This is linked to all the demands the dual-language bilingual need to control in such situations. The control demands more of the bilingual than what a single-language context demands and therefore the benefits are increased as well.

The fourth and final step to the adaptive control hypothesis in the metacontrol processes sets the framework of the mentioned control processes. The framework on this level re-adjusts according to changes in a skill. An example of this can be playing a card game and the individual missed an opportunity to win, then the meta-control processes will adjust itself and remember this and the next time the individual is subjected to a similar situation the individual might remember how to win before it is too late. Moving from how language processes work, the following section will look at bilingual proficiency.



Architecture of the adaptive control hypothesis. Filled arrows depict internal processes of control.

Figure 1.4: The adaptive control hypothesis by Green and Abutalebi (2013, p. 517)

1.2.8. Proficiency

The level of activation of a bilingual's languages and their ability to select or switch between them have been linked to aspects of their bilingual profile such as language use and language proficiency (Kroll & Stewart, 1994; Lagrou et al., 2013). Bilinguals are different in many ways. When it comes to bilingual proficiency different terms have been used to differentiate them, e.g., early and late bilinguals, and high and low proficient bilinguals. Looking into how the terms early and late bilinguals are used, are often determined by when the L2 was acquired. Early bilinguals relate to preteens while late bilinguals are usually young adults. The age of acquisition has been under research and some (Yow & Li, 2015) say that before a certain age the acquisition might affect the bilingual proficiency. Expanding on high and low proficient bilinguals, researchers such as Dufour and Kroll (1995) have used language tests to determine proficiency, and divide bilinguals into groups of low and high proficiency. There is a sliding scale, however, in order to differentiate when doing studies, bilinguals have been divided into high proficient bilinguals and low proficient bilinguals. More individual differences between bilinguals can play a role. As will also be further discussed in the Norwegian-English bilinguals in Norway section, environmental factors may contribute to the L2 proficiency. Some of the factors might be social media, tv, gaming and music and the age when they start learning L2 in school and much more. However, socio-economic status may also have an impact, since how the parents and other close parenting figures view the skill of knowing languages might impact the younger generations and their interest in having a good L2 proficiency.

1.2.8.1. Revised Hierarchical Model

A key variable that has been investigated is the proficiency of the L2. One of the key models suggests that proficiency has a very important effect on language representations and processing. A model presented by Dufour and Kroll (1995) called Revised Hierarchical Model (RHM) talks about how bilingual memory works (see Figure 1.5.).

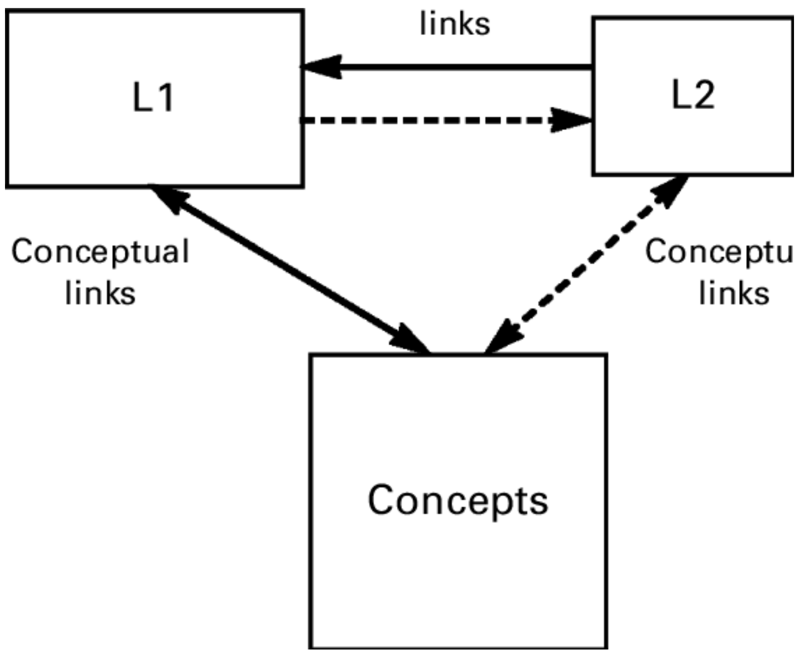


Figure 1.5: Revised Hierarchical Model by Kroll and Stewart (1994, p. 158)

The process of becoming a bilingual starts in early childhood according to the RHM. Children understand first the concepts of a certain thing, for example the concept of a dog. This is linked to the first language, and the concept there is a strong bond, since the first language is the way the child communicates with others around the concept of a dog, for a longer period of time. As the child grows and they learn a second language, there is the translation between L1 and the second language that grows stronger, while there is no immediate link between the concept itself and the L2. This link only starts once the bilingual reaches a fairly high level of proficiency in their second language. Then a link between the concepts and the second language is formed. As for the first and the second language, there might be a stronger link from L2 to L1 then the other way around. This is according to RHM, the second language was learned through the first language. Once the second language is in use it is often directly related to the first language. While when using the first language the link is not as strong to the second, since they already have strong communicative skills in their first and most dominant language. This is how Kroll and Stewart (1994) represent bilingual's mental lexicon and is relevant for the present thesis because this is a suggestion on the participants process of becoming bilingual. Once the L2 is strong enough there will be a link between the second language and the concept. If the second language becomes the most dominant language which can happen to some. E.g., if a bilingual move to a country where their second language is spoken, over time the dominant language changes and the bilingual who has moved start using their second language, replacing the first language.

Proficiency can therefore influence the speed of access to lexical semantics. This is the focus of this study which investigates how quickly and effectively people can process words and how that affects their memory of a scene. We will look at both self-rated proficiency and tests of lexical proficiency. The thesis also uses cognates and noncognates in order to manipulate the ease of lexical access for the bilingual. In relation to eye movements proficiency will be shown as the participants may take longer to reflect from the time they heard something to the time they look at the correct object. The next section will focus on what kind of advantages bilinguals can obtain from knowing two languages.

1.2.9. Bilingual benefits

The advantages of being a bilingual person might extend beyond the linguistic field. By knowing two languages there are also several possible non-cognitive benefits. For example, by having a second language one can have a better understanding of other cultures, giving easier access to the world outside of the first language. The most familiar one is traveling and working abroad. There are also political and economic advantages since you can reflect upon the political aspects in one's home country and compare that to other countries. This also applies to experiences in other countries while working there.

Other claimed benefits of being a bilingual person are more related to executive function. This is more on a metacontrol level where control of mental functions such as the ability to focus, plan and execute goals. This happens in the prefrontal cortex and is the control of the cognitive brain function (Kroll, 2008). Bilinguals have been shown to have better self-control and keep their attention focused on a specific task for longer as well as overlook distractions surrounding them (Bialystok, 1999; Bialystok et al., 2004). The ability of shifting between tasks and still concentrating fully on the task is also a cognitive advantage for bilinguals. (Bialystok, 2011). Bilinguals also have the benefits of having an expanded working memory, i.e., they can store more information for longer than monolinguals do (Blom et al., 2014).

1.2.10. Bilingual memory

There is evidence that bilinguals show some memory benefits (Sampaio & Konopka, 2013). Memory consists of both long term and short term memory. Short term memory includes the concept of working memory which has several elements. Among these elements are the central executive and phonological loop. They play an important role in language processing. The central executive aids semantic integration and comprehension. The phonological loop has a function in phonological processes in language. (Baddely & Hitch, 1974). The phonological loop is important for vocabulary acquisition to both L1 and L2. Different studies have shown that there are some consequences of damage to the phonological loop, however, few language processing consequences (Allport, 1984; Martin & Saffran, 1990, 1997; Saffran, 1990; Vallar & Baddeley, 1984). The phonological loop mostly aids the bilingual in learning new words (Baddeley et al., 1998). The acquisition of L2 vocabulary has shown to be learned with the use of working memory (Papagno et al., 1991). Phonological memory is important, since it is used to construct permanent representations. In other words, what brings short term memory into long term memory is the construct of the evolving permanent concept, starting with the phonological loop.

The study by Sampaio and Konopka (2013) looked at memory of bilingual's L2. Normally, people are not able to retell word for word what they have just heard or read, but they are quite successful at restating the gist of what they have heard or read. The authors of the study hypothesised that L2 speakers will be more likely to recreate lexical items that are not preferred by the native speakers. Meaning the bilinguals might use the word for word method while monolinguals might recall the gist and not the full word for word information. L1 speakers are therefore more likely to recall high frequent lexical items. The strategy used was testing memory on English sentence pairs, where the sentences have the same meaning but different surface forms. The study was conducted with the use of 78 participants in total. 26 of the participants were English monolinguals living in the US, 26 bilinguals, also living in the US but having English as their second language, and 26 bilinguals living in the Netherlands where the L1 is the spoken language most used. The participants listened to 24 sentence pairs where each sentence included a target word that had two very close synonyms. The sentences were divided into two 12 items lists. The same random order was given to all 78 participants. The participants received booklets containing cues in the same order as they were presented in, in the study. The participants were instructed to write down something after each sentence they heard, even if it was a guess.

To measure the phonological loop capacity of the L2 speakers living in L1, they completed a nonword repetition task. The measure was included to see if the performance of the task could be predicted by the test of the phonological loop capacity. Since L2 speakers need to be more attentive when listening in their second language they recover more of the precise word for word information. Sampaio and Konopka (2013) confirmed that the phonological loop can predict the ability of language learning. The prediction by the authors was less gist errors in memory for sentences in L2 compared to L1. This was because of a more substantial lexical process. The performance of L2 speakers on nonpreferred sentences can correspond to a greater phonological loop capacity than of an L1 speaker.

The conclusion drawn by Sampaio and Konopka (2013) was that speakers of their non-native language may outperform speakers of their native language in sentence memory regarding the concept’s surface form. This study shows that L2 speakers use their executive function and L2 cognition in other ways than what an L1 speaker does in order to remember what has been said. This links the following section discussing the disfluency of bilinguals compared to monolinguals.

1.2.11. Disfluency affects

Disfluencies are hesitations used in oral speech. People use hesitations for different reasons, e.g., to signal that they have not finished their sentence and they need some time to reflect upon what they are about to say next. Examples of hesitation might be *ah, eh, mm, um.*

Fox Tree (1995) considers 6 /1000 words to be affected by disfluencies in spoken conversation. Disfluencies often occur before low frequency and unpredictable words (Beattie & Butterworth, 1979; Levelt, 1983; Schnadt & Corley, 2006). Brennan and Williams (1995) found that there are some long-term effects of disfluency such as listeners being more aware of the uncertainty shown with the use of disfluency by the speaker on a metacognitive level. This means that listeners understand and respect these signals of uncertainty a speaker portrays when using disfluencies in speech production. Short term effects were described as participants being faster at word monitoring tasks (Fox Tree, 2001) where hesitation helped listeners focus more specifically on the subsequent word (Corley, MacGregor, & Donaldson, 2007). The study by Corley et al. (2007) was conducted with 12 participants. Eighty sentence pairs were used. Each pair consists of a disfluent version and a fluent version of a sentence. The study was done in the participants' first language, which was English. The participants listened to recordings of the 80 sentence pairs for 2 x 15 minutes, with a break of a few minutes in between. The participants were told to focus on listening and understanding the sentences presented to them. The results of the study by Corley et al. (2007) showed that participants were affected by disfluencies. The participants showed more difficulty recognising target words with a fluent sentence compared to words being preceded by a disfluency. Participants recognised these target words easier. The conclusion drawn by the authors was therefore that disfluencies gave both short term and long-term consequences for the listeners. The consequences were because the participants recognized word proceeding disfluencies easier than those without, even after some time had passed. The present study will examine how disfluencies affect bilinguals and if they are affected in the same way monolinguals are.

1.2.12. Norwegian-English bilinguals in Norway

Norwegian and English have many similarities between them (Harbert, 2007; Tabouret-Keller, 2013) because they originate from the same ancestor, called the Proto-Germanic language ancestor. The ancestry splits into different branches of languages where North Germanic and West Germanic separates Norwegian and English. Since they originate from the same language family, Proto-Germanic languages, they share some similarities such as semantic structure, word structure and phonological traits. In linguistics, the words that have shared ancestry in both languages are referred to as cognates, e.g., *hand, hånd* in English and Norwegian, respectively. In psycholinguistics, all words that share meaning and phonological, orthographic similarity are referred to as cognates which includes loanwords found in both languages, e.g., piano, pizza. This study uses the term cognates as it is used in psycholinguistics.

The younger generations in Norway are considered to have a higher L2 proficiency level than previous generations. In Norway, English is taught from the age of 6. However, children are often exposed to English before that from different media platforms such as audio entertainment, visual entertainment or in contact with a multilingual society. Norway does not have any restrictions on how one should or should not speak. Therefore, Norwegians tend to use English words and phrases in oral speech. Children growing up in Norway today are often exposed to English every day through music, gaming, movies, TV shows and a lot more. In Norway, films are usually not dubbed into Norwegian, instead Norwegian subtitles are used. This gives young children an earlier start of their L2 acquisition then specifically six years old when they officially start with English at school. With Norway's multilingual society it has become natural for young adults and adolescents to use code switching. That is to say switching between languages mid-sentence or using English words mixed in within a Norwegian sentence. All exposure to English, both through informal learning, such as Internet and visual or auditory media, and formal learning through school, Norwegian-English bilinguals might have an increased proficiency of their second language. English has a phonemically based language script. This means that the alphabetic language English is a system of letters and each of those letters serve as a unit of sound (Tao et al., 2011). The same goes for Norwegian. In order to understand the overlap of both English and Norwegian, there might be the need to look closer on cognates and how the languages overlap in this sense.

1.2.13. Cognate retrieval

Some researchers agree that cognates have shared lexical or partly shared lexical access for the first and second language (Sánchez-Casas & García-Albea, 2005). Others claim that cognates have separate representations for the different languages in the same way that all the rest of the lexicon. However, for cognates they become activated at the same time for both languages and give, therefore, a more powerful activation in their recognition and use (Costa, Santesteban, & Caño, 2005). Nevertheless, cognates have been found to be easier to retrieve then non cognates no matter if they have shared representations or through separate representations because cognates are then stronger activated together (Runnqvist et al., 2013). More accurately Strijkers, Costa and Thierry (2010) indicate that whether, on one hand, there is co-activation for lexical nodes by shared cognate representation while non cognates have different lexical nodes and thus does not get the same activation levels as cognates since they overlap. On the other hand, if the activation is from final logical feedback, there is still more activation for cognates than for noncognates (Runnqvist et al., 2013). The following section will look at eye tracking and how it is used as an aid in discovering how participants might be affected by spoken language comprehension. Not only did the study use cognates in order to even the proficiency difference between having English as a first and a second language, but the study also used eye tracking in order to track how they were influenced by the recordings versus what they saw.

1.2.14. Eye tracking

Using computer software, the participants' eyes can be tracked during the study. By doing so one can view how the participants look at the various objects at different times, which then can help discover how memory or other factors are affected. In other words, where the eye is considered a good measure on what one is attending to.

