A Bilingual Advantage? A Comparison of Switch Costs between Task Switching and Language Switching in High and Low Proficient Dutch-English Bilinguals.

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Acknowledgements

Writing your Master thesis is, what I believe, another definition for the phrase "so close, but yet so far". Friends, family, acquaintances and even colleagues will compliment you on getting so far and that you are "almost there". I can safely say, however, that "almost there" is a rather broad concept. I think I told everyone including myself, that I was "almost there" for over half a year, or maybe even longer. While writing this preface, I am however, literally "almost there".

I did not do this all by myself, so I would like to take this opportunity to thank all the people that participated in my experiment. An experiment cannot be conducted without the help of participants. Besides these participants, I want to say special thanks to my supervisor dr. Sybrine Bultena. Her ideas, help, criticism and most of all enthusiasm made this thesis possible. Without her help, I think I would still be "almost there".
I also want to thank my friends and family for being there for me throughout this entire process.

In the end I think I can be proud of what I created in almost a year time. And honestly, it actually was not all that bad. To be even more honest, I think I actually had fun during some (or maybe even most) of it.

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Abstract

The study conducted in this thesis aimed to make a more reliable comparison between the performance of low and high proficient bilinguals on a language switching task and task switching task. This study investigated if proficiency of the participants influenced the size of the switch costs per task and if their participants will show similar switch costs on both tasks indicating that these tasks rely on the same mechanisms. Lastly, this study investigated whether language influenced the size of the switch costs in such a way that high proficient bilinguals will show a reduction in the size of the switch costs compared to low proficient bilinguals during language switching.

Participants consisted of 26 native speakers of Dutch-English bilinguals, divided in a high and low proficient group. All participants were between the age of 18 and 35. Participants were asked to decide whether a digit was <5 or >5 during the task switching tasks, and whether the word was Dutch or English during the language switching task. Analyses were conducted by means ANOVAs. These showed switch costs, however neither proficiency nor tasks influenced the size of the switch costs of the participants. Participants responded faster during task switching than during language switching, and the low proficient bilinguals responded faster than high proficient bilinguals. Language had no effect on the outcomes of the study. The lack of significant interactions is explained by the similarities between both tasks, and by the possible high proficiency level of the low proficient bilingual group. Replicating this study with two more distinct groups of bilinguals would possibly lead to different results.

Keywords: bilingualism, task switching, cueing, language switching, proficiency, production, comprehension.

1. *Introduction*

The NRC Handelsblad published an article about a book written by Neuropsychologist Mark Tichgelaar, which is about switching, and moreover emphasises the lack of focus people undergo after they just switched from tasks (Vriesinga, 2019). Within the neuropsychology they call it "aandachtsresidu" (*lack of attention*), within the field of language switching it is defined as *switch costs*.

One topic in the field of bilingualism is whether or not bilinguals have a so-called *bilingual advantage*. The bilingual advantage proposes that a bilingual's experience of using two languages, the constant need to monitor and manage two languages simultaneously (Prior & MacWhinney, 2010), strengthens a bilingual's executive control. Executive control (EC) can be described as the ability to carry out goal-directed behaviour by using cognitive abilities and complex mental processes, this entails for instance inhibition (Zheng, Roelofs and Lemhöfer, 2018).

Fluent bilinguals are thought to be experts in switching between their first language (L1) and their second language (L2), activating one language and meanwhile inhibiting the other language, because this is a process they constantly have to conduct (Declerck & Philipp, 2015). Language switching paradigms allow researchers to explore how language control operates, and moreover which processes (i.e. inhibition) play a crucial role in language switching (Declerck & Philipp, 2015). Nowadays it is believed that a bilingual's good ability to switch between languages and inhibit languages could not solely be language specific but could also be domain-general. (Bialystok, Craik, Green & Gollan, 2009).

However, this belief is not shared among all studies conducted in the field of bilingualism and its (dis)advantages. Some studies criticise this believe and support the claim that the experience in switching and inhibition in bilinguals is more language specific rather than domain-general (Paap & Greenberg, 2013). This thesis, among other things, focusses on the discussion between these viewpoints and their contradicting vision on the possible existence of a *bilingual advantage*.

In the field of language switching and task switching, comparisons are often made between two tasks that differ in modality (production versus comprehension). Participants are often asked to name images or digits during a language switching task (Meuter & Allport, 1999; Costa & Santesteban, 2004; DeClerck, Koch & Philipp, 2012), whereas they are required to for instance press a button during a task switching task (Prior & MacWhinney, 2010; Prior & Gollan, 2011). Therefore, reaction times of producing words during digit- or image-naming are often compared to measuring reaction times by the time it takes a participant to press a button. The comparison of reaction times between the actual oral production of stimuli is hard – or maybe even impossible – to the pressing of a button. The same accounts for accuracy. The number of errors during oral production should not be compared to the number of errors made during button-press.

Moreover, in many of the studies that are conducted in the field of language switching and task switching, a comparison is made between groups with widely varying L2 proficiency levels (Meuter & Allport, 1999; Prior & MacWhinney, 2010). This means that the participants often used in these studies are either highly proficient in their L2 or barely proficient in their L2. Therefore, L2 proficiency is often not properly taken into account. This current study therefore aims to compare two groups of participants with less varying proficiency levels, so another comparison is made than the standard (very) high bilinguals versus (extremely) low bilinguals or monolinguals comparison.

Besides the discrepancies in response modality and L2 proficiency between language- and task switching tasks, there is also quite a discrepancy between the use of cues in these tasks. A cue is an important aspect of a switching paradigm and is implemented to tell the participant which decision to make. Cueing can occur during the display of stimuli, before the display of stimuli or maybe even before and during the display of stimuli. Cues come in all kinds of shapes or figures. They can for instance consist of colours (i.e. background colour) (i.e. Zheng, Roelofs & Lemhöfer, 2018), flags (Prior & Gollan, 2011) or non-linguistic shapes and/or figures (Prior & MacWhinney, 2010). It is important to take into account that the difference in cueing can also have an influence on the outcomes of these studies and make comparisons between switching tasks less reliable. Therefore, this current study aimed to use comparable cues in the language- and task switching task to make a more reliable comparison between both switching tasks.

Switching tasks are often compared with one another by means of switch costs. Switch costs are often defined as the “difference in naming latencies between switch and non-switch trials” (De Bruin, Roelofs, Dijkstra & Fitzpatrick, 2014, p. 348). In other words, response times are often slower when it comes to switch trials compared to non-switch trials, and the difference between these response times is defined as a switch cost. In line with former research, this study therefore also focusses on switch costs to compare the results between both tasks, the participants, and the different cues.

This thesis hopes to contribute to the discussion whether or not bilinguals experience a *bilingual advantage* while conducting a language switching and task switching task. In the current study, 27 native speakers of Dutch between 18 and 35 years old are scaled in a certain level of proficiency in their L2 (English) by means of an abridged version of the Language History Questionnaire (LHQ) 2.0 (Li, Zhang, Tsai & Puls., 2014) and the lexTALE test (Lemhöfer & Boersma, 2012). Moreover, the participants are asked to conduct a language switching task and a task switching task, in which their reaction times are measured by the time it takes the participant to press a button on the keyboard and their accuracy is measured by the number of errors the participants made during these tasks. This study therefore believes to make a more reliable comparison between both switching tasks (as they are both focussed on comprehension rather than production), and to make an accurate comparison between the participants' proficiency level of English and their performance on a language switching task and a task switching task. This study will investigate the following research questions:

1. Will the proficiency of the participants influence the size of the switch costs per task? In other words, will there be a significant difference in the size of the switch costs for high proficient bilinguals compared to the size of the switch costs for low proficient bilinguals in both task switching and language switching task?

2. Will there be an overlap in performance between the switch costs of participants on the task switching task and language switching task indicating that these tasks rely on the same mechanisms?

3. Will language influence the size of the switch costs in such a way that high proficient bilinguals will show a reduction in the size of the switch costs compared to low proficient bilinguals during language switching?

This thesis will first provide an overview of relevant literature and afterwards state the hypotheses for the aforementioned research questions.