By the use of eye tracking (Tanenhaus et al, 1995) looked at spoken language comprehension of visual information. Since the mental process is quite rapid, eye movements were recorded while participants had instructions to follow. The eye tracker provided incite to the mental process of spoken language comprehension. The study tracked the participants' eye movements on a millisecond timescale while the participants performed specific tasks with their eyes. The results of the study show that eye tracking can help observing the rapid mental processes which are a part of the spoken language comprehension under everyday conditions by the use of specific tasks. The study shows that eye tracking is a good method to use when it comes to spoken language comprehension.

In the present study we used eye tracking in order to substantiate the results and have a clearer understanding of what happens during the study. In the past, eye tracking has mostly been used on production skills as mentioned above and therefore this study looks at comprehension in order to get a better understanding of those skills as well. Eye tracking was used in the present study in order to track the gaze duration of the participants. This method helped us follow the eye movement and for how long the participants looked at each object and if that time differed between the different variables this study used. There is evidence that the use of eye tracking is a good measure. Since the present study is based upon previous work by Konopka (2019) and their study used eye tracking. Therefore, a valid reason is using the same means here and giving this study the same structure and the same protocol in order to remove variables that might reshape the study.

There is a distinct link between eye movements and speech comprehension, as demonstrated in studies above. The link is that the person listening starts looking for the object at the same time as the speaker starts describing something. An example of this might be two people on a bridge looking over a skyline of a city and one of them starts describing a specific building. The first section of what the speaker conveys is that it is a tall building then the listener gazes only towards the tallest buildings on the horizon. Then the speaker says *it is the building with all the glass* and the listener can then move their eyes only to the specific building that the speaker is describing. However, the elimination process of the listener started at the same time as the speaker conveyed any kind of eliminating description.

1.3. The present study

The present study was based on a study by Konopka (2019). In Konopka's study she tested bilinguals and monolinguals to understand how they were affected by disfluencies. The study resulted in monolinguals being affected by disfluencies to a greater extent than bilinguals. The results established that the bilinguals had a lower test score than the monolinguals. The present study will therefore examine methods where we can assist the bilinguals achieve similar results as the monolinguals, when exposed to disfluencies, accomplished in Konopka's study.

The study consisted of three sections. The first section included the pre-tests. The pre-tests consisted of a Norwegian vocabulary test, which was followed by an English vocabulary test. Thereafter, the participants completed an auditory working memory test. The final pre-test was LexTALE, a vocabulary test. The second section ascertained the participant's language profile. This was done using a questionnaire which is an adapted version of the LEAP-Q (Marian et. al 2007). The third and last section consisted of the memory experiment.

The LEAP-Q and the vocabulary tests overlapped in the sense that they both tried to give a linguistic background by both a self-test and a scientific test. These tests combined gave a broader understanding of the participants that were being used for the memory test. The memory test might give results that are inconclusive or are difficult to comprehend because of the differences in the participants. Therefore, understanding the linguistic background of the participants might benefit the study in order to remove potential defects or abnormalities that may occur. Thus, a possible prediction might give us a certain intel on the participants, their linguistic background and regarding overall differences between them. This selection of Norwegian-English bilinguals and how they have acquired and used their two dominant languages in cooperation, can affect the test results.

The general memory, not specifically linked to language, was tested in this study in order to see the potential impact it might have on memory linked to language. Bilinguals have been shown to use parts of the brain which were not necessarily used for language since the bilingual brain works differently than a monolingual brain (Blom et al., 2014). The auditory working memory test was what we used in order to test the bilingual's general memory unrelated to their languages. The auditory working memory test was used in order to see if the participants general memory may in some way influence the linguistic memory. Thereafter, we tested the participants' linguistic memory to see if they behave similarly to the monolinguals in Konopka's study.

1.3.1. Predictions

As mentioned, the present study builds upon a study by Konopka (2019). She examined the effects of disfluencies in monolingual and bilingual visual memory. The study demonstrated that monolinguals are affected by the disfluencies. The monolinguals were shown to have higher scores if the target word was preceded by a disfluency than when the target word was alone. In the same study Konopka found that bilinguals who did the exact same experiment were unaffected by the disfluencies. The bilinguals had a higher test score for both with and without disfluencies but not as high as for monolinguals with disfluencies.

This leads to the present study where the primary aim is to consider why the bilinguals were not affected by the disfluencies in the same way when it comes to memory of visual scenes. We focus on the following research question:

- Why do bilinguals show no effects of disfluency on memory for visual scenes in the same way that monolinguals do?

Based on Konopka's study (2019) one might predict the following. The present study was based upon one meta-prediction and two sub-predictions. Will proficiency predict whether the second language (L2) speaker influences how they respond to the disfluencies. In other words, do L2 speakers of high proficiency respond like monolinguals as they did in Konopka's study. The prediction, therefore, was to look at the effects of second language proficiency in response to disfluency. This was investigated with sub-prediction. First, do more proficient bilinguals behave more similarly to monolinguals? In order to test this, the present study includes proficiency tests such as lexical tests and general working memory tests as well as a bilingual profile questionnaire. Second, do bilinguals behave more similarly to monolinguals when L2 processing is easier? This is examined with the use of cognate and noncognate manipulation.

The method of the current study is described below. The method section has the same order as the present experiment was conducted in. The study started with a questionnaire followed by vocabulary pre-tests and then the tests for the experiment itself which were conducted in a laboratory environment.

Table 1.1. Giving a general overview of the different tests and the order the tests were done in, as well as the time each task took to compete for the participants.

Study Description (order of execution)	**Time** (in min)
1. Pre-Tests	**Total time: 25 min**
Norwegian Vocabulary; Synonyms Then Antonyms	
English Vocabulary: Synonyms Then Antonyms	
Auditory Working Memory Test	
LexTALE	
2. Language Profile	**Total time: 15-45 min**
Questionnaire LEAP-Q	
3. Memory Experiment	**Total time: 55-65 min**
Study Phase	35
Maths	10
Test Phase	10-20

2. Method section

2.1. Participants

Thirty-three participants were tested (19 females and 14 males). The participants' age was between 18 and 32 with a mean of 24 years and 6 months. All participants were native Norwegian speakers with English as their second language (L2). The participants had standardised schooling in Norway. This means that they started with L2 English at the age of 6 and had English classes until they were at least 16 or 17 years old. Therefore, all of our participants had a minimum of 10 years of English schooling. The participants were university students and people who worked at the university or other places in Kristiansand. The participants in this experiment were required to have normal or corrected to normal vision for the eye-tracking part of the study. Lenses or glasses were allowed to correct the vision since the eye-tracking software could be adjusted to accommodate this. The participants also had normal hearing and reported no language impairments. The participants were selected randomly from the common room of the university or were known to the experimenters.

2.2. Apparatus for the questionnaire and the language tests

The language tasks were run on a Lenovo ThinkPad T440 using experiment running software called *Open Sesame*. For the auditory test, participants wore Sennheiser Momentum M2 AEBT headphones which was wired to the computer. In order to set up the programs in advance a Logitech B100 USB mouse was used.

2.3. Pre-tests and questionnaire

2.3.1. Pre-tests

In addition to the experiments and questionnaire, participants were also tested on their language skills. The participants completed a number of tests including a vocabulary test in Norwegian and in English, followed by a listening test of auditory working memory and finally the LexTALE vocabulary test of L2 English (Lemhöfer and Broersma, 2011). These are described in detail below.

2.3.1.1. Vocabulary test

The Norwegian and English vocabulary tests were designed to test vocabulary depth. Both the English and the Norwegian vocabulary tests comprise two sections; in the first section the participants had to choose the synonym of a target word and in the second section the participants had to choose the antonym of a target word from a list.

2.3.1.1.1. Materials

The vocabulary tests in both languages consisted of 20 noncognate low frequency target words for the synonym section and 20 noncognate low frequency target words for the antonym section (see Appendix C for the full list). The participants were exposed to the target word along with four possible answers, where one of them was the correct answer and a fifth answer 'I do not know'. The other answers were either similar in meaning to the target word, its antonym or similar in form to the correct answer. For instance, with the target word 'vocation' the possible responses *were occupation, holiday, vocabulary, pronunciation* and *I do not know.*

2.3.1.1.2. Design and Procedure

The participants were tested individually in a quiet room. The participants were asked to sit in front of a computer with the *open sesame* program already set up. Then they were asked to read the instructions (see Appendix A and B) on the screen. Precedingly, the experimenter went through the instructions with the participants, in order to eliminate misinterpretations that could occur. The participants always started with the synonym task first. The task was structured with a word appearing on the screen, with five options underneath choosing which word was the most similar in meaning (for the synonyms) or had the opposite meaning (for the antonyms). The stimuli were presented with a 24-pixel black text on a white background. The participants had four options of different words and a fifth option they could press stating 'I do not know'. All participants were told not to guess and thus choose the fifth option. All participants had a different randomisation within the subset of the task. The participants used the keys on the keyboard 1,2,3,4 and 5 in order to give their response. The task lasted about 5 minutes and when the participants finished the Norwegian test, they did exactly the same for English synonyms and antonyms. their responses were recorded, and their percentage accuracy calculated. The tasks took 5 minutes per language to complete.

2.3.1.2. Auditory working memory test

The third pre-test was a listening task. The participants were exposed to a sound recording where they had to remember the order in which they heard the recorded sounds in. This task involved recognising sound patterns in oral speech. The test was conducted with the use of headphones and two keys on the keyboard for responding either 'yes' if the recordings were in the same order or 'no' if the recordings were in a different order.

2.3.1.2.1.Materials

The stimuli consisted of sequences of nonsense syllables that were between 5 and 7 syllables in length. The first sequence of nonsense syllables was the target sequence, while the second sequence was either the same or differed in order of the syllables. The test sequence of syllables could have changes on any two syllables except the first and last. The stimuli also included fillers that did include changes on the first and last syllables. In total there were 144 nonsense syllables constructed from a variety of vowels and both single consonants and consonant clusters were used in onset and offset positions. All syllables were made so they were appropriate for English. All sequences of syllables had as few consonant repetitions as possible and the sequences were made so the syllables with a sequence all had dissimilar vowels.

2.3.1.2.2. Design and Procedure

For each trial the participants heard two sequences of nonsense syllables varying between 5 and 7 syllables in length. The participants listened to two utterances of syllables with nonwords and had to choose whether the utterances were the same or if the utterances were in a different order. With this starting point, two lists were constructed, with half of the stimuli on each, and half of the participants were assigned to their part. Each list had equal numbers of same and different trials. The lists were shown pseudorandomised, meaning mathematical algorithms were used to completely computer-generate the order. We then controlled the lists to make sure there were no more than three consecutive same or different trials and no consecutive trials with syllables switching in the same block.

The screen was white while the participants listened to two sequences of utterances and their task was to decide if the sequences were in the same order or if the utterances were in a different order. The utterances consist of nonsense syllables. After the participants had heard each set of utterances, they were asked to respond by pressing 1 or 2, where 1 was 'same' and 2 was 'different' in terms of if the utterances were the same one the participants heard over again or if the utterances were presented in a different order.

The participants read the instructions on the screen then the instructions were paraphrased by the experimenter as well and ensure the participants have understood the task. The same software was used for the language tasks only now participants listened to the utterances with headphones on. Once the participants had heard the pair of syllable sequences. The participants were instructed to press 1 for same and 2 for different. The participants decided if the utterance pairs were the same repeated twice or if the syllables in the utterance were different. This task took approximately 7 minutes to complete, and the test continued as soon as the participants locked in their answer and the next pair of utterances were played on the headphones. The two utterances were separated by a small pause of 750 ms.

2.3.1.3. LexTALE

The following test provided intel on the participants English vocabulary. LexTALE is an acronym for *Lexical Test for Advanced Learners of English* created by Lemhöfer and Broersma (2012). This test was completed after the working memory test.

2.3.1.3.1. Materials

The test consisted of 60 items, 40 words and 20 nonwords (see full list in Appendix D). The nonwords were constructed to look like real words, meaning the words used were orthographically legal and pronounceable possible words that had no meaning. The nonwords were made by altering real words by for example changing the number of letters (e.g., prom to proom). Another way was by recombining existing morphemes (e.g., rebondicate). None of the nonwords were existing words in Norwegian. The items were chosen from an unpublished vocabulary test (Meara, 1996). Lemhöfer and Broersma (2012), who invented LexTALE, included more words than nonwords because the words included could be interpreted as difficult. Challenging in the sense that the words were not used much in daily speech and were therefore more difficult to recognise. Hence, many of the words could become subjectively nonwords. Therefore, to equalise the proportions subjectively a higher number of words than nonwords were included. The items used were between 4 and 12 letters long with a mean of 7,3 letters long. Between 1 and 26 occurrences per million were the mean frequency of the 40 words. All lexical word classes were represented. With 15 nouns, 12 adjectives, 1 verb, 2 verb participles, 2 adjectives and 8 trans syntactic words (words that fit in more than one-word class e.g., *dispatch* is both a noun and a verb).

2.3.1.3.2. Design and procedure

The participants saw the words in black letters on a white screen, with the target word on the top of the screen in a large font. Underneath the target word, there was a number with corresponding options, 'yes' or 'no' to a key on the keyboard (1 for 'yes' and 2 for 'no'). Like the other tasks, the test started with the participants reading the instructions on the screen. Before proceeding to the test, the experimenter going through the instructions with the participants and answered any potential questions. The participants started the test and responded to whether the words that appeared on the screen were real or fake British English words. This task was only done in English and not Norwegian. This task was not timed.

2.3.1.4. General procedure for language tests

There were two experimenters, therefore a protocol was designed to ensure similar treatment of participants. The protocol was made by the experimenters who went through the tests from a participant's perspective. Meaning, reviewing the information for each task and adding any clarifications to the protocol. The protocol was made in a separate document which was printed and brought with the experimenters for the tests. The tests and the LEAP-Q were developed and adapted in the Experimental Linguistic Laboratory at the University of Agder.

The tests and the LEAP-Q questionnaire were not speed based. Therefore, participants were allowed to take the time they needed to answer as correctly as possible. The LEAP-Q took between 15-45 minutes and the tests took between 15-30 minutes to complete depending on the participants.

The vocabulary tests, the auditory memory task, the LexTALE and the adapted LEAP-Q were all done in one setting. All except the LEAP-Q used the *Open Sesame,* while LEAP-Q was on an excel sheet. The location varied, from the lab, where the memory test took place, to different group study rooms at the university grounds.

2.3.2. Bilingual Profile Questionnaire

This questionnaire was an adapted version of the LEAP-Q (Marian, Blumenfeld, & Kaushanskaya, 2007), (see Appendix F). The questionnaire was divided into four categories: *screening*, *language background*, *Norwegian-English proficiency.* A final section on *dialect and accent* was included for another study and will not be discussed further.

2.3.2.1. Design

This adapted version of the LEAP-Q changed the original by reorganising the questions from two sections into four sections. With the new sections many questions were added, specified or moved to different places than the original.

The first section was screening, this section started the same as the original with the first two questions. Thereafter, the adapted version added questions on whether the participants were a native speaker of Norwegian, if the participants spoke other languages at home and if they consider themselves a good speaker of English. Question 6, 7 and 8 (see Appendix E below), were originally one question which was made into three independent questions in the adapted version. Then follows the added questions of the participants hand dominance, country of birth and their current country of residence. The last two questions on this section where from the original LEAP-Q.