2. ***Literary review***

2.1 Lexical access: Language non-selective

Nowadays, research has found supporting evidence that bilinguals have an integrated lexicon for their L1 and L2, and consequently that lexical access is language non-selective (Dijkstra, Timmermans, & Schriefers, 2000; Weber & Cutler, 2004; Libben & Titone, 2009; Lagrou, Hartsuiker & Duyck, 2011). Language non-selective lexical access entails that both a bilingual's L1 and L2 will be activated, despite the input language, and that the input language eventually is activated more strongly which consequently leads to the recognition of the input (Dijkstra et al., 2000; Libben & Titone, 2009; Lagrou et al., 2011). However, research has also shown that not only the target language helps to activate meaning. The non-target language also helps to activate meaning (Libben & Titone, 2009; Lagrou et al., 2011). Because two languages are co-activated, it is important to focus on the mechanisms of inhibition of and switching between languages to understand how the correct target and correct target language are selected. So how exactly does the correct target and correct target language get selected?

Multiple activation and competition: evidence for the language non-selective view

When the selection of the target, and target language, has to occur, there are always multiple candidates activated that are in competition with one another for activation. When bilinguals have to select the target word, there is not solely within language competition, but also between language competition (Allopenna, Magnusen & Tanenhaus, 1998).

Evidence for the language non-selective view in bilingual auditory word recognition comes from a study conducted by Weber and Cutler (2004). They found that their participants looked longer at competitor objects with a phonemically similar L1 onset than to the distracter objects. In other words, when the participants were asked to "pick up the *desk*, they fixated longer on a picture of the *lid* than on a control picture, due to the fact that *lid* is the translation equivalent of the Dutch word *deksel*, phonologically overlapping with the word *desk* (the L2 target word). This means that the non-native listeners' native vocabulary adds competition.

Evidence for the assumption that bilingual visual word recognition is language non-selective is found in studies focussing on cognate facilitation and homograph inhibition. Cognates are words that share semantic, orthographic and phonological representations across languages (Lagrou et al., 2011). Research has shown that participants respond faster to cognate words than to control words in a lexical decision task. This is called the *cognate facilitation effect* (Libben & Titone, 2009).

A homograph is a word that shares visual representation between languages but has a different meaning in each language (i.e. Dutch-English homograph *room,* which when translated into Dutch means “kamer”, but is a word itself in Dutch as well that means *cream*. (Lagrou et al., 2011). Dijkstra et al. (2000) observed longer reaction times when their participants read homographs in a language decision task, and they also found longer reaction times in a go/no-go task. The Dutch-English bilinguals in this study were slower in recognising homographs compared to control words, because the homographs activated two meanings instead of one meaning (one meaning in each language).

More support for the lexical non-selective view was found by Van Heuven, Dijkstra and Grainger (1998), who studied the effect of orthographic neighbours in both languages during a lexical decision task. An orthographic neighbour is any word that differs by a single letter from the target word, taking into account length and letter position (Van Heuven et al., 1998). It takes time to recognise a target word, and the time it takes to recognise a target word is influenced by the number and frequency of that word’s neighbours (Van Heuven et al., 1998; Kroll & Sunderman, 2003). In this study, Van Heuven et al. (1998) researched whether the time for Dutch-English bilinguals to recognise a string of English letters as an English word would be influenced by the presence of either English or Dutch neighbours. Results showed that the performance of the bilinguals was influenced by neighbours in both languages when only English was required for lexical decision. These results indicate that access to the lexicon is language non-selective, and that the lexicon is integrated rather than separated, at least for languages that are relatively similar as English and Dutch (Van Heuven et al., 1998).

Over the years, much research has been done in favour of language non-selective (lexical) access, and different models and theories have been proposed about bilingual production and recognition. Below this thesis will expand on the Bilingual Interactive Activation + (BIA+)

model, which is a model that proposes that word recognition occurs in a language non-selective way (Dijkstra & Van Heuven, 2002), and on Green's (1998) Inhibitory Control model that focusses on the importance of inhibition during target language selection in oral naming.

2.2 Models

2.2.1. BIA+ model

The BIA+ model is an upgraded version of the former BIA model (Dijkstra & Van Heuven, 1998) and is an algorithmic model of bilingual word recognition that does not only implement non-selective bottom-up processing, but also implements language-specific top-down processing. This means that the visual input (i.e. letters) activate words from both languages in an integrated lexicon, but that on the other hand language nodes selectively inhibit activity in words of the non-target language (Dijkstra & Van Heuven, 2002). Besides only taking into account orthographic information as in the BIA model (Dijkstra & Van Heuven, 1998) this new upgraded version also takes into account phonological and semantic lexical representations (Dijkstra & Van Heuven, 2002).

The BIA+ model has two basic assumptions. Firstly, the words from both the L1 and L2 are represented in an integrated lexicon rather than two separate lexicons, and secondly, word recognition occurs in a language non-selective way, with candidates in both languages activated whenever the input shares features with alternatives in either language (Dijkstra & Van Heuven, 2002; Kroll & Sunderman, 2003).

As can be seen in Figure 1 below, the BIA+ model assumes that upon receiving orthographic input, first letter and then word units are co-activated for words in both languages. "Inhibitory connections then create competition among same and other language alternatives" (Kroll & Sunderman, p. 107, 2003). In contrast to monolingual models, this

BIA+ model includes a node that accounts for languages. This node makes it possible to bias activation of one language relative to the other. In a language switching paradigm, there are non-switch and switch trials. During a switch trial, another language node needs to be activated and in turn interferes processing, whereas during a non-switch trial the same language node is activated and thus processing can occur without language interference (Declerck & Philipp, 2015).

Over the years, more and more studies have shown results in favour of the language non-selective view, and thus supporting the assumptions of the BIA+ model (Libben & Titone, 2009; Lagrou et al., 2011).

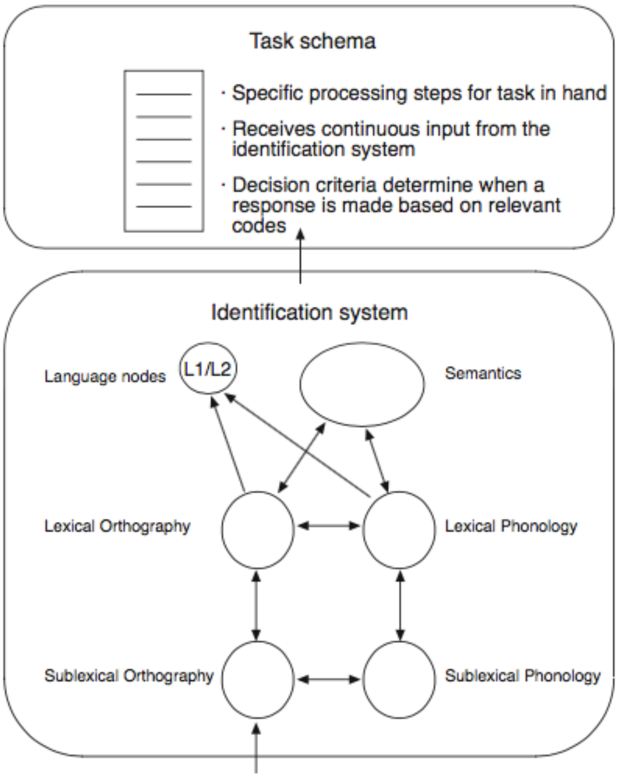

Figure 1. The BIA+-model (Dijkstra & Van Heuven, 2002).

2.2.2. Inhibition

As mentioned before, bilinguals are thought to be good switchers. However, bilinguals are not only thought to be experts in switching, but also in inhibition, which is thought to be a process that plays an important role during language switching (Declerck & Philipp, 2015). When selecting the correct language, the other language needs to be supressed, or in other words, inhibited, therefore inhibition entails the reduction of the non-target language activation (Declerck & Philipp, 2015). Evidence for the existence of inhibition during language control are *asymmetrical switch costs*. Asymmetrical switch costs refer to the process that switch costs are larger when switching into the bilingual's first language (L1) than when switching into the bilingual's second language (L2) (Green, 1998; Meuter & Allport, 1999). On the one hand, naming in the L2 requires more inhibition of the stronger L1. As a consequence, it takes more time to switch back to your L1 from your L2. On the other hand, naming in L1 requires less inhibition of the weaker L2 and therefore it takes less time to switch back to your L2 after speaking in your L1 (Green, 1998; Meuter & Allport, 1999). However, this finding of asymmetrical switch costs seems to be applicable to unbalanced bilinguals, but not to balanced bilinguals, whereas they show symmetrical rather than asymmetrical switch costs (Costa & Santesteban, 2004).

This extensive practice in switching between languages and inhibiting of languages for bilinguals leads to the question whether bilinguals have an enhanced ability in cognitive control that is not solely applicable to language switching and inhibiting, but rather applicable to switching and inhibiting in general.

Thus far, studies researching whether this enhanced ability in cognitive control is general rather than language specific have shown contrasting evidence. Some studies believe that an enhanced ability in cognitive control in bilinguals is general for switching and inhibition tasks (whether these are linguistic or non-linguistic) (Prior & Gollan, 2011), whereas other studies point out that this quality is language specific rather than domain-general (Paap & Greenberg, 2013). One model that proposes that language-switching and inhibition is part of a general switching mechanism, rather than a language specific mechanism is Green's Inhibitory Control (IC) model (1998).

2.2.3. Green's Inhibitory Control (IC) model (1998)

Green's Inhibitory Control (IC) Model (1998) proposes that language-switching is controlled by language-external inhibitory control networks, which is not solely applicable to language-switching, but also applicable to switching in general. During object-naming in bilinguals, multiple candidates are activated (from both languages), and these candidates compete for selection (Green, 1998). The item that reaches the highest activation gets selected by inhibiting the items in the non-target language. The IC model consists of two assumptions:

1. The amount of inhibition depends on a speaker's relative proficiency in a language. In unbalanced bilinguals, their L1 is more dominant than their L2. The IC model assumes that when unbalanced bilinguals speak in their L2, they will experience more inhibition of the stronger L1 compared to less inhibition of the weaker L2 when they speak in their L1 (Green, 1998). In other words, when a bilinguals' proficiency in their L2 increases, they will (probably) also experience more difficulty inhibiting this growing L2. This could lead to the fact that balanced bilinguals will experience a similar inhibition in their L1 and in their L2.

2. The second assumption that the IC model makes is that it takes time to overcome this inhibition that unbalanced bilinguals experience mentioned in assumption one. According to the IC model, this inhibition leads to asymmetrical switching costs in unbalanced bilinguals.

The assumptions made in Green's IC model (1998) solely focus on unbalanced bilinguals and do not make any assumptions about balanced bilinguals. However, as mentioned above, it could be believed that balanced bilinguals experience an equal inhibition in both languages, as these languages are both equally dominant. This would indicate that balanced bilinguals will not (or barely) experience switching costs. The assumptions made by Green's IC model (1998) were supported by several studies (Meuter & Allport, 1999; Jackson, Swainson, Cunnington & Jackson, 2001).

2.2.3.1. Evidence for Green's IC Model (1998) from production tasks

Several studies found evidence that support the assumptions made in the IC model. For instance, a classic language switching paradigm study conducted by Meuter and Allport (1999). In this study, Meuter and Allport investigated a bilingual's ability to switch between languages. They tested 16 heterogeneous unbalanced bilinguals by letting them name numerals in either their L1 or L2. The participants knew which language they had to name the numerals in because of the colour of the rectangle around the numeral. This colour of the rectangle functioned as a colour-cue. The results showed that the participants' RTs were slower when they had to name the numerals in their L1 than in their L2.

Results also showed that the reaction times were slower when the participants had to switch between languages. As the researchers predicted, language-switching costs were significantly larger when switching from the weaker L2 to the dominant L1 than vice versa, and thus the unbalanced bilinguals in this study showed asymmetrical switch costs (Meuter & Allport, 1999). This means that during switch trials, L1 responses were slower than L2 responses. These results are in line with the two assumptions made by the IC model mentioned above.

So, to sum up, the unbalanced bilinguals in Meuter and Allport's study (1999) experienced more inhibition of the stronger L1 than the weaker L2. Consequently, the participants experienced asymmetrical switch costs, because the switch costs were significantly larger when switching from the weaker L2 to the dominant L1 than switching from the dominant L1 to the weaker L2.

Meuter and Allport's study (1999) is not the only study that found supporting evidence for Green's IC model (1998). Another study that supported Green's IC model (1998), is the study conducted by Jackson et al. (2001). They conducted a language-switching study with 24 native speakers of English. They performed a speeded digit naming task, in which the participants repeatedly had to switch between their first language, English, and their second language. The participants in this study were not a homogeneous group, and therefore the L2 differed among the participants. The participants chose a language as their L2 in which they could fluently name the numbers one up to and including eight. The numbers were presented in a certain colour and this colour indicated in which language the participants had to name the digit.

Jackson et al. (2001) also found significantly smaller switch costs when the participants had to name the digits in their second language. However, Jackson et al. (2001) did not find the asymmetrical switch costs that the study mentioned above by Meuter and Allport (1999) found and was assumed by Green's IC model (1998). Jackson et al. (2001) found that the RTs when switching from L2 to L1 did not differ from those observed switching from L1 to L2. Instead, they mentioned that their data "was better described in terms of asymmetric "non-switch benefits" in which participants are equally slow when switching from one language to another but experience an RT advantage for remaining within a language" (Jackons et al., 201, p.177). Jackson et al.'s study (2001) therefore do not support the second claim described by Green's Inhibitory Control model (1998), as they did not find asymmetrical switch costs.

The assumptions proposed by Green's IC model (1998) focussed on unbalanced bilinguals, and on object naming. However, what would happen to these assumptions if the participants were not unbalanced bilinguals, but rather more balanced or even completely balanced bilinguals? Would the RTs still be slower for the "weaker" L2 than the dominant L1 or would those RTs be rather similar due to the fact that the L2 is not that much weaker than the L1 anymore? Moreover, what if the participants were not asked to name the objects, but rather to read the stimuli? Would Green's (1998) assumptions still hold or would the results show an entirely different pattern? Although, supporting evidence has been found for Green's IC model (1998), it is important to note that these assumptions proposed by this model only took into account L1 and L2 production (i.e. object naming) and did not take into account for instance the comprehension of objects by for instance listening or reading the stimuli. Moreover, these assumptions also only took into account unbalanced bilinguals rather than balanced bilinguals.

In conclusion, it might be interesting to see whether the assumptions of the IC model (Green, 1998) will still account for (more) balanced bilinguals, and whether these assumptions also still hold when bilinguals are asked to read stimuli and respond by button-press rather than the naming of stimuli.

2.2.3.2. Comprehension and Green's IC model (1998)

As described, it is clear that empirical studies on language production on switching from one language to the other involve switch costs, and apparently that the proficiency of the bilinguals influences the direction of the switch costs (whether they are symmetrical or asymmetrical) (Jackson et al., 2001; Costa & Santesteban, 2004). Are switch costs, and therefore also switch cost (a)symmetries, however, also found for studies focussing on language comprehension rather than language production?

Most studies, either by means of self-paced reading or electrophysiological research, that focus on comprehension and language switching focus on reading of a word in another language embedded in a meaningful sentence context (Proverbio, Leoni & Zani, 2004; Ibáñez, Macizo & Bajo, 2010; Bultena, Dijkstra & Van Hell, 2014). Ibáñez et al. (2010) for instance, examined lexical access and language control in professional translators and bilinguals (Spanish L1, English L2) by means of self-paced reading times. All participants were visually presented with sentences in both L1 and L2 that contained a cognate, and switched languages between trials. Firstly, the participants were asked to read and repeat the sentences. Afterwards, they were asked to solely read the sentences. During the first task of reading and reading out loud, translators showed no switch costs in either direction, but did show a cognate effect in reading time in both languages (Ibáñez et al., 2010). Bilinguals showed asymmetrical switch costs as their reading times were slower when the sentences switched from English to Spanish and showed no cognate effect (Ibáñez et al., 2010). During the second task, however, both translators and bilinguals showed a cognate effect, but no switch costs were examined (Ibáñez et al., 2010). This study therefore shows that when the experiment involved a production element (reading out loud) a switch cost asymmetry was found, whereas no switch cost (a)symmetry was found when the participants were asked to just read the sentences (Ibáñez et al., 2010).