The second section, language background, starts with three questions from the original LEAP-Q. The first one asked the participants to list all known language in order of dominance. The second asked the same, only to list them in order of acquisition. The third question asked about the percentage of the time the participants were exposed to each language. The fourth question asked the participants to list the time then speaking each language with the response having to add up to 100%. The fifth question was the same as question four only relating to reading. Question six and seven where from the original LEAP-Q, while question eight and nine were additions. Question eight asked if the participants felt that they had to become less fluent in one of their languages and if so which one. Question nine asked which language the participants used in different settings such as simple maths, when dreaming and when talking to oneself.

Section three were about Norwegian and English proficiency. In this section, all questions were from the original LEAP-Q and only the order and layout were changed. The fourth and final section were not relevant for this study and is therefore not discussed further.

In the adapted LEAP-Q there were only two questions that was completely removed and not included. Of the two excluded questions, the first was the participants being asked if they had a date of immigration to the US and whether the participants had lived abroad with the specifications of dates and name of the country. The second excluded question regarded to read in different languages which amount of time in percent would the participants choose. This had the same setup as the third question in section two.

2.3.2.2. Procedure

The LEAP-Q was conducted after the language tests. The experimenter read the questions out loud to the participants, and the experimenter wrote down what the participants answered. Each question was done separately given additional information when needed from the protocol. The LEAP-Q protocol was put in place in advance by the two experimenters. Each section was gone through adding specific information for questions that could be hard to understand.

2.4. Memory test

Followed by the pre-tests and the questionnaire was the memory test. The memory test consisted of three parts, the first part was the study phase and the second a maths section and the third was the memory test. The first phase was the participants trying to remember as much as possible from the scenes presented with descriptive sound recording. The third and final section, the memory test was about the participants showing how much they remembered from the study phase after doing ten minutes of multiplication maths.

2.4.1. Apparatus

The experiment used two computers, one where the eye-tracking software was processing and another to run the experiment. Participants were tested in a sound attenuated booth sitting in front of an iiyama 24" g2530hsu-b1 monitor screen and an Intel NUC NUC8i7HNK Intel Core. The eye-tracking software SR Research Eye Link 1000 Plus version 5.10 was run on a Dell Latitude E7470 which was monitored by the experimenter. All data was recorded by the SR Research Eye Link DM-890 Desktop mount. There was also the use of Creative BS270 speakers for the study phase. The participants answered by the use of the keys on a Logitech k120 keyboard.

2.4.2. Study phase

The first section of the memory phase was the study phase. The study phase took the longest and were the most intense for the participants, since they had to stay still for 35 min and try to remember as much as possible from what was shown on each scene. This section goes into detail on what technology was used, what preparatory work had been done and a step-by-step process of how the study phase was done.

2.4.2.1. Materials

The materials needed consist of experimental words, experimental scenes, experimental sentences, experimental recordings and experimental fillers. The stimuli manipulated were cognate status and fluency. Table 2.1. demonstrates the four versions these manipulations create.

Table 2.1. Demonstrating the recordings of what was said. This is a scene of a large bedroom with its four different versions. In order to make eight, all of them were flipped in orientation of the picture.

Cognate	
Fluent	Disfluent
This is a large bedroom: there was a bed, a clock on the wall, a stool and a jumpsuit lying on the floor.	This is a large bedroom: there was a bed, a clock on the wall, *eh*, a stool and a jumpsuit lying on the floor.
Noncognate	
Fluent	Disfluent
This is a large bedroom: there was a bed, a mirror on the wall, rocker and trousers lying on the floor.	This is a large bedroom: there was a bed, a mirror on the wall, *eh*, a rocker and trousers lying on the floor.

2.4.2.1.1. Experimental words

The first step acquired in order to design the experiment, was finding appropriate words to use in the scenes. The experiment required 560 words in total. There were the between items which was cognates and noncognates, with 3 for each of the 80 scenes adding up to 240 cognates and 240 noncognate words. There was also the need for 80 additional words, one for each of the scenes to be used as a dual word (see Table 2.2.). This word was used as a lead in for all versions of the scene. The 80 scenes required three cognates and three noncognates. The words used were common nouns, more specifically generic names for objects that could fit into a scene, as shown in Table 2.2. In order for the experiment to be conducted properly, there were quite specific criteria for the words used.

The first criterion for choosing test words was frequency. This means how often a word is used in daily life. In other words, how well a specific word is known in general. Therefore, the frequency had to be even for the cognate and noncognate words throughout (see example in Table 2.2.). In order to find the frequency, two different programs were used, the Machugga and N-Watch. This helped compare and overlap when a word did not exist in one or the other database.

The second criterion was the number of phonemes and syllables a word could have. This had to be as close as possible both across cognate status but also in average. The third criterion were the cognates and noncognates themselves. The cognate had to be a word that shared a meaning and general appearance to the Norwegian equivalate e.g. *clock* (English) and *klokke* (Norwegian) (see more in Table 2.2.).

The fourth criterion was that the word had to match the scene. This means that if the scene was a kitchen, then a bathrobe would not match the scene as well as a coffee machine would. Fifth, the size of the object mattered. The cognate or noncognate object had to have roughly the same size. This was in order for them to replace each other in the corresponding scene. An example of this might be a mouse and a deer which are not the same size and can therefore not replace each other in a corresponding scene.

The final criterion was the word length. Having this match across cognates and noncognates was important so that the scenes were as close to identical as possible. The same goes for type of object. A good replacement for stool was rocker, since they were both objects that take the same amount of space, have the same function and can be the same size.

Table 2.2: Words used in a specific scene with their additional information.

Scene 4: bedroom2	Words for the scenes	Frequency	Frequency	Syllables	Phonemes (r)	**Dual word**
Cognates	clock	35.59	4.89	1	4	double bed
	stool	8.88	3.71	1	4	
	jumpsuit	0.001	2.58	2	7	
Non cognates	mirror	41.06	4.45	2	5	
	rocker	1.28	3.15	2	5	
	trousers	28.38	4.24	2	6	
Mean frequency	clock and mirror	-5.47				
	stool and rocker	7.6				
	jumpsuit and trousers	-28.379				

2.4.2.1.2. Experimental scenes

The scenes were adapted with the use of the photo editing software Photoshop. The software aided with the use of different layers the experimenters were able to have the scenes in the background and add the cognates and the noncognates to different layers on top. This verified the placement of the cognates and the noncognates to be precisely on top of each other. Pictures of the different cognates and noncognates object were from google pictures. Mostly chosen, were pictures with a white background since those kinds of pictures were easier to transfer into the scene. The objects were placed strategically in the photo, not only finding a logical place for them, but also having them placed on order from one side to another. This was to correspond the order with the recordings, since the scenes had mirrored versions as well (see Figure 2.2.). The pictures of objects used were preferred without writing on them in order to make producing the mirrored images easier. However, some of them had writing on them and had to be manually altered. The cognate and noncognate scenes were made simultaneously in order to make sure the object overlapped in the exact position across the cognates and the noncognates. Making sure that the shape, size and colour were the same across the cognate and noncognate scenes. In total there were 101 scenes for the participants to see through.

2.4.2.1.3. Experimental sentences and recordings

Recordings were made by a native English speaker with a mild Scottish accent. Sentences were recorded in Praat, and 500 ms were added in between each critical item in order for the times to be the same for each scene. There was added the appropriate hesitations in front of different words to the recorded sentences (such as *eh,* see Table 2.1.). The same hesitation was spliced into the same position in the sentences describing cognate and noncognate versions of a given scene, which contributed to having eight versions of a scene (see Table 2.2.).

The hesitations for the sentences we were testing them on was on the second or third word making the disfluency a clear part of the middle flow of the sentence. There were four different versions of hesitations (ah, eh, mm, um). The hesitations were randomly assigned to different pictures. However, the same hesitation was used for both the cognate and the noncognate versions of a scene. The hesitations were inserted in front of the critical word, second or third word in the sentence (object 2 or object 3).

Figure 2.1 demonstrates the sentences from figure 4 in the speech editing software Praat, how the sentences were laid out with 500 ms between each section. This can be demonstrated in written form by *This is a large bedroom [500 ms] there was a bed, [500 ms] a clock on the wall, [500 ms] a stool [500 ms] and a jumpsuit lying on the floor [500 ms].* The same pattern was used for all sentences. In Figure 2.1B. the orange box marks the hesitation in the cognate disfluent sentence. This exact hesitation was used in the noncognate diffluent version for the same scene. The blue box in Figure 2.1C. demonstrates this.

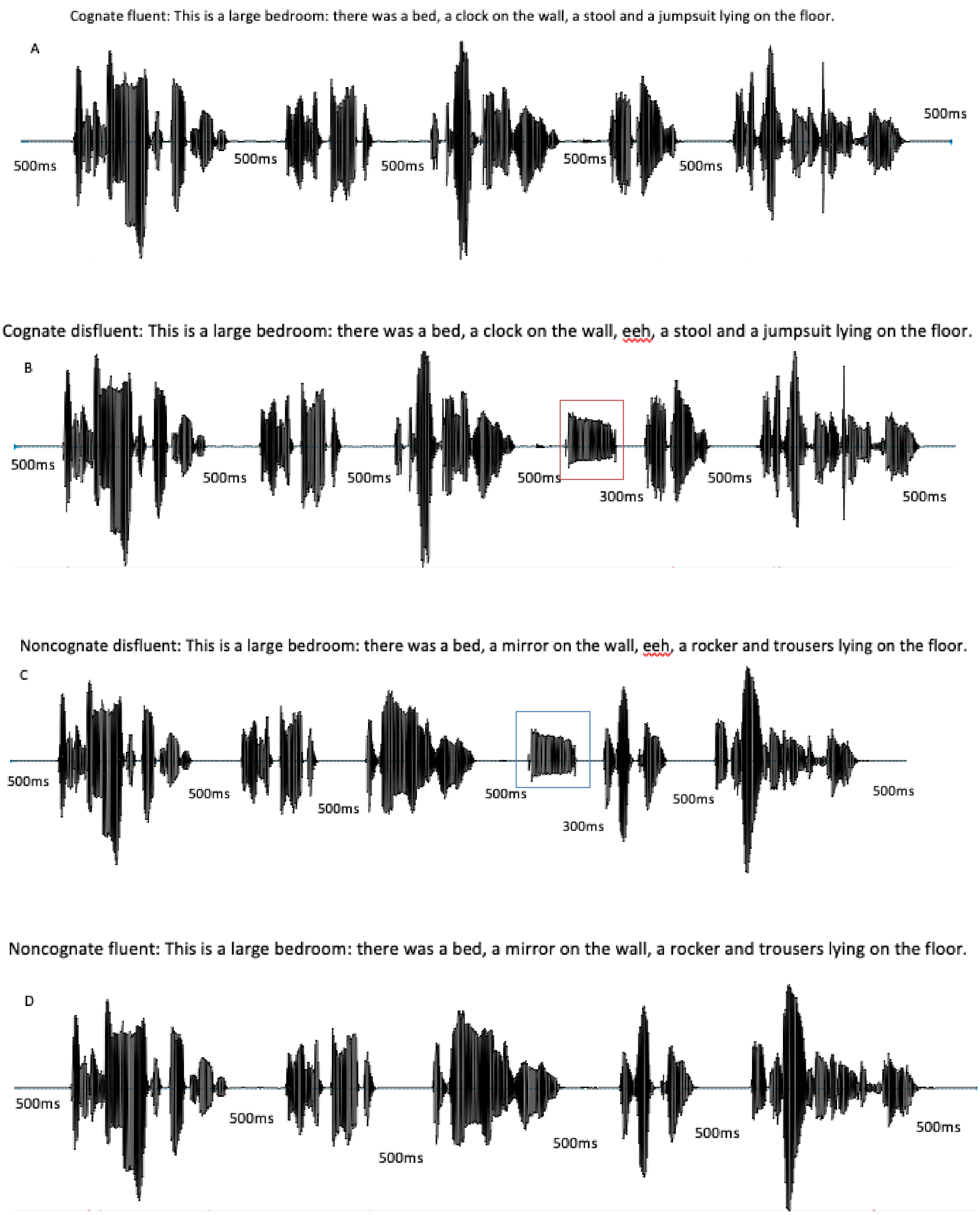


Figure 2.1 A-D: Displaying the sentences in Praat with the 500 ms spaces in between each word.

2.4.2.1.4. Experimental fillers

The study phase included 20 filler scenes. The same 20 filler scenes were used for all eight different versions. The filler scenes were not analysed nor included in the result section. The hesitation on the filler scenes were on the first or the fourth word of the sentence. This was done because then the participants were not lingering on an important word. For the fillers the hesitations were randomly assigned, so that the hesitations appeared the same number of times across stimuli.

2.4.2.2. Design

The experiment has a 2x2 design with the factors word type (cognate, noncognate) and fluency (fluent, dysfluent). Both the word-type manipulation and hesitation manipulation were within subject because all participants were exposed to all manipulations. In addition, all scenes occurred in mirror image making eight version of each scene. This resulted in 8 different versions of each scene. Therefore, eight lists were constructed each containing one version of each scene and equal numbers of scenes from each condition (101 including the filler scenes). There were 20 scenes from each condition within each list (half mirror image): meaning that there were ten noncognate fluent directed left to right scenes, ten cognate fluent directed left to right scenes, ten noncognate disfluent directed left to right scenes, ten cognate disfluent directed left to right scenes, ten noncognate fluent directed right to left scenes, ten noncognate disfluent directed right to left scenes, ten cognate fluent directed right to left scenes and ten cognate disfluent directed right to left scenes. Participants were assigned in equal numbers to each list.

Table 2.3: Overview of the different versions of a scene.

NUMBER OF SCENES	WORD ASOSIATION	FLUENCY	PICTURE ORIENTATION
1	noncognate	fluent	left- right
2	noncognate	fluent	right left
3	noncognate	disfluent	right left
4	noncognate	disfluent	left- right
5	cognate	fluent	left- right
6	cognate	fluent	right left
7	cognate	disfluent	right left
8	cognate	disfluent	left- right

2.4.2.3. Procedure

All other manipulations were counterbalancing effects. The visual duration for all pictures was 14 sec. This was measured by looking at the longest sentence and adding 2 sec so that all scenes were displayed for the same amount of time. There was no difference there which could cause different outcomes for the results of the different scenes. Since all sentences without hesitations were shorter, the longest sentence was one of the hesitation sentences that was measured as the longest.

Once the participants had found a comfortable position, they were asked to keep their head still on the fixed chin rest and look at the white screen, with their dominant hand on the spacebar of the keyboard. The experimenter looked at the machine tracking their eye and adjusting so that the tracker was tracking the eye movements of the participants. This was done by first asking the participants to look in turn at all four corners of the white part of the screen. This was to make sure that no matter where the participants were looking their eye was still within the setup the tracker prefers. What followed was calibration and validation. These steps were for the participants exactly the same, where they followed a dot on the screen with their eyes. For the person running the experiment the two were somewhat different. The calibration was done so the experimenter could confirm the placement of the eye's specific locations on the screen. The validation was where we do a similar thing again but this time, the experimenter marked a validation of where the eyes should be according to the first run through. With validation the experimenter could see how close the participants were with their sight to the original place they looked for the calibration part. Following this, the participants were asked not to move their head until the study test was done, in order for the eye-tracker to be able to track them. If the participants moved, the calibrations would be wrong and the results might be unusable since the participants had rearranged their focus points, even with doing a recalibration they would have a different point of view than what they had originally.

The participants then read the instructions for the study phase on the screen in front of them. Once the participants finish reading the instructions, the experimenter and the participants went through the instructions orally with them in order to make sure the participants understood what they were supposed to do. When the participants were ready, they were presented with a white screen with a black dot. The participants were told to look straight up at this dot and press space in order to start the test with the first scene. The participants needed to do this before every picture. Once the participants press space, the participants continued uninterrupted until the break which was between scene number 53 and scene number 54. Here the participants were allowed to rest their eyes and all subjects were recalibrated. This part of the experiment took approximately 35 minutes and the same amount and order for all participants. The scene was constructed with the participants looking at a picture while they listened to a recording of a description of the picture, naming some of the objects with or without hesitations.

2.4.3. Maths

The participants were then given simple math tasks to complete as a distraction, having the participants focus on something else than what they had to remember for the test. This was done so the test would be a bit more difficult.

2.4.3.1. Procedure

Once the study phase ended, the participants were asked to remove their head from the chinrest and conducted maths for ten minutes. The maths (e.g., 3+83; see Appendix F) was given to the participants within 10-20 seconds after they finished the memory phase. The participants stayed in the same place inside the booth beside the computer. The participants were instructed to do the addition tasks for ten minutes. Once the participants started, a timer was set for ten minutes. Once the time had run out, the experimenter instructed the participants for the next phase, the memory phase.

This was easy addition maths for them to do so that the participants were forced to direct their focus of something quite unrelated to the task at hand. After the ten minutes the participants got instructions for the test phase.

2.4.4. Test phase

After completing the first phase, the study phase where the participants had the objective to memorise as much as they could, and after the maths, the participants were now ready for the final phase, the test phase. This was the section the participants had to demonstrate in a test on a computer what they remembered from the study phase.

2.4.4.1. Materials

The materials here are the same as the ones for the test phase. In addition, there were a version of the scenes with a changed object. Appendix I displays this with two different versions of a large bedroom.

2.4.4.2. Design

By the use of eye tracker and a memory test, the study aimed to see if there were a correlation between where the participants looked, how long they looked for and if the participants lingered with their eyes on something in the scene. The second factor we looked at was, with the use of certain words, whether we would see a contextual relationship between disfluencies and which cognate status the word following had on the participants.

The way stimuli were assigned across participants was with the use of an excel sheet (see Appendix G) the stimuli were randomised with the restrictions. And the number of variables was the same for each version. This was how the eight versions came to be.

Each participant had a subset of the stimuli. This was in order to avoid having repetition of the stimuli. A participant saw one of the eight versions. In order to have a whole run-through of the entire study we needed eight participants. This is why the number of participants were 32, which gives the experiment four complete sets of data. In order to make sure the stimuli were only presented once per subject, an excel sheet was created (see Appendix G). All participants experienced the same. They had the same order of scenes and the same number of scenes. The only variation was the cognate status and the disfluencies within each scene. The first three scenes and the final two scenes were always filler scenes as shown in Appendix G.

2.4.4.3. Procedure

After the maths, the participants were instructed to continue with the memory test on the computer. Following the instructions and the paraphrasing, there was an example picture of what the test would look like. The experimenter informed how the participants could go about the task. As demonstrated in Appendix H, the participants had to choose which version of the scene they had seen in the study phase.

Not only did the participants have to choose which version, they also had to state how certain they were by the selectin of keys on the keyboard. The keys 1,2 and 3 were used for the picture on the left and 7, 8 and 9 for the picture on the right. The keys 1 and 9 were used if the participants were sure of their choice of picture. The keys 2 or 8 were pressed if the participants thought it was the picture and 3 and 7 were used when the participants were guessing which picture they saw. The scenes were very similar with only the difference of a shade or version of one of the objects on the screen (for an example, see Appendix H). The object changed with a slightly different shape or the same kind of object only a different brand from the original one. The placement of the correct response was counterbalanced across subjects. The memory test included the 80 target scenes with their different subsection the participants saw in the study phase. This part of the study was not timed. Meaning, the participants could take as much time as they needed in order to complete each task. Therefore, the time varied from 10 to 20 minutes depending on the participants.

2.4.5. General procedure for the memory test

The experiment had a set order to follow (see Table 1.1.). For most participants the experiment was divided into two days. One for the language tests and the language profile, and another for the memory experiment. The two days could be consecutively following each other or up to seven days apart. Some of the participants did all sections in one day. In between the language tests and the LEAP-Q the participants were offered an intermission which none of the participants took. For those who did the entire experiment in one day, were offered an intermission between the questionnaire and entering the booth. This was mostly declined as well. Once inside the booth there were no intermissions. Inside the booth the study phase, maths and the test phase run non-stop. For each participant there were most variances when it came to the questionnaire and the test phase. For the LEAP-Q, the time varied from 15 minutes to 45 minutes.

3. Results

3.1. Questionnaire data

The 33 participants were aged between 18 and 32 years with a mean of 24.6. The genders were divided close to equal with 19 females (57%) and 14 males (43%). Of the 33 participants, 4 were left-handed while the rest were right-handed. When it came to higher education, such as upper secondary and above, their scores ranged from 12 to 19 years of education with a mean of 16.3 years.

3.1.1. Language dominance and language acquisition

Table 3.1: Overview in dominance of the languages the participants speak

	L1	L2	L3	L4	L5
Norwegian	33				
English		33			
Danish			1	2	
Swedish			2		
Germain			4		
French			1	1	1
Spanish			1	1	
Indonesian				1	
Japanese			1		
Total	33	33	10	5	1

Table 3.2: Overview in acquisition of the languages the participants speak

	L1	L2	L3	L4	L5
Norwegian	33				
English		30	3		
Danish		2		1	
Swedish		1		1	
Germain			4		
French			2		1
Spanish			1	1	
Indonesian				1	
Japanese				1	
Total	33	33	10	5	1

All participants were born and resided in Norway at the point of inquiry. All 33 participants listed Norwegian and English as their most dominant languages. All participants considered Norwegian as their first language and English as their second language. Ten of the participants reported having a third language, five had a fourth language and one had a fifth language. According to the self-rating, the participants reported having low percentage of use for their third, fourth and fifth languages. For example, only knowing some lower secondary grammar of a language. The order of acquiring, unlike dominance, differs some for the different languages the participants speak. All 33 participants placed Norwegian as their first acquired language. Three people learned a Scandinavian language before English, as their second language. The third language, European languages got emphasised including English, while less was reported for Scandinavian languages as well as Japanese was also lower. For the fourth acquired language Scandinavian languages and French lost one participant each, while Japanese gained one participant.

3.1.2. Culture identification

Thirty-two participants listed their primary identification with Norwegian culture, and one listed their primary identification with Canadian culture. Nineteen reported having a second cultural identity were 8 of whom identified with the US, including 1 relating to the Hawaiian culture. Six was relating to the British culture, one to Spanish culture, one to Japanese culture, one to Danish culture, one to Canadian culture, one to Norwegian culture and one outlier reported themselves to have a musician culture. Nine participants related to a third culture, of whom 6 related to the American culture, one to the British-, one to Swedish- and one to the Indian culture. Three of the participants reported having a fourth culture, they were one that related to Chinese culture, one to Italian- and one Hungarian culture.

3.1.3. Fluency

Twenty-three participants reported having lost language fluency in one of their languages. Five mentioned Norwegian as their reduced fluency language and 12 mentioned English. Six other participants reported that they had become less fluent in Danish, German and French.

Table 3.3: Overview of the results from the LEAP-Q.

	Norwegian			English		
	Mean	High	Low	Mean	High	Low
language exposure (in %)	61.5	80	30	36.7	70	19
time spent speaking each language (in %)	84.2	99	40	14.3	40	1
time spent reading each language (in %)	49.7	95	15	50.3	90	5
free choice of language (in %)	83.8	100	0	14.6	100	0
months spent in a country where this language is spoken	278	381	221	5	48	0
months spent with a family where this language is spoken	257	384	203	48	96	0
months spent in a school where this language is spoken all of the time	84	144	0	6	60	0
months spent in a school where this language is spoken some of the time	181	264	96	150	252	0
months spent in a workplace where this language is spoken all of the time	24	120	0	1	12	0
months spent in a workplace where this language is spoken some of the time	72	180	0	60	180	0
learning contribution friends / colleagues	6.8	10	2	5.8	10	0
learning contribution family	9.4	10	3	2.5	10	0
learning contribution through reading	6.9	10	3	7.8	10	4
learning contribution school and education	7.9	10	3	7.5	10	2
learning contribution through self-instruction	1.4	10	0	2.9	9	0
learning contribution through visual media	4.1	9	0	7.5	10	1
learning contribution through audio media	3.5	8	0	6.6	10	0
current Interaction with friends / colleagues	8.3	10	5	2.0	6	0
current Interaction with family	9.2	10	0	0.8	10	0
current reading exposure	4.7	9	1	5.5	10	1
current exposure to self-instruction	0.4	5	0	1.4	10	0
current exposure visual media	3.2	6	0	7.1	10	3
current exposure audio media	3.0	7	0	7.2	10	3
age of first acquisition	0.0	0	0	5.6	10	1
age of fluency speaking	3.3	7	2	11.7	16	5
age of reading	5.2	8	4	7.1	11	5
age of fluent reading	7.9	11	5	10.7	14	8

Thirty-two participants reported using Norwegian as their primary language to do mathematics and simple counting while one reported using English. Thirty-one participants dreamt in Norwegian while two dreamt in English. Thirty participants preferred to talk to themselves in Norwegian while 3 did this in English. When it comes to expressing anger or affection 31 participants primarily did this in Norwegian while 2 expressed themselves in English.

3.1.4. Language background

The results from the language use questions are summarised in Table 3.3. Participants in this study where exposed to more Norwegian than English on average. The participants also spent more time speaking Norwegian than English. When it came to reading, the time spent was quite evenly divided between English and Norwegian. When the participants were given the choice of which language, they would choose to speak with a person who knew the same languages as them, most would prefer to speak their native language; Norwegian.

According to the participants responses', they spent most of their life in Norway with a Norwegian family. When asking the participants about their work and school life they had relatively low scores for this when it came to dividing it into the different languages. However, their scores increased when the participants included time spent in both language environments, especially when it came to the time spent in a school where both languages took place.

Enquiring how the participants rated different factors that contributed to their learning of each language, the results showed the following: For the Norwegian language most placed 'interacting with family' as a high valued contributor, while 'self-instruction' scored as the lowest contribution. For English, the highest score was 'reading: including books, magazines and online material' and 'interacting with family' contributed the least for the participants in learning English according to themselves (for full overview see Table 3.3).

The participants' current exposure to different factors were as follows: The highest rated for Norwegian self-reported exposure was 'interacting with family'. This means that they reported being exposed mostly to Norwegian through their family during the last month or so. The lowest contributing factor for Norwegian according to the participants, was ‘self-instruction’ like learning language through video or apps. For English, the highest rated score for self-reported exposure ‘in the last month or so’ was ‘listening to music or media’ and the lowest self-attributed score was for ‘interacting with family’ (see Table 3.3 for full overview).

As shown in table 3.3, all participants started hearing Norwegian from birth. On average, the participants remember being told they became fluent around their first few years of life. On average, participants started to hear English on a regular basis a few years after they were fluent in their first language, Norwegian. English fluency was reached in their preteens according to their own estimates. Participants used approximately the same time to become fluent readers in both languages according to their own best estimate. According to our results, Norwegian was learned a few years before English.

Table 3.4: Proficiency ratings

	Norwegian			**English**		
	Mean	**High**	**Low**	**Mean**	**High**	**Low**
Proficiency Speaking (general fluency)	9.4	10	5	7.4	10	5
proficiency Pronunciation (accent)	9.2	10	8	6.6	9	3
proficiency Reading	9.4	10	8	8.4	10	6
proficiency Writing	8.3	10	6	7.0	10	4

3.1.5. English proficiency

The participants that reported the highest ratings to speaking and reading when it came to Norwegian proficiency. While for English, the highest rating by the participants was reading. The participants rated themselves lowest in Norwegian grammar and English pronunciation. See table 3.3. for a full overview.

3.2. Pre-tests

The results of the pre-tests described in the method section will be reported in this section. The vocabulary tests in both English and Norwegian had much lower scores than the LexTALE. LexTALE, on the other hand, had the best scores of the four pre-tests. See Appendix I for individual test results.

Table 3.5: Results of the pre-tests

(in %)	**From**	**To**	**Mean**
Auditory Working memory test	46.7	86.7	65.8
Norwegian vocabulary test	10	57.5	32.8
English vocabulary test	7.5	60	31.7
LexTALE	63.5	92.2	82.4

3.3. Questionnaire data vs pre-tests

To investigate the relationship between the subjective proficiency ratings (LEAP-Q) and the objective tests (pre-test), a two-way scatterplot with regression lines was created matching the results against each other. In the two-way scatterplot, figure 3.2 the Y axis is the subjective rating, and the X axis is the English vocabulary pre-test. The figure shows that there is a correlation between the two measures. The English vocabulary scores and proficiency ratings showed a significant positive correlation, $r=0.43$, $p<.05$. The correlation between LexTALE and the English proficiency ratings also showed positive correlation, $r=0.59$, $p<.0001$.

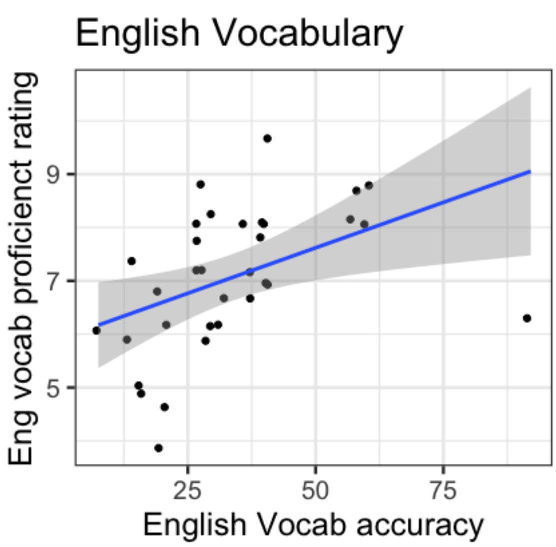


Figure 3.1: English Vocabulary accuracy against English vocabulary proficiency rating.

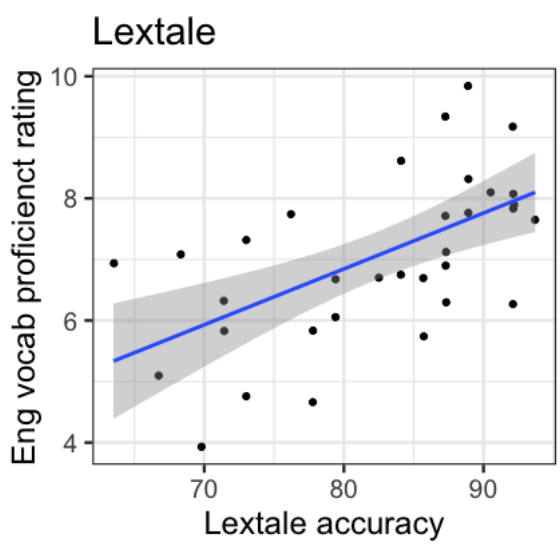


Figure 3.2: LexTALE accuracy against English vocabulary proficiency rating.