Alvarez, Holcomb and Grainger (2003) did conduct a sequential word reading task rather than using words embedded in sentences to investigate switch cost (a)symmetries in comprehension and language switching. Their sequential word reading task was performed by late L2-learners, which were unbalanced bilinguals. These unbalanced bilinguals had to read within- and between-language repetitions of (non-cognate) words. The decrease of the N400 amplitude for the second word of a pair indicated that a repetition effect was observed (Alvarez et al., 2003), and that this effect was smaller for the between- than within-language repetitions, indicating that translations (in other words: switches) were more difficult to process (Alvarez et al., 2003). The effect for repetition in the within-languages repetitions was larger for L2 than L1, and thus the direction of the switch costs was asymmetrical. This asymmetry could indicate that there is an effect of proficiency (Alvarez et al., 2003).

These studies showed converging evidence for the assumptions made by Green's IC model (1998). Ibáñez et al. (2010) observed asymmetrical switch costs during sentence production, but not during sentence comprehension, which would indicate that Green's assumptions (1998) are indeed applicable to language production but could not also account for language comprehension per se. Alvarez et al. (2003), however, did find asymmetrical switch costs in their study, which could indicate that the switch cost asymmetry is found in both language production and recognition.

2.3 Proficiency and its effect on (a)symmetrical switch costs

Besides taking into account the effect of recognition or production tasks on switch cost (a)symmetry, proficiency should also be taken into account. Costa and Santestaben (2004) conducted five separate experiments in their study that took into account several proficiency levels rather than focussing on just unbalanced or balanced bilinguals. Their goals were to replicate the results of the asymmetrical switch costs in L2 learners found by the aforementioned study of Meuter and Allport (1999), but more importantly to research whether L2 proficiency affected the pattern of switching performance, as formerly assumed by Green's IC model (1998).

Costa and Santestaben's (2004) first experiment investigated two groups of rather low-proficient bilinguals and aimed at replicating Meuter and Allport's (1999) finding of asymmetrical switch costs. They tested Spanish-Catalan participants and Korean-Spanish participants during a picture-naming switching task. Costa and Santestaben's (2004) results of the first experiment replicated Meuter and Allport's (1999) finding and showed that the magnitude of switch costs was larger for L1 than for L2, and thus switching into L1 was harder than switching into L2.

The results of the second experiment, which was conducted similarly as the first experiment, but with highly proficient Spanish-Catalan bilinguals rather than with late L2-learners and thus low- proficient bilinguals, were in line with another prediction made by Meuter and Allport (1999) and in line with Green's Inhibitory Control model (1998), and also formerly mentioned in this study. Meuter and Allport (1999) argued that asymmetrical switch costs were dependent on a bilingual's proficiency. In other words, the higher the proficiency the smaller the asymmetry. This notion was supported by the results of the second (and third) experiment, whereas Costa and Santestaben (2004) found that the highly proficient bilinguals in this study showed the same switch costs in L1 and L2. In other words, the switching costs were equal for both ways.

Experiment four focused on whether the results of the highly proficient Spanish-Catalan bilinguals would differ if they performed the switching-task in their L1 compared to their much weaker L3, instead of their L1 compared to their L2. Results showed that the performance of the participants was similar, whether they performed the switching task with their two dominant languages, or their L1 compared to their L3. Highly proficient bilinguals did not show asymmetrical switch costs when performing the switching task in their L1 compared to their much weaker L3 (Costa & Santesteban, 2004).

These results found by Costa and Santesteban (2004) are not in line with the prediction that proficiency level leads to asymmetrical switch costs, whereas if this prediction was valid, Spanish-Catalan highly proficient bilinguals would have shown asymmetrical switch costs when performing this task in their L1 and much weaker L3. This result is rather striking after former assumptions and results that have been found in favour of the relation between proficiency and switch costs (Green, 1998; Meuter & Allport, 1999).

The study by Costa and Santesteban (2004) investigated the effect of proficiency on production and language switching. However, is there also an effect of proficiency on language switching during a comprehension task? As described above, Alvarez et al. (2003) found that during their study, unbalanced bilinguals had more difficulty processing translations than repetitions, and thus switch costs were observed. They also found that the direction of the switch costs was asymmetrical (Alvarez et al., 2003).

Another study focussing on the effect of proficiency on language switching during a comprehension task was conducted by Geyer, Holcomb, Midgley and Grainger (2011). They conducted an ERP study with 20 Russian-English highly proficient bilinguals. Their experiment was similar as the experiment conducted by Alvarez et al. (2003), only in this study participants also had to press a button if the stimulus was a pseudo-word in either language. This was done to ensure that participants really attended all items in both languages (Geyer et al., 2011). Alvarez et al. (2003) found asymmetric priming effects as a function of language and thus asymmetrical switch effects, as their switch effects were larger from L1 to L2 than L2 to L1. Geyer et al. (2011) showed a symmetrical pattern of within-language repetition and between-language translation priming effects in the ERP's, and their participants thus showed a symmetric switch pattern. These results indicate that proficiency plays a role in the effect and direction of switching regarding language switching during a comprehension task.

2.4 Cueing

An important aspect of a switching paradigm is cueing. A cue tells the participant which decision to make. A very common way of cueing is the use of colour cues. The classic language switching study conducted by Meuter and Allport (1999) started with this way of cueing. Nowadays, many studies still follow their example. One study, for instance, is the study by Zheng et al. (2018), who conducted a language switching study using colour cues. They used two colours for each language and counterbalanced these between participants.

The colour cues were inserted as a frame around the stimulus and were presented simultaneously with the stimulus on the screen (Zheng et al., 2018). Another way of cueing during language switching studies is for instance the use of flags that represent the correct language (Prior & Gollan, 2011).

During task switching paradigms, it is rather common to use non-linguistic cues (Prior & MacWhinney, 2010; Prior & Gollan, 2011). Prior and Gollan (2011) used a colour-gradient as a colour cue, and a row of small blocks as a cue for shape. However, this study used <5 and >5 as a cue during task switching. It could be argued that these cues are rather linguistic instead of non-linguistic and might therefore have a similar effect as language cues and show (a)symmetrical switch costs (Costa & Santesteban, 2004). Implementation of the cues varies among studies. Prior and MacWhinney (2010) presented cues before the display of the stimulus (i.e. before each trial), just like Jin, Zhang and Li (2014) did but they used auditory cues instead of visual cues. Prior and Gollan (2011) presented them during and before the display of the stimuli, similarly to Declerck et al. (2012) and Declerck et al. (2017).

To sum up, cueing differs among studies by means of modality (i.e. visually or auditory), timing (before stimulus onset or during the display of the stimulus) and cue itself (i.e. colour, flag). It is important to note that in switching literature, studies are often compared that use an entirely different way of cueing, which might be a reason for the difference in results. Therefore, this study tried to keep the way of cueing between the task switching task and language switching task as equal as possible, comparable to the study conducted by Declerck et al. (2017).

2.5 Bilingual advantage: domain-general?

Research in the field of bilingualism, does not solely focus on a bilingual's possible "advantage" during language switching, but also focusses on whether this possible "advantage" is also applicable to other switching paradigms. As mentioned before, Green's IC model (1998) assumes that language-switching is controlled by language-external inhibitory control networks, which indicates that this is an inhibitory control network that is not solely applicable to language switching, but also applicable to switching in general. If this is the case, one could argue that the two assumptions proposed by Green's IC model (1998) could also be found during task switching.

2.5.1. *Bilingual advantage during task switching?*

Prior and MacWhinney (2010) researched whether bilinguals had an advantage when it comes to switching during a non-linguistic switching task. 44 English monolinguals and 44 bilinguals, that learnt English and another language before the age of six, participated in this experiment. The participants had to perform a task switching paradigm, the so-called colour-shape task. Prior and MacWhinney (2010) adapted this colour-shape task from another experiment conducted by Rubin and Meiran (2005).

The participants either saw a circle or triangle, which were either red or green. Participants were presented with a cue that indicated whether they had to name the colour or name the shape of the stimulus. The cues were graphic to avoid any linguistic information and were presented before and during every trial. The cue for colour was a colour gradient and the cue for shape was a row of small black shapes. The responses of either colour or shape were both linked to the participant's right or left hand and were counterbalanced among participants. Participants were instructed to use the one hand whenever the cue stated that they had to decide which colour the stimulus was, and the other hand whenever the cue stated that they had to decide which shape the stimulus was. The red and circle response were assigned to the index finger, and the green and triangle response were assigned to the middle finger. These responses were again counterbalanced. The participants were presented with a sandwich design. First, they completed 2 single task blocks that consisted of one task only (either colour or shape), then 3 mixed task blocks that consisted of non-switch and switch trials and concluded the experiment with two more single task blocks.

Results showed that both participant groups performed similarly in the single-task blocks. Results showed switch costs for RTs and in terms of accuracy, meaning that participants were slower on switch trials, and made more errors on switch trials. There was no effect of language in the mixed task blocks. However, the interaction of language and trial type was significant in terms of RTs (not in terms of accuracy), bilinguals were significantly faster to perform switch trials. Prior and MacWhinney (2010) found a pronounced bilingual reduction in switching costs. This study therefore showed that bilinguals “displayed greater facility at activating a certain task set in response to a cue and took less time to overcome any residual interference or activation from the task performed on the previous trial” (Prior and MacWhinney, 2010, p.259).

Prior and MacWhinney’s study (2010) showed that bilinguals have less difficulty in switching between tasks than monolinguals do, and thus indicates that bilinguals not only have less difficulty in switching between languages, but that they might also show less difficulty in switching between tasks.

Results on a possible bilingual advantage during task switching show converging evidence however. Branzi, Calabria, Gade, Fuentes and Costa (2018) conducted two task switching experiments with bilinguals and monolinguals to research the n-2 repetition cost in task switching. The n-2 repetition cost refers to the fact that when switching among three tasks, switching back to a recently performed task (ABA) is harder than switching to a new task (CBA), as indicated by RT and error rates (Branzi et al., 2018). Some studies even suggest that the n-2 repetition cost captures the efficiency of an executive control (EC) mechanism, which is crucial for bilingual language control, that is inhibitory control (Branzi et al., 2018).

In their first experiment, 40 Catalan-Spanish bilinguals and 50 Spanish monolinguals conducted a task switching task where they had to sort a given target according to three possible cues (type, size, colour). This task switching paradigm consisted of n-2 switches (CBA) and n-2 repetitions (ABA). Results showed that the magnitude of the n-2 repetition cost in RTs is not modulated by bilingualism (no significant interaction). The second experiment was conducted with 100 Catalan-Spanish bilinguals and 105 Spanish monolinguals. This task switching paradigm was similar as the task switching paradigm from experiment one, only now repetitions were involved (n1-repetition: CAA). Results showed that the magnitudes for the costs were similar (measured between A and A) for both groups in RTs and error rates (Branzi et al., 2018).

It has been argued that a bilingual's daily experience with inhibitory control during language processing, results in a better inhibitory system, which should result in increased n-2 repetition costs (Branzi et al., 2018). However, neither in experiment one nor in experiment two did bilinguals show increased n-2 repetition costs. So, in an experiment conducted with about 200 bilinguals, there was no effect of bilingualism on n-2 repetition costs (Branzi et al., 2018). This study also failed to reveal any effect of bilingualism on the n-1 shift cost, which is in contrast with the results found by Prior and MacWhinney (2010) above.

The research by Prior and MacWhinney (2010) shows evidence that might support the assumptions that language-switching is controlled by language-external inhibitory control networks, which indicates that this inhibitory control network is not only applicable to language switching, but also applicable to switching in general (Green, 1998). However, the bilinguals that participated in Prior and MacWhinney's study are a heterogeneous group (which means that all participants spoke different second languages instead of speaking all the same second language, which is homogeneous), with varying levels of proficiency. The research conducted by Branzi et al. (2018) showed no effect of bilingualism on n-1 shift costs, and this study focused on a large, homogeneous group of bilinguals. Studies that solely focus on task switching also often compare their results to overall results found for bilinguals during language switching. However, there are often many discrepancies between these studies. The tasks differ in response modality, a different group of participants, varying ways of cueing, and so forth. For a more informing viewpoint on the status of a bilingual's performance on language- and task switching it might be good to look at their performance in one study.

2.5.2. Bilingual advantage: Are good language switchers good task switchers?

This thesis has mentioned several studies that investigated whether bilingualism influences a person's ability to switch between languages (Jackson et al., 2001; Ibáñez et al., 2010) or tasks (Prior & MacWhinney, 2010; Branzi et al., 2018). These studies showed that sometimes, bilinguals are not only good language switchers but also good task switchers (Prior & MacWhinney, 2010), but sometimes bilinguals do not seem to have an advantage during task switching (Paap & Greenberg, 2013; Branzi et al., 2018). However, most studies focussed on either bilingualism in language switching (i.e. Jackson et al., 2001; Costa & Santesteban, 2004) or on bilingualism in task switching (i.e. Prior & MacWhinney, 2010), and do not take into account both tasks in one study. To make a better comparison between a bilingual's ability to switch between languages and tasks, it is important to look at the results on both a language switching task and a task switching task conducted by the same participants in one study.

In 2011, Prior and Gollan investigated the association between task and language switching by examining these switching tasks together in two different bilingual groups. In this study, they looked at three different groups of participants. Mandarin-English bilinguals, Spanish-English bilinguals and English monolinguals. The Spanish-English bilinguals in this study were more balanced bilinguals and switched more often between both languages than the Mandarin-English bilinguals. All three groups performed a task switching task, a language switching task, a vocabulary test, fluency test and a brief intelligence test (Prior & Gollan, 2011).

During the non-linguistic task switching task the participants had to conduct a colour-shape task. They were presented with a screen with a fixation cross, followed by a blank screen, followed by a screen with a fixation cross and above that the cue for colour (colour-gradient) or shape (row of small black shapes) and eventually presented with a screen that showed a (green or red) circle or triangle, with the cue presented above the target. The participants were asked to by means of the cue press buttons for either which shape or which colour the stimulus had. Participants were presented with a sandwich design. Firstly, they conducted two single task blocks (either colour or shape), then three mixed task blocks, and they ended the experiment by conducted two single task blocks again (Prior & Gollan, 2011).

The language switching task was conducted similarly. The cues for the languages were either an American flag (English), Chinese flag (Mandarin) or Mexican flag (Spanish), and the stimuli consisted of the numbers one up to and including nine. Participants were asked to name the digits in the correct language indicated by the cues. Participants were again presented with a sandwich design (Prior & Gollan, 2011).

Results of the non-linguistic task switching task showed that Spanish-English bilinguals showed significantly smaller switch costs than monolinguals and the Mandarin-English bilinguals, but equivalent mixing costs (Prior & Gollan, 2011). This pattern is similar to previous research that also showed that the benefit of bilingualism is for reducing switch costs rather than mixing costs (Prior & MacWhinney, 2010).

Results of the language switching task showed that bilinguals named the numbers equally quickly in the dominant and non-dominant language, and that bilinguals responded more slowly on the language switch than on the language repeat trials. Results also showed that Spanish-English bilinguals had significantly smaller language switch costs than Mandarin-English bilinguals in both the dominant and non-dominant language (Prior & Gollan, 2011). It is important to note that the findings of both tasks for the Spanish-English bilinguals were only visible after controlling for parent-education level. The results of Prior and Gollan's study (2011) therefore replicate previous reports of bilingual advantages in not only language, but also task switching.

Another study that compared task switching and language switching with the same group of participants is a study conducted by Weissberger, Gollan, Bondi, Clark and Wierenga (2015). Weissberger et al. (2015) conducted an experiment providing behavioural results by a digit-naming language switching task, and a shape-colour naming task switching task with 19 English-Spanish bilinguals. They also provided fMRI results by means of the same tasks, only during the fMRI the participants had to push buttons instead of naming the stimuli. Cues were presented before the presentation of the stimuli and remained on the screen during the presentation of the stimuli (Weissberger et al., 2015).

Behavioural results showed that participants were significantly slower in naming switch trials during language switching than naming switch trials during task switching, and there was a small difference in switch costs between both switching tasks, in a way that switch costs were marginally larger for the language switching task (Weissberger et al., 2015).

fMRI results showed that there was significantly greater brain response for language switching than colour-shape switching on single and switch trials (Weissberger et al., 2015), which indicates that single and switch trials during language switching demanded more from the participants than single and switch trials during the colour-shape task.

Although the studies conducted by Prior and Gollan (2011) and Weissberger et al. (2015) compared the results of the two tasks within the same group of participants, the actual task switching and language switching tasks still differed quite a lot from one another by means of for instance cueing and response modality.