3.4. Memory effects

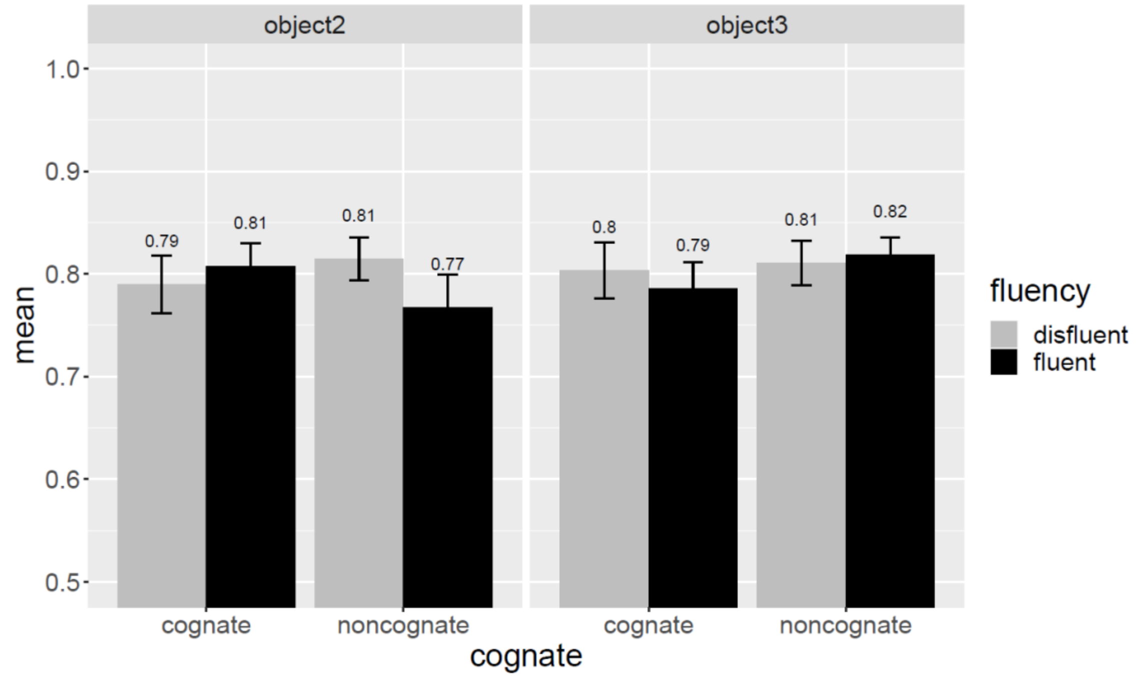


Figure 3.3: Proportion accurate responses by participants- test phase

Figure 3.3. shows the results of the two objects of interest related to the experimental targets. Along the x-axis we see the different cognate status for fluent and disfluent conditions, and the Y axis shows the corresponding mean response accuracy with standard error bars. As can be seen in Figure 3.3., there was high accuracy for both noncognate, cognate, disfluent and fluent for both object 2 and object 3. For object 3 there is not much happening. The difference between cognate and noncognate is relatively small. The same situation is present for fluent versus disfluent. Regarding object 2 noncognates show an effect of disfluency, where accuracy is a little higher for disfluent that fluent trials.

Table 3.6: Showing a linear mixed effect model of predicting accuracy. Best-fitting model (MLM) predicting accuracy (2x3 analysis)

```
Random slopes for Cognate; models with other slopes do not converge.
Fixed effects:
                             Estimate Std. Error z value Pr(>|z|)
(Intercept)                  -1.62569    0.12628 -12.873   <2e-16 ***
cognate1                     -0.01327    0.16335  -0.081   0.9352
fluency1                      0.07876    0.10497   0.750   0.4531
tested_object1               -0.05932    0.18759  -0.316   0.7518
cognate1:fluency1             0.11621    0.20990   0.554   0.5798
cognate1:tested_object1      -0.17916    0.27454  -0.653   0.5140
fluency1:tested_object1      -0.06149    0.20991  -0.293   0.7696
cognate1:fluency1:tested_object1 -0.69711    0.41958  -1.661   0.0966 .
```

The data was analysed using a linear mixed effect model that included the experimental conditions as fixed effects and the English language proficiency tests as a contributing factor. The best fitting model is shown in Table 3.6. Of all of the proficiency measures, none of them had a significant effect on the data according to the given probabilities from the model's coefficients and none of the continuous values seem to matter. Only a three-way interaction of cognate status, fluency and object approached near a .1 significance level (marked in Table 3.6 with a dot) suggesting, that participants remembered more for noncognate scenes when they were disfluent than when they were fluent for object 2.

3.5. Gaze duration effect

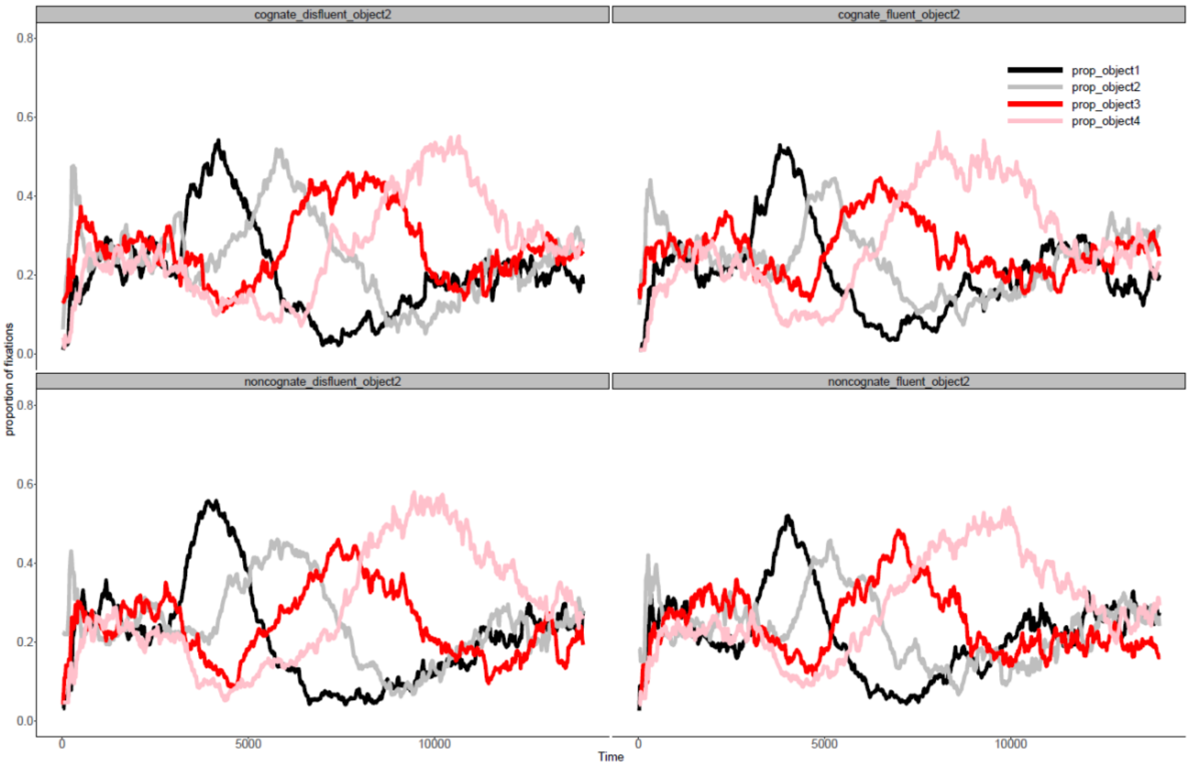


Figure 3.4: Demonstrating the effects of gaze duration for object 2.

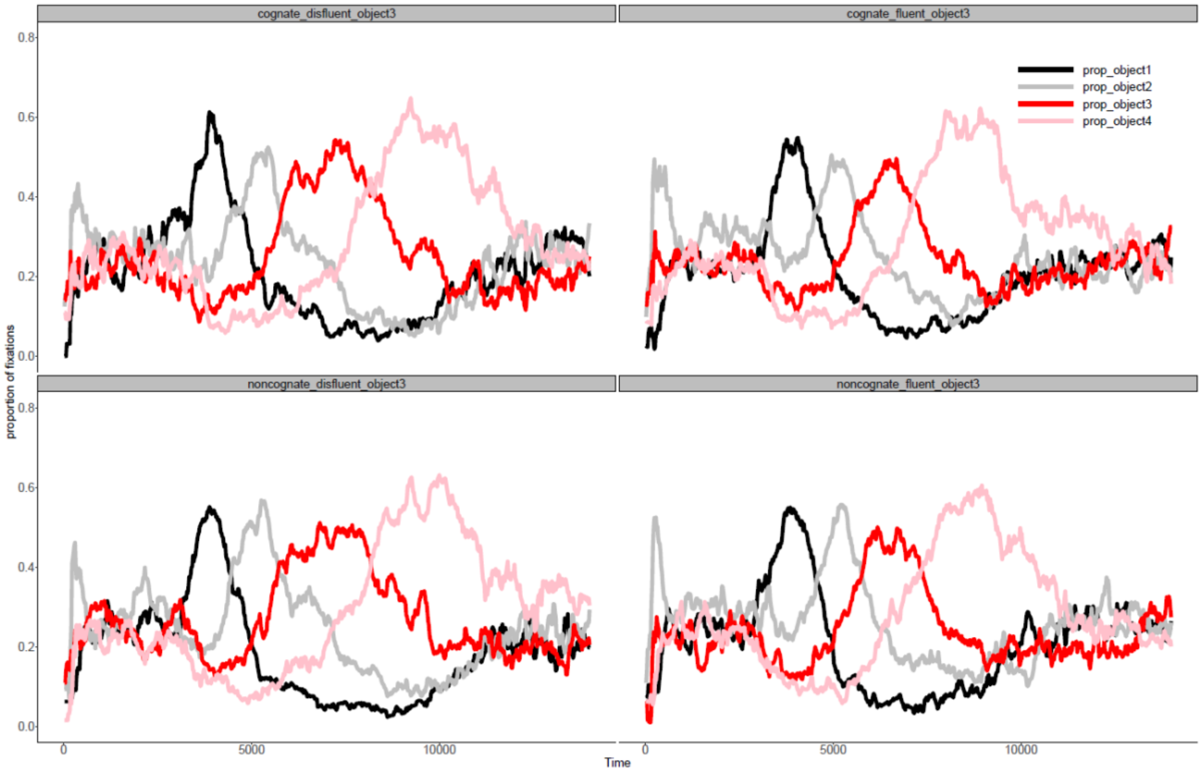


Figure 3.5: Demonstrating the effects of gaze duration for object 3

Figure 3.4 and Figure 3.5 show gaze duration data for object 2 and object 3 trials, respectively. The X axis shows the time over the course of the trials. The Y axis shows the proportion of fixations on all four objects. For all four different versions of object 2 in Figure 3.4, the participants were following the voiceover with their eyes. The same applies for Figure 3.5 with object 3. Figure 3.4 and Figure 3.5 are showing the order the participants saw the objects in. The order was object 1 which was the first described, then, object 2, object 3 and object 4 were all looked at in that order. This implies that the participants listened to the recordings and that their gaze was guided by what was being said.

3.5.1. Gaze duration for Object 2

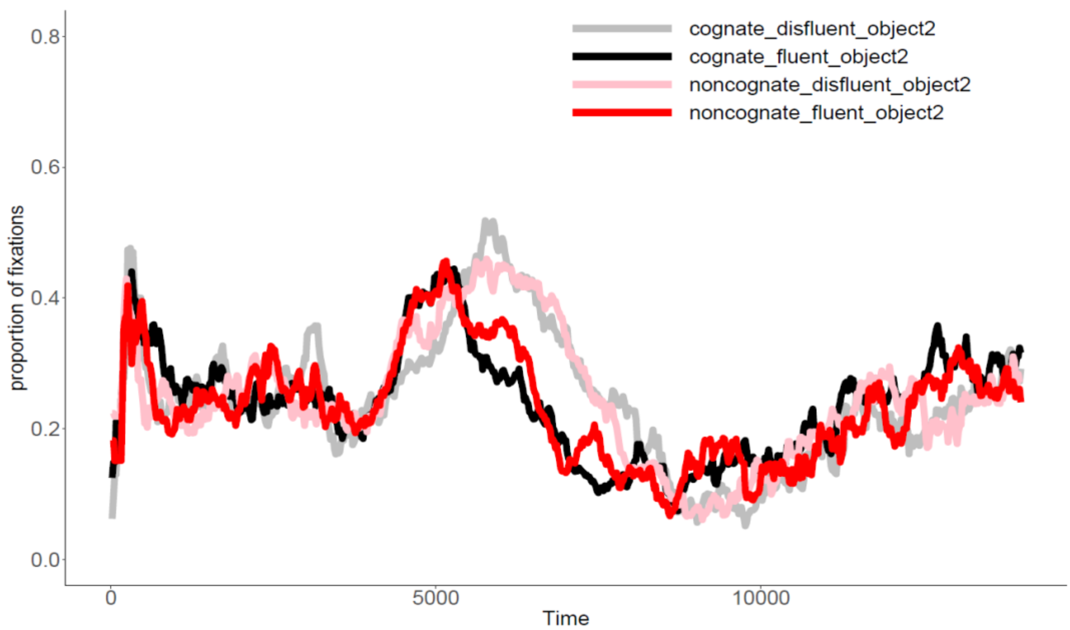


Figure 3.6: Items where object 2 were tested

Figure 3.6 shows the effects of cognate status and disfluency on gaze durations to object 2, with X axis showing time and the Y axis showing proportion of fixations, this graph shows the four different conditions shown to the participants. By overlapping them in the same graph one can see that there were longer fixation times when the participants were listening to disfluent recordings than when they were listening to fluent recordings. This is shown for both object 2 and object 3 (see Figure 3.6 and Figure 3.7).