Declerck, Grainger, Koch and Philipp (2017) set out to directly compare language switching and task switching using a similar set up for both tasks to further investigate the relationship between these two switching tasks, and therefore the relationship between language control and executive control. Declerck et al. (2017) conducted three experiments with similar methodologies to compare switch costs between language switching and task switching. The first two experiments were carried out by 24 native speakers of German, who learned English as their second language.

In the first experiment they either had to name digits (one or eight) in their L1 or L2 during language switching and categorize digits (one or eight) by magnitude or parity during task switching. Cues were green or blue squares implemented before the display of the stimulus. Results showed larger switch costs for task switching in terms of RTs, and slightly larger switch costs for language switching in terms of error rates (Declerck et al., 2017). The authors argued that the difference in switch costs between language switching and task switching could be due to the difference in methodology in experiment one, as the participants had to categorize digits in the task switching task and name digits in the language switching task.

Thus, a second experiment was conducted, in which the participants had to perform two categorization tasks in two languages. The only difference between both tasks would then consist of whether they switch between languages during languages switching while performing the same categorisation task within a block (parity or magnitude block), whereas during task switching they would switch between two categorization tasks while consistently producing the same language within a block (Declerck et al., 2017). Stimuli consisted of the digits one up to and including nine, excluding five, and the language/task cue was presented before the display of the stimulus. In terms of error rates, and in line with experiment one, the language switch costs and task switch costs did not significantly differ, and, in contrast with experiment one, switch costs were similar between both switching tasks in terms of RTs. Experiment two thus indicates that switch costs can be similar in language- and task switching if the tasks, cues, stimuli, response modality and number of response alternatives are identical between both switching tasks (Declerck et al., 2017).

However, participants not solely had to decide in which language they had to name the digit, but they also had to decide whether the digit was odd or even, or whether the number was smaller or larger than five. To exclude whether this extra processing stage had an influence on the outcomes, Declerck et al. (2017) carried out a third experiment. This last experiment consisted of two switching tasks that were more language specific. In this experiment, a different group of bilinguals was used. 24 native speakers of French, who spoke English as their second language took part in this third experiment. The stimuli were no longer digits, but pictures. Participants had to name the picture in either their L1 or L2 (*robe* or *dress*) or name the category of this picture in either their L1 or L2 (*vêtements* or *clothes*). Stimuli consisted of four different pictures. During language switching they had to name the pictures in the correct language, and during task switching they had to name the category of the picture in the correct language. In terms of error rates, a significant difference was found between language switch costs and task switch costs, as the switch costs for language switching were significantly higher. This result is not in line with the result of experiment two. However, in terms of RTs, there was no significant difference between language switching costs and task switching costs. This result is in line with the result obtained in experiment two (Declerck et al., 2017).

To sum up, Declerck et al. (2017) found a significant difference in language- and task switch costs in terms of RTs in experiment one. This difference in switch costs could indicate that switch cost mechanisms might not entirely overlap, but as stated above these differences could also be due to the difference in tasks. When using the same tasks for language switching and task switching in experiment two (non-linguistic) and experiment three (linguistic) no significant differences between these RT switch costs were obtained. Only a significant difference in error rates switch costs between these two tasks was found in experiment three. These results thus indicate that when language switching and task switching tasks are more similar, RT switch costs do not significantly differ from one another, and thus suggest that there is a relationship between language and executive control (Declerck et al., 2017).

2.6. The present study

As discussed, studies that focus on testing a bilingual's ability to switch between languages or tasks generally conduct an experiment consisting of a switching paradigm. However, as mentioned above, it is hard to compare these results with one another. Studies focussed on either a bilingual's ability in language production (Meuter & Allport, 1999; Jackson et al., 2001; Costa & Santesteban, 2004; De Clerck et al., 2012) or in language comprehension (Alvarez et al., 2003; Ibáñez et al., 2010; Geyer et al., 2011). Besides, studies using the same participants for both tasks often compare language switching tasks and task switching tasks that differ in response modality (i.e. comparing digit naming during the language switching task with a colour-shape task as a task switching task) (Prior & Gollan, 2011; Weissberger et al., 2015).

Besides the differences in focus on either language production or language comprehension and response modality (naming and i.e. button-press), the participants participating in these studies are also hard to compare to one another. Studies used either high proficient, balanced bilinguals (Costa & Santesteban, 2004) or low proficient unbalanced bilinguals (Meuter & Allport, 1999), and sometimes even took into account monolinguals (Prior & MacWhinney, 2010; Prior & Gollan, 2011). Sometimes the group of participants were not even homogeneous, but they compared results of heterogenous bilinguals with one another (Meuter & Allport, 1999; Jackson et al., 2001; Prior & MacWhinney, 2010).

Lastly, it is also important to note the discrepancies in the use of cues. During a switching paradigm, cueing is a very important aspect. Sometimes studies use colour cueing in their paradigms (Meuter & Allport, 1999) or auditory cueing (Jin et al., 2014), flags that represent a country and therefore function as a cue for language (Prior & Gollan, 2011), or non-linguistic cues like shapes/figures (Prior & MacWhinney, 2010; Prior & Gollan, 2011). Not to mention the timing of the cues, which can either be represented before representation of the stimulus, but also during the representation of the stimulus (Meuter & Allport, 1998; Geyer et al., 2011) or sometimes even both (Prior & MacWhinney, 2010).

The study conducted in this thesis aimed to make a more reliable comparison between a bilingual's performance on a language switching task and task switching task, as the aforementioned study by Declerck et al. (2017). Both tasks focussed on comprehension rather than production, and RTs and accuracy were measured by means of button-press during both tasks. Participants consisted of Dutch-English L2-learners, who were divided into two groups of proficiency (a low proficient group versus a high proficient group) based on their performance on the lexTALE (Lemhöfer & Boersma, 2012) and an abridged version of the LHQ 2.0 (Li et al., 2014).

Cueing occurred by means of colour cues that represented a language cue during the language switching task, and higher or lower than five as a task cue during the task switching task and were visible during the entire experiment, as they were presented simultaneously with the stimuli. Colours, order of the tasks and the buttons were counter-balanced between participants. This study hopes to provide more insight into the debate of the possibility of a bilingual advantage.

This study hypothesizes that participants will perform rather similarly on both the language switching task and the task switching task, as both tasks show many similarities, and therefore indicates that switching is more domain-general rather than language specific (Prior & Gollan, 2011; Declerck et al, 2017).

This thesis expects to find a significant difference between the performances of the high-proficient bilinguals and low-proficient bilinguals on the language switching task, in the sense that the high-proficient bilinguals will show smaller switch costs than the low-proficient bilinguals (Meuter & Allport, 1999; Alvarez et al, 2003; Costa & Santesteban, 2004), and will thus experience a bilingual advantage during the language switching task. Because this study hypothesizes to find no significant difference in switch costs between the two tasks, the bilingual advantage for the high proficient group will not solely apply for language switching, but also for task switching (Prior & Gollan, 2011).

As for the effect of language, the current study expects to find asymmetrical switch costs for low proficient bilinguals, in the sense that low proficient bilinguals will need more time switching back to their L1 than to their L2 (Green, 1998; Meuter & Allport, 1999; Alvarez et al, 2003). The size of the switch costs for the English language cue will therefore be larger than the size of the switch costs for the Dutch language cue for low proficient bilinguals. The size of the switch costs for high proficient bilinguals is expected to be equal for their L1 as their L2, as they experience equal inhibition of both of these languages (Declerck & Philipp, 2015).

This means that the expected results of this thesis will probably point towards the existence of a *bilingual advantage* when it comes to switching and inhibition, because high proficiency in the L2 leads to a decrease in switch costs. The expected results will also most likely support the claim that a bilingual's expertise in switching and inhibiting is not just language specific but more domain-general for it is believed that a high proficiency in the L2 leads a decrease in switch costs in both switching tasks rather than just the language switching task.

3. Method

3.1. Participants

The experiment consisted of a number of 30 participants, of which eight were male and 22 were female. Three participants were excluded from the experiment, because they suffered from the language disorder dyslexia. These three participants were all males, which meant that the analyses were conducted over the remaining 27 participants, of which five were male and 22 were female. The educational level of the participants varied between secondary school and a master's degree, as can be seen in Table 1 below. All participants were between 18 and 35 years old. Simultaneous bilinguals (i.e. early bilinguals) were also excluded from the experiment. All participants had good or corrected to good vision (i.e. glasses).

Table 1. Overview of the sex and educational level of all participants and per group (high vs low proficient)

	Total (*N*=27)	**High proficient (*N*=13)**	**Low proficient (*N*=14)**
Sex	5 males	3 males	2 males
	22 females	10 females	12 females
Education	5 WO: MA/MSc	4 WO: MA/MSc	1 WO: MA/MSc
	17 HBO	7 HBO	10 HBO
	4 MBO	2 MBO	2 MBO
	1 VO	-	1 VO

The participants' native language was Dutch, and their second language was English. Their proficiency of the English language varied. This variation is shown in Table 2 below. Independent *t*-tests were conducted to compare the level of proficiency (high versus low) with age, experience in the Dutch language, experience in the English language, current level of Dutch, current level of English, switching between Dutch and English per day, English use per day and the lexTALE scores.

There was no significant difference found between their current level of Dutch, their English use per day and their switching between Dutch and English per day. All other variables did show a significant difference. Results of the independent *t*-tests are displayed in Table 2 below.

Participants were divided into two groups based on their proficiency of the English language. These groups presented a high proficient group and a low proficient group. The participants were divided based on their lexTALE scores. Participants above the Median (76,25%) were placed in the high proficient group, and participants that scored lower than the

Median score were placed in the low proficient group. Three participants had the same score as the Median (76,25%). Two of those were placed in the high proficient group, and one in the low proficient group based on the other proficiency indicators of the questionnaire.

Table 2. Overview of the Mean scores and Standard Errors for all 27 participants and per group (high vs low proficient) and the outcomes of the independent t-tests conducted between the means of both groups.

	Total (*N* = 27)	**High proficient (*N*=13)**	**Low proficient (*N*=14)**	**Independent t-test**
Age (in years)	*M*=25.78 (*SE*=0.87)	*M*=28.69 (*SE*=1.07)	*M*=23.07 (*SE*=0.86)	t (25) = 4.133, p = 0.000*
Dutch experience (in years)	*M*=25.70 (*SE*=0.85)	*M*=28.62 (*SE*=1.04)	*M*=23.00 (*SE*=0.84)	t (25) = 4.229, p = 0.000*
English experience (in years)	*M*=15.81 (*SE*=1.07)	*M*=19.69 (*SE*=1.38)	*M*=12.21 (*SE*=0.86)	t (25) = 4.664, p = 0.000*
Current level of Dutch[a]	*M*= 6.74 (*SE*=0.17)	*M*=7[b]	*M*=6.50 (*SE*=0.31)	t (13.00) = 1.612, p = 0.131
Current level of English[a]	*M*= 5.07 (*SE*=0.17)	*M*=5.54 (*SE*=0.14)	*M*=4.64 (*SE*=0.25)	t (25) = 3.059, p = 0.005*
Switching between Dutch and English[a]	*M*=4.00 (*SE*=0.24)	*M*=4.38 (*SE*=0.29)	*M*=3.64 (*SE*=0.36)	t (25) = 1.598, p = 0.123
English use per day (%)	*M*= 24.43 (*SE*=3.40)	*M*=25.385 (*SE*=4.10)	*M*=23.54 (*SE*=5.48)	t (25) = 0.267, p = 0.792

LexTALE scores (%)	*M*= 72.72 (*SE*=2.58)	*M*=82.96 (*SE*=2.01)	*M*=63.21 (*SE*=2.77)	t (25) = 5.696, p = 0.000

a. Participants had to indicate these answers based on a scale from 1-7.
b. Because all high-proficient participants indicated that their level of Dutch was native-like (7), SPSS did not generate an SE for this variable.
*Significance at the $p < 0.05$ level. *$p < 0.05$.*

3.2. Materials

This experiment consisted of four parts; a language-switching task, a task-switching task, a Language History Questionnaire (LHQ), and the LexTALE, and took approximately 25 minutes in total. Below, the materials used during the switching tasks of this experiment were specified.

3.2.1. Materials for both tasks

Stimuli were displayed in the mono font, which is the standard font for Open Sesame, in black, 18 pixels big and in the centre of the screen. Between the screens displaying the stimuli, the participants were presented with a screen that consisted of a fixation cross. The background colour of this screen was grey, and the fixation cross was black. The black fixation cross was placed in the centre of the screen and had a pen width of 6 pixels.
Both tasks consisted of practice trials and experimental trials.

3.2.2. Language switching task

During the language-switching task, the stimuli in both the practice and experimental trials consisted of four English words (*fire*, *wing*, *farm* and *duck*) and four Dutch words (*blik*, *kruk*, *vlot* and *poes*), and thus eight different words in total. All words were four-letter words, nouns, and non-cognates. Some words were however ambiguous in meaning (i.e. *vlot* or *kruk*). Words were selected from the Dutch and English PPVT-IV (Dunn & Dunn, 2007) from the first few sets and therefore likely to be familiar to the participants in this study. Words were all the same length, and therefore all consisted of four letters. The stimuli were accompanied by a different background colour, either green or purple, which functioned as a colour-cue. Therefore, in total, there were 2x8=16 combinations possible (each of the eight words presented with either a purple or a green background). The practice trials consisted of three blocks of 16 stimuli, and thus 48 stimuli in total. The experimental trials consisted of eight blocks of 16 stimuli, and thus 128 stimuli in total.

In all four *a*-versions of the lists, the purple background colour-cue was linked to the Dutch language-cue, and the green background colour-cue was linked to the English language-cue. Moreover, the response key that represented the answer "yes" was placed on the "d"-key of the keyboard, whereas the response key that represented the answer "no" was placed on the "k"-key of the keyboard. In all four *b*-versions, the response options were counterbalanced. This entailed that the purple background colour-cue was linked to the English language-cue, and the green background colour-cue was linked to the Dutch language-cue. Moreover, the response key that represented the answer "yes" was placed on the "k"-key of the keyboard, whereas the response key that represented the answer "no" was placed on the "d"-key of the keyboard. Consequently, this experiment accounted for left- or right index finger preference.

3.2.3. Task switching task

During the task-switching task, the stimuli in both the practice and experimental trials consisted of the numbers one up to and including four, and six up to and including nine. These were presented as Arabic numerals. Each number was linked to one of two background colours, either yellow or red, as a colour cue. Therefore, in total, there were 2x8=16 combinations possible (each of the eight numbers presented with either a red or a yellow background). The practice trials consisted of three blocks of 16 stimuli, and thus 48 stimuli in total. The experimental trials consisted of eight blocks of 16 stimuli, and thus 128 stimuli in total.

The lists of the task switching task were also numbered from one to four, and each list consisted of two versions (either *a* or *b*). In all four *a*-versions, the red background colour-cue was linked to the number-cue <5 (whether the number presented was smaller than five), and the yellow background colour-cue was linked to the number-cue >5 (whether the number presented on the screen was bigger than five). For the four b-versions, the response options were again counterbalanced.

3.3. Procedure

Every participant was required to participate in each of the four parts of the experiment. These four parts had to occur in a consecutive order on the same day, with no to minimal breaks in between the parts of the experiment. Before the individual could participate in the experiment, he/she was asked to sign a consent form (Appendix A). By signing the consent form, the participant agreed upon participating in this experiment. The order of both switching tasks was counterbalanced. In other words, half of the participants first completed the language-switching task, and secondly the task-switching task. The other half of the participants completed both tasks vice versa.

Participants were also asked to fill in the LHQ. Participants always filled in the questionnaire after they finished both the language- and task-switching experiments. The last task that was administered to every participant was the lexTALE. Below, this study will explain the procedure of both switching tasks, the lexTALE and the LHQ.

3.3.1. Procedure during both tasks

Each participant received one of the eight different lists of the language-switching task and one of the eight different lists of the task switching task. The order of the representation of the stimuli in the practice trial was fixed and similar in each of the eight lists per task. The order of the stimuli during the experimental trials, however, was pseudo-randomised. This pseudo-randomisation was made via Excel. Excel randomised the order of the stimuli, and the experimenter manually made sure that all constraints were met.