Table 3.7: Best fit model for dwell times on object 2

	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	2055.47	127.22	42.97	16.157	< 2e-16	***
object_name1	-22.75	82.84	36.62	-0.275	0.78518	
fluency1	-170.83	55.79	1161.17	-3.062	0.00225	**
tested_object_freq_z	-27.04	54.07	43.32	-0.500	0.61957	
object_name1:fluency1	-82.04	111.36	1167.64	-0.737	0.46145	
object_name1:tested_object_freq_z	-91.79	114.81	45.88	-0.799	0.42814	
fluency1:tested_object_freq_z	68.91	55.04	1149.78	1.252	0.21088	
object_name1:fluency1:tested_object_freq_z	-126.41	109.96	1144.10	-1.150	0.25053	

3.5.2. Gaze duration for object 3

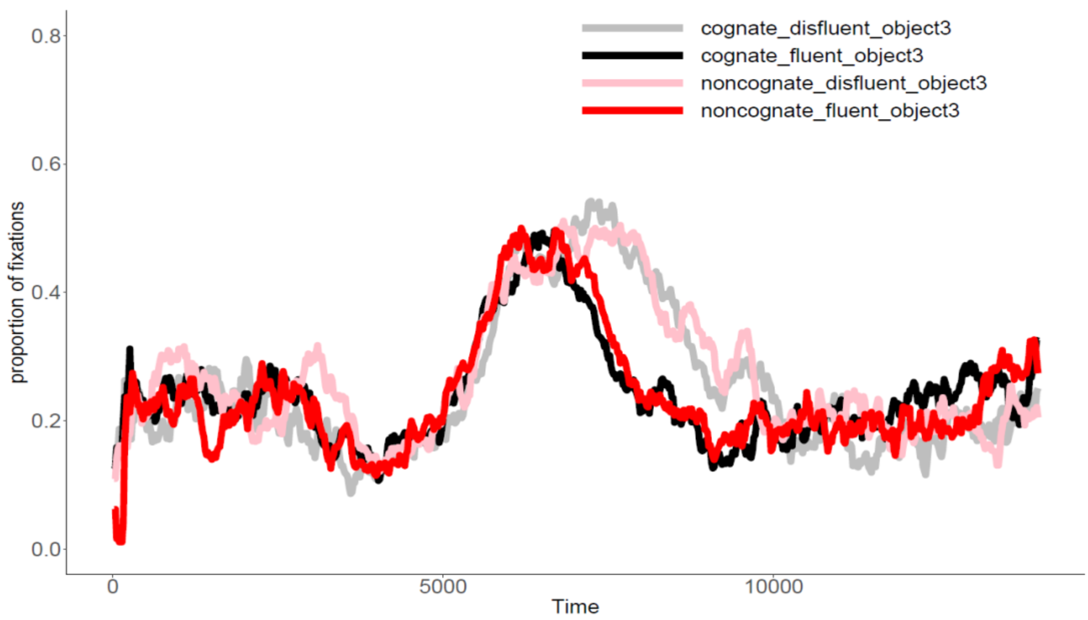


Figure 3.7: Items where object 3 were tested.

Table 3.8: Best fit model for dwell times on object 3

-	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	2146.5652	108.5479	49.6749	19.775	< 2e-16	***
object_name1	96.5206	74.1187	37.2134	1.302	0.201	
fluency1	238.8608	57.6962	1134.9902	-4.140	3.73e-05	**
tested_object_freq_z	0.3276	51.5707	48.1995	0.006	0.995	
object_name1:fluency1	-69.9749	115.2064	1139.2598	-0.607	0.544	
object_name1:tested_object_freq_z	-103.1483	95.6160	44.2689	-1.079	0.287	
fluency1:tested_object_freq_z	86.0204	58.1309	1140.8704	1.480	0.139	
object_name1:fluency1:tested_object_freq_z	67.5533	116.1369	1138.6852	0.582	0.561	

The data are subjected to a linear mixed effect model. The best fitting models for object 2 and object 3 are shown in Table 3.7. and Table 3.8. respectively. As one can see there are effects on gaze duration for both objects. Disfluency significantly increased gaze duration for both objects.

3.6. Effects of individual differences in objective proficiency tasks and gaze duration to accuracy

The results up until now have shown the relationship in memory effects between cognate status and fluency for object 2 and object 3. The last analysis, however, looks at the relationship between gaze duration and accuracy.

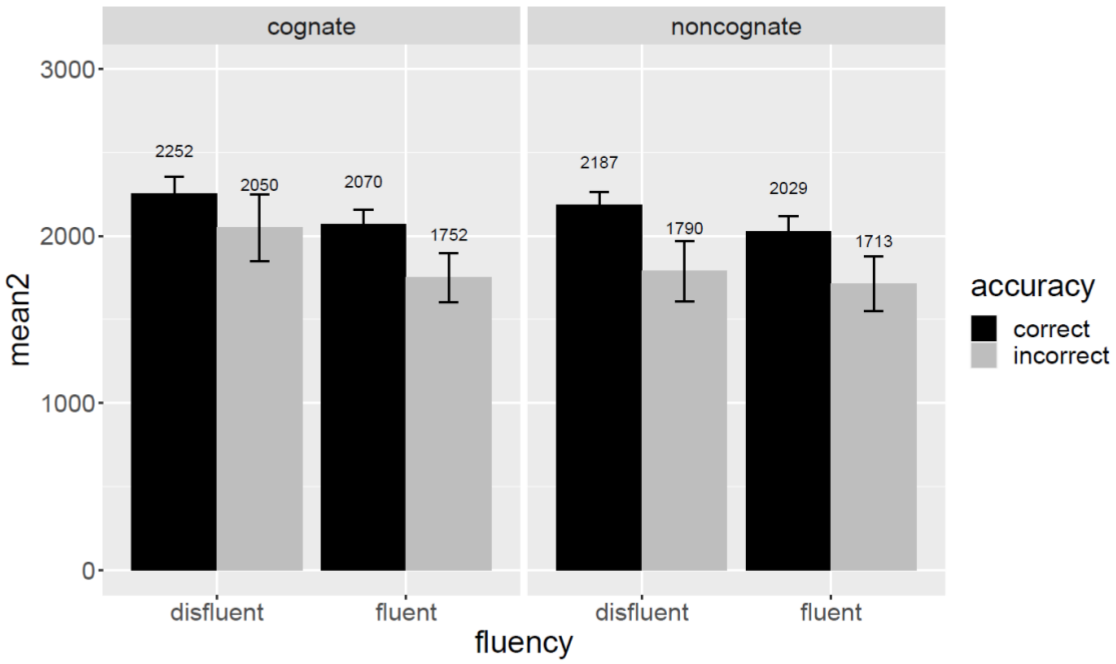


Figure 3.8: Mean accuracy related to gaze duration for cognate and noncognate words on object 2 in fluent and disfluent conditions.

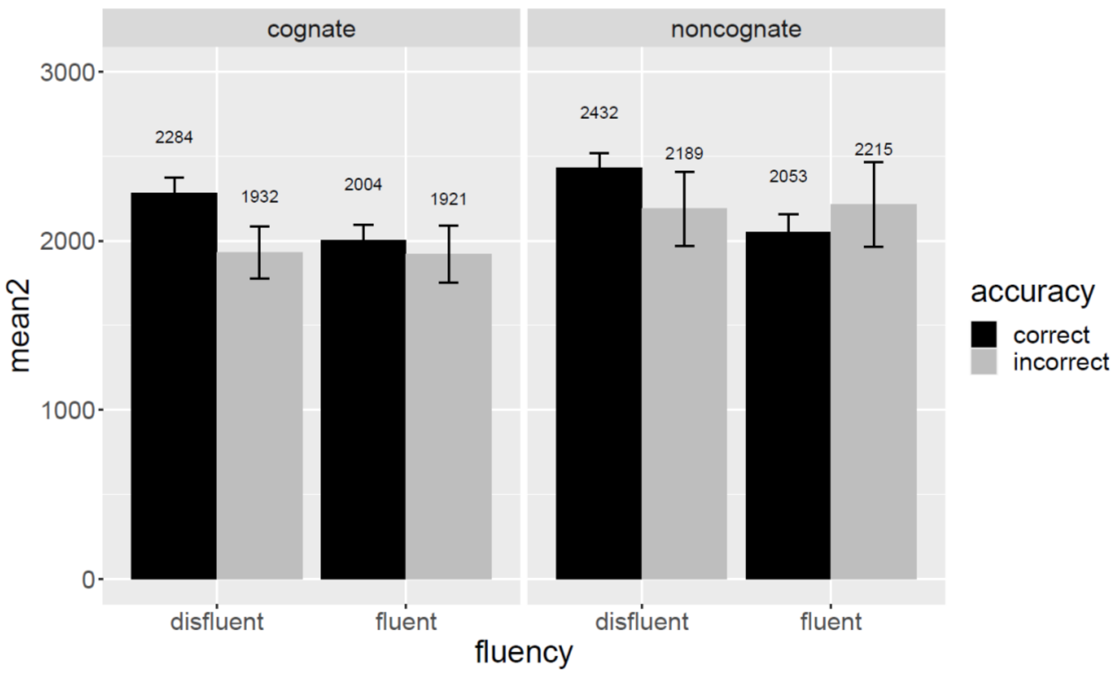


Figure 3.9: Mean accuracy related to gaze duration for cognate and noncognate words on object 3 in fluent and disfluent conditions.

The Y axis in Figure 3.8 and Figure 3.9 shows how long the participants looked at the different scenes where the target word was object 2 for Figure 3.12 and object 3 for Figure 3.13. The X axis shows memory accuracy for the scenes for cognate and noncognate words in fluent or disfluent conditions. Black bars visualise the mean correct responses of the participants and the grey bars show the mean incorrect responses. Gaze duration is linking up the accuracy data with what the participants eyes did during the test phase. Accurate response shows longer dwell times, except for fluent noncognate responses. Participants got more correct when they looked at the pictures for longer.

Table 3.9: Best fitting model for Dwell time and accuracy on object 2

	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	-1.62389	0.16997	-9.554	<2e-16	***
object_name1	0.05353	0.19816	0.270	0.787	
fluency1	0.19873	0.15344	1.295	0.195	
dwell2_centered	-0.16322	0.11371	-1.435	0.151	
object_name1:fluency1	0.45490	0.30649	1.484	0.138	
object_name1:dwell2_centered	0.13125	0.20121	0.652	0.514	
fluency1:dwell2_centered	-0.05672	0.16114	-0.352	0.725	
object_name1:fluency1:dwell2_centered	-0.11787	0.32052	-0.368	0.713	

Table 3.10: Best fitting model for Dwell time and accuracy on object 3

	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	-1.57362	0.14499	-10.853	<2e-16	***
object_name1	-0.18066	0.19801	-0.912	0.3616	
fluency1	0.06487	0.15291	0.424	0.6714	
dwell3_centered	-0.10934	0.12901	-0.848	0.3967	
object_name1:fluency1	-0.27392	0.30794	-0.890	0.3737	
object_name1:dwell3_centered	0.12954	0.18994	0.682	0.4952	
fluency1:dwell3_centered	0.30258	0.16135	1.875	0.0608	.
object_name1:fluency1:dwell3_centered	-0.14432	0.32400	-0.445	0.6560	

The data are subjected to a linear mixed effect model. The best fitting models are shown in Table 3.9 (object 2) and Table 3.10 (object 3). As can be seen in Table 3.9 there are no significant results. And as shown in Table 3.10 the interaction between fluency and dwell time approached significance.

4. Discussion

In this study we looked at how being a bilingual affects memory. Being a bilingual can influence memory, as researchers have discovered, knowing several languages affect different areas of the brain more than a monolingual. Specifically mentioning non-linguistic sections which are more constructed for task-oriented activities (Green & Bavelier, 2012; Maguire et al, 2000). Because bilinguals activate more parts of the brain, research has discovered that bilinguals tend to postpone the onset of dementia with up to four years (Bialystok, Craik, & Freedman, 2007).

The aim of the present study was to achieve a better understanding of the potential effect disfluency has on bilingual memory for visual scenes. The present study builds on the results of disfluencies found in Konopka's lab rapport (2019). The study presented in the rapport discovered that bilinguals did not behave the same way that monolinguals did when disfluencies were used. The monolinguals had higher test scores when disfluencies preceded the target word than when the sentence were without disfluencies. The bilinguals on the other hand, had the same score for both disfluent and fluent sentences, however, the bilingual result was higher than the result of fluent test scores and lower than the disfluent test scores of the monolinguals. The present study did give a better understanding of the disfluency effect on bilingual memory for visual scenes. There were null results for effect on memory, meaning we need more data. However, we did find longer fixation times for bilinguals when listening to disfluent recordings. This means that when bilinguals listened to the recordings which included disfluencies, the bilinguals showed significantly longer dwell time compared with the fluent versions of the same sentences. This result was found for both object 2 and object 3 suggesting that the place in the sentence did not affect how the bilingual was affected by the disfluency.

4.1. Discussion of bilingual's results on disfluency effect and cognate retrieval affect

The memory of bilinguals in the study by Sampaio and Konopka (2013) might suggest, as the present study, that bilinguals pay more attention to detail when listening to or using their L2. This is because Sampaio and Konopka's study discovered, as they predicted, that bilinguals have a better memory of surface form than monolinguals. In the study, the monolinguals recall the gist of the target word in the sentence, whilst the bilinguals recall the surface form of the sentence including the correct target word. The bilinguals have higher tendencies remembering target words than monolinguals. Sampaio and Konopka suggest the reason for this might be that bilinguals using their second language might struggle more with finding the correct synonym to create a gist. Hence, the bilinguals have a higher tendency to remember the correct information word by word to not misunderstand any of the information given in their second language. The procedure of Sampaio and Konopka's study included giving the participants a booklet containing recalled cues. As soon as the participants finished listening to the recordings, they were asked to complete a questionnaire. Since this questionnaire followed the test phase without intermission of any kind, the participants used their short term memory to complete this study by Sampaio and Konopka (2013). For the present study we can see that bilinguals spend more time on the target word when there is an abnormality such as a disfluency in the recorded sentence. Bilinguals behave differently than monolinguals as seen in both Sampaio and Konopka's study and the present study. This is because bilinguals are, in our study, affected by disfluencies which influence their behaviour by having a higher gaze duration on target words preceded by a disfluency. For Sampaio and Konopka's study, bilinguals behaved differently on account of remembering the surface form and not the gist as the monolinguals did with the use of the bilingual's short term memory. Corley et al. (2007) discovered both short- and long term memory with the use of disfluencies on monolinguals. The present study suggests that disfluencies have participants look longer on objects but not giving any conclusive results on if the memory gets affected. The results for the present study are a null result and there is the need for more data to achieve a more conclusive result. The results also show that bilinguals were affected by disfluencies.

Costa et al. (2000) has their own way of looking at the bilingual language process, where they propose a division between cognate and noncognate words. Relating this to the results of the present study, we did not see a difference of gaze duration between cognates and noncognates. There were also no significant results for cognate results relating to memory. However, there were tendencies showing more correct responses for noncognates than for cognates for object 2. While for object 3 there were more correct for noncognates (see Table 3.4). Cognates and noncognates was the visual and auditory input the participants were exposed to. With the Bilingual Interactive Activation model (Dijkstra & van Hauven, 2002) one can see the process of the participant looking at the visual and listening to the auditory input and how the bilingual participants were affected by this. Since the participant looked longer for disfluent target words, it suggests that participants allowed the bilingual language process to take a bit more time and be more reflected in the different levels or on the process in total. This is because increased gaze duration gives the brain more time to focus. However, no results were found that the memory was affected in the present study. The study concluded in a null result, which means we need more participants to test to get a higher chance in receiving a conclusive result. The present study was conducted with 33 participants, which evidently, was not enough to collect data with any implementation on how disfluency affects bilingual memory. Above focused on results that can relate to theoretical aspects in the introduction, the section earlier mentioned discussed results we found significant data on. The following section will focus on what we did not find, meaning results we found that had inconclusive results.

4.2. Discussion of the predictions and the results of the present study

There were not found any significant conclusive results on the disfluency effect on memory. What was found, however, was a null result when it comes to the memory of bilinguals in the present study. This does not mean there is no correlation between memory and gaze duration, only that for the present study there were inconclusive results. The reason for this might be the subject pool being too small. Without sufficient foundation of data, no further conclusions can be drawn. As mentioned in section 2.4.2. Study phase, there are eight different versions of each visual scene with different variables, the variables being cognate, noncognate, fluent and disfluent. As shown in Figure 2.4, the large bedroom visual scene has four different versions and to make eight versions the scene is mirrored. Expanding on the example in Figure 2.4, eight participants are required to fulfill a complete scene. To achieve the target of 33 participants, the completion of the scene had to be done four times. Each participant is exposed to 101 scenes where only one version of all the scenes are shown. To increase the reviews of the scenes, the study requires more participants. The combination of bilingual memory and disfluency might impact one another. As shown in the result section, the present study did not discover any significant results regarding disfluency affecting the memory of bilinguals. However, the present study did find a significant increase in the participants gaze duration when disfluencies were used. These results might therefore indicate if the disfluency affecting bilingual memory is worth pursuing or not. The purpose of the present study was to investigate disfluency effect on bilingual memory. Specifically, we predicted the effects of a higher second language proficiency or an easier use of L2 might achieve similar responses to disfluency as those found in monolinguals of Konopka's study (2019). Generally, we did find effects that bilinguals are reacting to disfluencies. However, no memory effects were discovered.

The first sub-prediction was getting the participants to behave more similarly to monolinguals. To know the participants' proficiency level, they were tested with the use of Norwegian and English vocabulary tests, an auditory working memory test and LexTALE. The English (L2) vocabulary test got a low score with a proximity to the Norwegian (L1) vocabulary test results. The results were higher for LexTALE and the participants had a relatively good result for the auditory working memory test (see Table 3.5.) suggesting a generally good memory. Since the participants were equally levelled at English and Norwegian, maybe the test itself should be evaluated. The words used (see Appendix C) had a low frequency and seemed to be more commonly used several decades ago. Since the participants scored relatively similar across the first and the second language (see Table 3.5.) suggest that their English and Norwegian might be on the same proficiency level. Since the bilinguals are native Norwegians and have a high L1 naturally acquired proficiency, which scored about the same level as their English on the vocabulary test. The participants might be equally good in both English and Norwegian, which is equally high on the tests, suggesting that the test itself should be altered for testing the level of L2 proficiency. The LexTALE gave the participants a higher test score than they achieved on the vocabulary tests. This might further suggest that giving the vocabulary test was a false result on the bilingual language proficiency of the participants. On the other hand, the general memory level of the bilingual participants is relatively good, with the average of 65,8%. The score suggests that the bilingual participants' working memory is at a decently good level, meaning the bilinguals' general memory is at a good level. According to Baddeley and Hitch (1974), elements of working memory have crucial factors for the phonological process in language. Working memory is a highly involved factor in the bilingual language comprehension and having a working phonological loop aids bilingual with their first and second language acquisition

(Baddeley and Hitch, 1974). Since the participants scored reasonably high on the working memory test, suggesting their ability to memorize is relatively good. The participants did have a high score for memory for both object 2 and object 3 (see Figure 3.4.) which was around 80%. Only not relating to disfluency, since they achieved approximately the same number of correct responses for both cognates, noncognates, disfluent and fluent variations. Therefore, when it comes to memory, the participants scored high, whereas not relating to the aim of the study itself, which involved the effect of disfluency on bilinguals.

The second sub-prediction was having bilinguals respond more similarly to monolinguals when L2 processing was easier with the use of cognates. The results with the use of cognate effect did not show any significance in the present study. The only tendencies shown in Figure 3.4 is that the noncognates for object 2 have more correct responses for the disfluent than for fluent. This is the opposite to what was predicted. To determine if the results can mean anything is by collecting more data which is done by testing more people. The results might therefore suggest that specific Norwegian-English bilinguals that were tested are not affected the way we predicted.

4.3. Future research

As mentioned earlier, there is not enough data on disfluency when it comes to visual scenes of bilingual memory to draw significant conclusions. Suggestive changes to the present study might be testing more participants. This will give a stronger indication in which affect's disfluency might have on bilingual memory. As shown in Figure 3.4 as bilinguals are listening, the participants are better at the early parts of the sentences while when the object is further back in the sentence they have tendencies of falling behind. A suggested next step to the study is to critically compare this data to the data of the monolinguals in Konopka's study (2019) where they are doing the exact same study with these objects. If the monolinguals do not show this difference between object 2 and object 3, there might be a deviation with the bilinguals that are making the difference between the cognate status and the disfluency effects.

What is worth considering for the present study is the nature of the bilinguals. The age of the bilingual participants and their degree of education might have had an interference towards the results of the present study. The educational direction the participants have studied, might impact the study. An idea can be to ask the participants in the questionnaire about the direction of their education. This might have an impact on the participants level of proficiency. The educational direction may suggest how much English the participants were exposed to. The participants' ages ranged from 18 to 32 years old. The years of education of the participants varied from 12 to 19 years. There was a parallel between the years of education and the participants' ages. The participants with the lowest years of education are affiliated with the youngest participants' age. Some of the youngest participants around the age of 18 had 12 years of education. Participants around the age of 26 had 19 years of education. The participants' age and their years of education might give information about the participants' young age corresponding to their low years of education. The fact that some participants were 18 years and only had 12 years of education is quite different from the older participants who had around 19 years of education. The contrast between the ages might alter the results of the study their years in education had such a large difference. To improve the study, a suggestion might be to have the participants closer in age.

4.4. Summary

In sum the main finding the present study found was on bilinguals listening to disfluent recordings. Bilinguals spent significantly longer time on recordings where the target word was preceded by a disfluency. In other words, there was a significantly higher gaze duration for bilinguals when disfluencies were added to the recordings.

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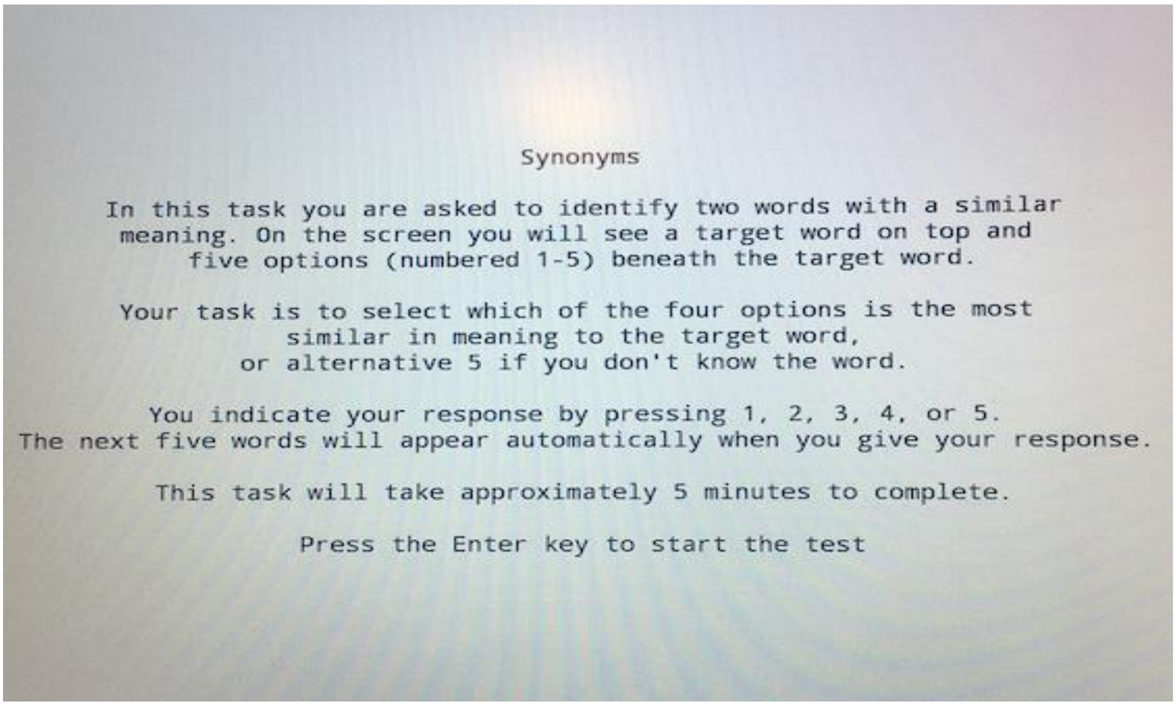
6. Appendices

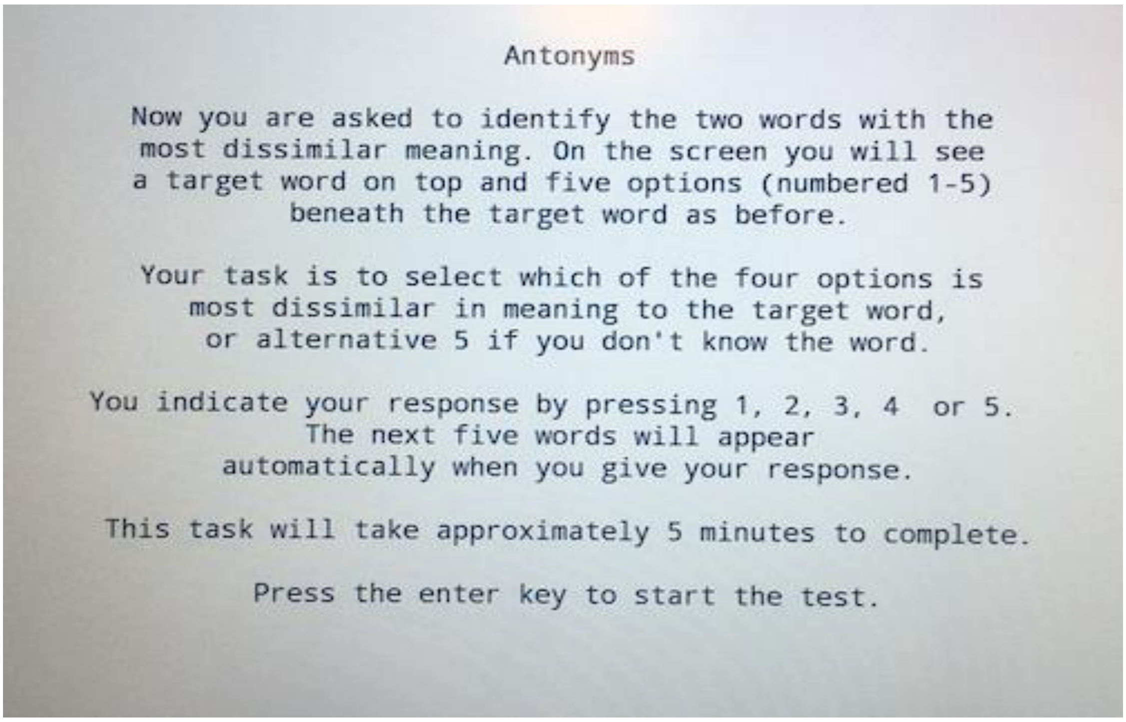
Appendix A:

Demonstrating the instructions, the participants were given before the English synonym task.



Appendix B:

Demonstrating the instructions, the participants were given before the English antonym task.



Appendix C: Vocabulary test

Norwegian words

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

Test	Language	Item	Word	Length	WordFreq	DomPos_UK	DomPos_dic	Correct	FoilA	FoilB	FoilC	orrectFre	FoilAFreq	FoilBFreq	FoilCFreq	Source
anto	N	1	lapidarisk	10			a	pratesyk	usann	kortfattet	fremmed					NoWaC
anto	N	2	distré	6			a	oppmerksom	utakknemlig	motsatt	fordelt					NoWaC
anto	N	3	sjofel	6			a	hyggelig	annerledes	lumpen	skjærende					NoWaC
anto	N	4	vanvidd	7			n	fornuft	ordstrid	viktighet	velklang					NoWaC
anto	N	5	armod	5			n	rikdom	avsporing	elendighet	bopel					NoWaC
anto	N	6	overflod	8			n	fattigdom	omskifte	flom	vrede					NoWaC
anto	N	7	avertere	8			v	skjule	tirre	kunngjøre	forstyrre					NoWaC
anto	N	8	nennsom	7			a	voldsom	sparsom	virksom	strevsom					NoWaC
anto	N	9	ødsle	5			v	spare	hevde	nære	tvile					NoWaC
anto	N	10	bebreide	8			v	berømme	beleire	betvile	betenke					NoWaC
anto	N	11	uaffisert	9			a	påvirket	redigert	offentlig	merkelig					NoWaC
anto	N	12	besynderlig	11			a	alminnelig	snevert	omfattende	anerkjent					NoWaC
anto	N	13	ublu	4			a	rimelig	skjør	freidig	skral					NoWaC
anto	N	14	hovmod	6			n	ydmykhet	angst	avskjed	tilregnelighet					NoWaC
anto	N	15	anfektelse	10			n	visshet	forhindring	åpenbaring	straff					NoWaC
anto	N	14	petimeter	9			n	slask	lekmann	tommestokk	skritt-teller					NoWaC
anto	N	17	avferdige	9			v	godta	avslutte	forhindre	testamentere					NoWaC
anto	N	18	bifalle	7			v	avvise	tilta	snuble	erobre					NoWaC
anto	N	19	fetere	6			v	overse	pine	ernære	flytte					NoWaC
anto	N	20	nidkjær	7			a	slurvete	trassig	selvopptatt	streng					NoWaC

English words

Test	Language	Item	Word	Length	WordFreq	DomPos_UK	DomPos_dic	Correct	FoilA	FoilB	FoilC	CorrectFre	FoilAFreq	FoilBFreq	FoilCFreq	Source
syno	E	1	caprice	7	2,73	noun	n	whim	cattle	brute	lounge	3,16	4,25	3,33	4,19	SubtlexUK
syno	E	2	baffle	7	2,6	verb	v	confuse	hide	warp	bully	3,5	4,66	3,19	3,72	SubtlexUK
syno	E	3	ponderous	9	2,39	adjective	a	unwieldy	useless	supportive	thoughtful	2,56	4,1	3,87	3,52	SubtlexUK
syno	E	4	banter	8	3,66	noun	n/v	chatting	whispering	denial	beating	4,03	3,43	3,6	4,31	SubtlexUK
syno	E	5	garish	6	2,85	adjective	a	tasteless	spiky	green	bland	2,96	3,51	5,22	3,5	SubtlexUK
syno	E	6	sequin	6	2,36	noun	n	bead	stamp	sledge	order	2,93	4,2	3,3	5,15	SubtlexUK
syno	E	7	loquacious	10	1,87	adjective	a	talkative	broad	roomy	marshy	2,69	4,22	2,95	2,63	SubtlexUK
syno	E	8	covet	5	2,39	verb	v	desire	pad	cradle	cave	4,24	3,97	3,46	4,19	SubtlexUK
syno	E	9	acumen	6	2,65	noun	n	cleverness	blame	spicy	wealth	2,44	4,66	3,98	4,33	SubtlexUK
syno	E	10	drench	6	2,06	noun	n/v	soak	raise	erase	flatten	3,78	4,85	3,08	3,24	SubtlexUK
syno	E	11	abide	5	3,45	verb	v	endure	inhabit	crave	depart	3,5	2,99	3,13	3,27	SubtlexUK
syno	E	12	vocation	8	3,14	noun	n	occupation	holiday	pronunciation	vocabulary	3,86	4,94	3,09	3,43	SubtlexUK
syno	E	13	gulch	5	1,81	name	n	crevasse	swallow	shed	dislike	2,42	3,89	4,38	3,52	SubtlexUK
syno	E	14	cogitate	8	1,9	verb	v	ponder	achieve	succeed	enquire	3,06	4,66	4,15	2,75	SubtlexUK
syno	E	15	vexatious	9	2,02	adjective	a	effortful	engaging	horrifying	priceless	1,3	3,75	3,19	3,7	SubtlexUK
syno	E	16	peril	5	3,39	noun	n	danger	shiny	delight	shelter	4,75	4,15	4,04	4,13	SubtlexUK
syno	E	17	feral	5	3,13	adjective	a	savage	hungry	impartial	ugly	3,83	4,55	3,24	4,23	SubtlexUK
syno	E	18	ludicrous	9	4,41	adjective	a	ridiculous	developed	nasty	certain	4,57	4,51	4,45	4,99	SubtlexUK
syno	E	19	brisk	5	3,35	adjective	a	energetic	disposable	section	stern	3,58	3,31	4,53	3,57	SubtlexUK
syno	E	20	truculent	9	1,74	adjective	a	defiant	delicious	juicy	tardy	3,22	4,66	3,86	2,3	SubtlexUK

Test	Language	Item	Word	Length	WordFreq	DomPos_UK	DomPos_dic	Correct	FoilA	FoilB	FoilC	CorrectFre	FoilAFreq	FoilBFreq	FoilCFreq	Source
anto	E	1	concerned	6	4,93	verb	a	uncaring	scarce	misleading	understanding	2,48	3,51	3,64	4,47	SubtlexUK
anto	E	2	timorous	8	1,81	adjective	a	fearless	forestry	funny	emotive	3,51	3,56	5,06	3,22	SubtlexUK
anto	E	3	disdain	9	2,73	noun	n	admire	unload	misfortune	huge	3,97	3,12	3,18	5,32	SubtlexUK
anto	E	4	acerbic	7	2,17	adjective	a	sweet	itchy	loud	beautiful	4,98	3,45	4,48	5,42	SubtlexUK
anto	E	5	nonplus	7			v	enlighten	subtract	gain	disadvantage	3,12	2,62	4,34	3,6	SubtlexUK
anto	E	6	surfeit	7	1,84	noun	n	lack	southern	excess	fake	4,62	4,5	4	4,51	SubtlexUK
anto	E	7	vicious	7	3,87	adjective	a	gentle	slippery	fierce	disobedient	4,23	3,84	3,97	2,34	SubtlexUK
anto	E	8	saunter	7	2,25	verb	v	rush	fry	punish	daydream	4,44	4,19	3,64	2,9	SubtlexUK
anto	E	9	slipshod	8	1,6	adjective	a	careful	difficult	clumsy	footwear	4,84	5,4	3,63	3,24	SubtlexUK
anto	E	10	umbrage	7	2,14	noun	a/n	delight	dungeon	demanding	appeal	4,04	3,14	4,09	4,59	SubtlexUK
anto	E	11	strenuous	9	2,92	adjective	a	effortless	arduous	smooth	tricky	3,13	3,06	4,36	4,51	SubtlexUK
anto	E	12	divulge	7	2,67	verb	v	conceal	purchase	disclose	smuggle	3,24	4,28	3,22	3,12	SubtlexUK
anto	E	13	loathe	6	3,16	verb	v	cherish	rejoice	kindle	undress	3,37	3,22	2,73	2,68	SubtlexUK
anto	E	14	querulous	9	1,3	adjective	a	agreeable	feathered	blatant	squeaky	3,03	3,14	3,19	3,42	SubtlexUK
anto	E	15	forgo	5	2,55	verb	v	acquire	precede	journey	disappear	3,46	2,53	4,91	4,21	SubtlexUK
anto	E	16	conquer	7	3,64	verb	v	surrender	demand	retain	release	3,76	4,56	3,9	4,6	SubtlexUK
anto	E	17	hovel	5	2,57	noun	n	palace	float	cloudy	stairwell	4,55	3,96	4,17	2,93	SubtlexUK
anto	E	18	adversity	9	3,24	noun	n	advantage	delay	grudge	persevere	4,67	4,11	3,19	2,85	SubtlexUK
anto	E	19	alacrity	8	2,08	noun	n	slowness	annoyance	fog	ingenuity	2,33	3,03	4,08	3,31	SubtlexUK
anto	E	20	penury	6	2,02	noun	n	wealth	dispatch	cunning	famine	4,33	3,34	3,82	3,62	SubtlexUK

Appendix D: Stimulus materials from LexTALE

	LexTALE Items	Correct Response	Norwegian Translation			LexTALE Items	Correct Response	Norwegian Translation
					29	Bewitch	Yes	Fortryllelse
Practice Item	Platery	No			30	Skave	No	
Practice Item	Denial	Yes	Fornektelse		31	Plaintively	Yes	Klagelig
Practice Item	Generic	Yes	Generisk		32	Kilp	No	
1	Mensible	No			33	Interfate	No	
2	Scornful	Yes	Hånlig		34	Hasty	Yes	Forhastet
3	Stoutly	Yes	Tøff		35	Lengthy	Yes	Langvarig
4	Ablaze	Yes	Flammer/ Brann		36	Fray	Yes	Slåss
5	Kermshaw	No			37	Crumper	No	
6	Moonlit	Yes	Månelyst		38	Upkeep	Yes	Vedlikehold
7	Lofty	Yes	Høy/Høye		39	Majestic	Yes	Majestetisk
8	Hurricane	Yes	Orkan		40	Magrity	No	
9	Flaw	Yes	Feil		41	Nourishment	Yes	Næring
10	Alberation	No			42	Abergy	No	
11	Unkempt	Yes	Uforsiktig		43	Proom	No	

12	Breeding	Yes	Avl		44	Turmoil	Yes	Kaos/Uro
13	Festivity	Yes	Festlighet		45	Carbohydrate	Yes	Karbohydrat
14	Screech	Yes	Skrik		46	Scholar	Yes	Lærd
15	Savoury	Yes	Velsmakende		47	Turtle	Yes	Skilpadde
16	Plaudate	No			48	Fellick	No	
17	Shin	Yes	Legg		49	Destription	No	
18	Fluid	Yes	Væske		50	Cylinder	Yes	Sylinder
19	Spaunch	No			51	Censorship	Yes	Sensur
20	Allied	Yes	Alliert		52	Celestial	Yes	Himmelsk
21	Slain	Yes	Drept		53	Rascal	Yes	Rakker
22	Recipient	Yes	Mottaker		54	Purrage	No	
23	Exprate	No			55	Pulsh	No	
24	Eloquence	Yes	Veltalenhet		56	Muddy	Yes	Gjørmete
25	Cleanliness	Yes	Renslighet		57	Quirty	No	
26	Dispatch	Yes	Utsendelse		58	Pudour	No	
27	Rebondicate	No			59	Listless	Yes	Sløv
28	Ingenious	Yes	Genial		60	Wrought	Yes	Smidd

Appendix E: Adapted LEAP-Q

REMEMBER TO 'SAVE AS' Y + SUBJECT NUMBER (E.G., Pp_01) FIRST!!

General note: cells are locked to prevent formula being changed (you can unlock if necessary by removing the worksheet protection).

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; 3 = fair; 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)?

Q17 Which written form of Norwegian have you predominantly been using?

END OF QUESTIONNAIRE - THANK YOU FOR YOUR TIME!

Appendix F: Distractor maths

1	Answer		Answer		Answer		Answer
18+33=		11+34=		32+8=		520+73=	
10+4=		66+2=		3+59=		11+44=	
3+19=		102+87=		95+8=		69+2=	
55+2=		4+13=		92+7=		12+47=	
72+3=		21+1=		9+133=		7+143=	
7+33=		99+6=		18+31=		12+83=	
2+81=		2+67=		96+23=		26+11=	
68+1=		33+29=		12+7=		100+34=	
12+34=		7+6=		4+14=		22+71=	
14+9=		19+17=		32+7=		81+6=	
2+16=		3+3=		2+39=		12+33=	
42+1=		20+6=		155+3=		6+24=	
5+9=		65+97=		902+7=		72+8=	
35+8=		23+5=		17+33=		14+19=	

6+19=	35+2=	4+83=	8+6=
3+99=	2+197=	54+1=	436+2=
54+2=	71+6=	199+3=	44+1=
33+5=	28+13=	4+49=	6+87=
9+12=	10+45=	2+87=	3+63=
18+7=	52+73=	22+8=	88+9=
8+2=	44+8=	34+6=	11+54=
20+2=	210+67=	22+5=	3+258=
32+9=	42+6=	9+36=	16+41=
7+42=	3+55=	19+3=	10+22=
2+33=	8+6=	14+44=	98+71=
6+99=	49+2=	72+6=	5+5=
12+91=	4+10=	7+43=	7+9=
64+4=	37+25=	3+727=	8+44=
78+4=	34+6=	76+11=	1+156=
249+4=	60+45=	8+8=	3+21=

2	Answer		Answer		Answer		Answer
102+3=		33+3=		14+41=		100+54=	
22+9		1+78=		4+18=		6+6=	
765+1		86+6=		2+69=		53+66=	
72+91		3+80=		854+1=		85+4=	
12+3		54+7=		763+3=		7+11=	
56+9		43+70=		3+67=		13+91=	
32+32		38+6=		4+69=		2+44=	
55+63		99+30=		39+8=		6+68=	
88+1=		6+9=		5+65=		1+72=	
76+9=		4+87=		48+3=		23+5=	
38+3=		21+1=		9+133=		17+34=	
87+33=		9+6=		28+31=		82+8=	
2+81=		5+91=		9+73=		56+12=	
8+194=		13+9=		32+6=		612+4=	
2+37=		89+6=		75+15=		82+41=	

547+9=	19+17=	32+27=	27+26=
19+45=	3+83=	24+9=	17+43=
4+188=	206+6=	75+1=	61+4=
5+89=	73+91	30+62=	4+227=
68+62=	16+39=	87+352=	8+82=
10+66=	23+123=	44+83=	51+40=
3+86=	20+87=	65+13=	4+52=
56+89=	3+92=	44+37=	45+10=
19+3=	1+7643=	203+90=	52+27=
32+31=	8+84=	111+76=	54+4=
14+65=	47+33=	65+45=	15+93=
82+37=	188+2=	23+57=	72+98=
101+95=	50+82=	81+83=	44+76=

Appendix G: Overview of the subset order with its eight versions.

This section shows all eight lists. The ones in black are non-mirrored and the ones in red are mirrored versions. The colour coded backround shows how the different versions are mixed. The ‘x’ means filler scenes, which was the same filler scenes for all participants.

list1_condition	list2_condition	list3_condition	list4_condition
x	x	x	x
x	x	x	x
x	x	x	x
study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order
x	x	x	x
study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order
study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order
study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order
study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order

x	x	x	x
study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order
study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order
study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order
study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order
x	x	x	x
study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order
study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order
study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order
x	x	x	x
study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order

study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order
study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order
x	x	x	x
study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order
study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order
study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order
x	x	x	x
study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order
study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order

study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order
study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order
x	x	x	x
study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order
study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order
study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order
study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order
x	x	x	x
study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order
study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order
x	x	x	x
study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order
study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order

study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order
study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order
x	x	x	x
study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order
study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order
study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order
x	x	x	x
study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order
study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order
x	x	x	x
study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order

study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order
study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order
x	x	x	x
study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order
study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order
study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order
study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order
x	x	x	x
study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order
study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order
study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order

study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order
x	x	x	x
study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order
study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order
study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order
x	x	x	x
study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order
study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order
study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order
x	x	x	x
x	x	x	x

list5_condition	list6_condition	list7_condition	list8_condition
x	x	x	x
x	x	x	x
x	x	x	x
study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order
x	x	x	x
study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order
study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order
study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order
study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order
x	x	x	x
study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order
study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order
study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order

study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order
x	x	x	x
study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order
study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order
study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order
x	x	x	x
study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order
study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order
study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order
x	x	x	x
study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order

study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order
study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order
study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order
x	x	x	x
study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order
study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order
study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order
study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order
x	x	x	x
study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order
study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order
study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order

study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order
x	x	x	x
study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order
study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order
x	x	x	x
study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order
study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order
study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order
x	x	x	x
study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order
study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order

study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order
x	x	x	x
study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order
study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order
x	x	x	x
study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order
study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order
study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order
x	x	x	x
study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order
study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order

study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order
study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order
study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order
x	x	x	x
study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order
study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order
study_cognate_disfluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_fluent_RL_rec_order
study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order
x	x	x	x
study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order
study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order
study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order

study_noncognate_fluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_disfluent_LR_rec_order
x	x	x	x
study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order	study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order
study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order	study_noncognate_disfluent_RL_rec_order	study_cognate_fluent_RL_rec_order
study_cognate_disfluent_LR_rec_order	study_noncognate_disfluent_LR_rec_order	study_cognate_fluent_LR_rec_order	study_noncognate_fluent_LR_rec_order
study_noncognate_disfluent_RL_rec_order	study_cognate_disfluent_RL_rec_order	study_noncognate_fluent_RL_rec_order	study_cognate_fluent_RL_rec_order
x	x	x	x
x	x	x	x

Appendix H: Example of what the participants sees on their screen during the test phase.

The specific example is of the large bedroom used as examples in Figure 2.4, 2.5 and 2.6 in the method section.

Appendix I: Results of all four pre-tests

(in %)	subject_nr	Auditory working memory test	Norwegian vocabulary test	English vocabulary test	LexTALE
1	1	63.3	10	35	92.2
2	2	56.7	50	30	87.3
3	3	50	42.5	27.5	84.1
4	4	63.3	30	27.5	76.2
5	5	56.7	30	37.5	73
6	6	66.7	42.5	40	88.9
7	7	66.7	20	57.5	92.1
8	8	80	30	57.5	88.9
9	9	70	45	60	88.9
10	10	76.7	35	12.5	71.4
11	11	53.3	25	20	63.5
12	12	66.7	35	60	87.3
13	13	73.3	20	30	85.7
14	14	80	52.5	27.5	92.1
15	15	73.3	30	15	73
16	16	80	50	20	69.8
17	17	70	57.5	27.5	68.3
18	18	66	57.5	30	71.4
19	19	70	40	15	66.7
20	20	66.7	20	15	79.4
21	21	76	45	40	92.1
22	22	53.3	22.5	40	93.7
23	23	60	12.5	27.5	82.5
24	24	80	22.5	40	90.5
25	25	46.7	30	20	77.8
26	26	56.7	15	20	77.8
27	27	53.3	47.5	40	85.7
28	28	60	27.5	27.5	87.3
29	29	66.7	15	32.5	87.3
30	31	63.3	17.5	7.5	79.4
32	32	86.7	40	40	84.1
34	34	66.7	32.5	37.5	87.3
35	35	53.3	32.5	30	92.1
Mean		**65.8**	**32.8**	**31.7**	**82.4**