One constraint was the number of switch- versus non-switch trials in each list. The practice trials always consisted of 30 switch trials versus 18 non-switch trials (62,5%). During the experimental trials, the 128 stimuli were always divided in 79 switch-trials and 49 non-switch trials (61,72%). Another constraint that had to be met, was that in each list the same trial (switch or non-switch) could occur with a maximum of four consecutive trials.
The lists were numbered from one to four, and there were two different versions of each list (either *a* or *b*). The eight different lists were randomly administered. However, participants always received the same list of both the language-switching and task-switching task.

Both tasks were administered on a Macbook Air 11 inch via the programme Open Sesame. Participants were seated in front of the laptop in a quiet room, preferably with a blind wall in front of them, so that they would not be distracted by any background noise or movement. The location of the administration of the experiment differed among participants. The participant was given a short oral instruction (according to the test-protocol (Appendix B). During the oral instruction, the experimenter made clear that the participant was always able to ask questions. The participant also received so-called *cheat sheets* that entailed the colour- and language/task-cue combination of the experiment (Declerck et al., 2012). The participants were told that they were able to look at these *cheat sheets* at any time and as many times as they would prefer during the experiment. The experimenter filled in the participant's unique participant-number, which included the version of the experiment that was administered to this participant. Then the experiment would start.

The experiment started by displaying a screen with written instructions. The participants had to read the instructions carefully after which they could start the experiment by pressing either the "yes"- or "no"- key. After pressing either of these buttons, the practice trials started. The practice trials were implemented to familiarise the participants with the stimuli and colour-cues used in the experimental trials. The results of the practice trials were therefore not analysed. The practice trials and experimental trials were conducted similarly. The participant was presented with one of the eight stimuli linked to a background colour. This background colour thus indicated whether the participant had to decide whether the word on the screen was Dutch or English or whether the participant had to decide whether the number on the screen was smaller or bigger than five.

Whenever the answer was "yes", the participant pushed the key on the keyboard that contained the sticker with the letter "J" on it. Whenever the answer was "no", the participant pushed the key on the keyboard that contained the sticker with the letter "N" on it. After pushing either the "yes"-key or "no"-key, the next trial appeared. The next trial also appeared after 5000 ms if the participant did not push any key. Between each trial, a grey screen with a fixation cross was shown for 500 ms.

During the practice trials, the experimenter stayed near the participant. Once the practice trials had finished, the participant was presented with another screen that repeated the instructions of the task. After re-reading these instructions carefully, the participant could press the "yes"- or "no"-key again to start the experimental trials. After the participants finished the experimental trials, they were presented with one last screen that thanked them for their participation and indicated the end of the task.

3.3.2. Language History Questionnaire (LHQ)

Besides the switching tasks, the participants also had to fill in a Language History Questionnaire (LHQ). The LHQ used in this study (Appendix C) was relatively short and an abridged version of the LHQ 2.0 (Li et al., 2014). This LHQ consisted of 11 short questions. These questions only focussed on the data that the study intended to use, and all data was anonymous and was therefore according to the General Data Protection Act (GDPR). The LHQ was administered after the language-and task switching experiments and before the lexTALE. The LHQ was used as a subjective, self-rating measurement of each participant's knowledge of the English language.

3.3.3. lexTALE

The lexTALE is the Lexical Test for Advanced Learners of English. Administering the lexTALE takes approximately 3,5 minutes and is therefore a quick and feasible test to measure general proficiency in a bilingual's L2 for highly and medium proficient speakers of English as a second or foreign language (Lemhöfer & Boersma, 2012). Lemhöfer and Broersma have shown that, in spite of the brevity of the lexTALE, the results correlate well with more time-consuming measures of English proficiency and vocabulary knowledge (2012).

The lexTALE is a visual decision task and was administered online during this study. Firstly, the experimenter filled in the participant-number and e-mail address of the examiner to which the lexTALE score could be send. Secondly, the participant was presented with instructions for the lexTALE. When the participant clicked on the "OK"-button, the lexTALE started.

The participant was presented with 60 trials, including three dummy trials. The three dummy trials were not taken into account when calculating the participants' scores. Each trial consisted of a string of letters, of which the participant had to decide whether this string of letters was an existing word in the English language. After these 60 trials, an individual score for this participant was calculated and sent to the experimenter.

The LHQ administered before the lexTALE was a subjective, self-rating measurement of the participants' knowledge of the English language. By administering the lexTALE, however, this study had an objective predictor of every participant's English vocabulary knowledge, and a fair, objective indication of every participant's general English proficiency (Lemhöfer & Boersma, 2012).

3.4. Design

This study firstly conducted two 2x2x2 ANOVA Repeated Measure Design (RMD) analyses. One analysis for the independent variable accuracy (whether or not the participants responded correctly or not) and one analysis for the independent variable RT (the time it took participants to press the button). These ANOVAs compared the between-subject dependent variable proficiency (high versus low proficient bilinguals), and the within-subject dependent variables condition (switch versus non-switch) and task (language switching versus task switching).

Afterwards two other 2x2x2 ANOVAs RMD per task were conducted. One analysis for the independent variable accuracy and one analysis for the independent variable RT. These ANOVAs compared the between-subject dependent variable group (high proficient versus low proficient bilinguals), and the within-subject dependent variables condition (switch versus non-switch trials) and cue (<5 versus >5) during the task switching task and language (Dutch versus English) during the language switching task.

Before all analyses took place, the data had to be checked for any outliers and assumptions for the RMD ANOVAs needed to be checked.

4. Results

This study aimed to investigate whether bilinguals scored (significantly) differently on a task switching task compared to a language switching task (both consisting of switch and non-switch trials) depending on their proficiency of the English language (either high or low proficient).

Firstly, this study established whether any participants had to be excluded from further analyses completely. Participants would be completely excluded from further analyses if their response times were too slow or if they gave too many incorrect answers.

Analyses calculated the percentage of correct answers per participant per task and then calculated a Mean for these percentages. Next, the maximum percentage of errors (mean of percentages + 2.5 SD of mean of percentages) was calculated that could be made per participant in each task. Results showed that no participant had made more errors than the maximum number of errors that was permitted, and therefore no participants were excluded from further analyses based on the outcomes of their accuracy data.

This study then calculated the mean RTs per participant per task, calculated a mean for these means and then calculated the maximum RT (mean of means + 2.5 SD of mean of means) that a participant could take for each task. Results showed that one participant responded too slowly during the task switching task, as the mean RT of this participant was above the maximum RT that was established for this task. This meant that based on these calculations, one participant was excluded from further analyses. Because this participant was too slow during the task switching task, this participant was consequently excluded from the language switching task. Results showed that all other 26 participants responded within the maximum RT, which meant that they were able to participate in further analyses.

Next, this study had to establish whether, besides participants, there were any trials on which participants responded too slowly, and which should therefore be excluded from further analyses. These RTs were only calculated for trials that were given a correct response to. The mean RTs per participant per condition (switch versus non-switch) for the task switching task and language switching task were calculated. Next, the maximum RT (mean + 2.5 SD of mean) that could be made per participant per condition in the task switching task and in the language switching task was calculated, and based on this maximum, the trials that were responded to more slowly than these maximum RTs were excluded from further analyses. This meant that for the task switching task 2.92% of the total number of trials were excluded from further analyses and for the language switching task 3.67% of the total number of trials were excluded from the analyses. In summary, only trials that were responded to correctly, and trials that were responded to fast enough were analysed in the ANOVAs.

4.1. Accuracy analysis

Before a 2x2x2 ANOVA Repeated Measures Design (RMD) analysis could be conducted, the accuracy data had to account for several assumptions.

Table 3. Tests of Normality – Accuracy.

Task - Condition	**Group**	**Shapiro-Wilk**	
		df	***p***
Task switching – switch trials	High proficient	12	.032*
	Low proficient	14	.001*
Task switching – non-switch trials	High proficient	12	.009*
	Low proficient	14	.001*
Language switching – switch trials	High proficient	12	.115

	Low proficient	14	.061
Language switching – non-switch trials	High proficient	12	.001*
	Low proficient	14	.001*

*Significance at the p < 0.05 level. *p < 0.05.*

An assumption that had to be accounted for, was whether or not the data were normally distributed. The test of Normality showed, as can be seen in Table 3 above, that almost all data were significant, which meant that the data were not normally distributed, hence the assumption of Normality was violated. However, for accuracy data, these outcomes are expected, because the percentage of correct answers is usually quite high, which means that the data would automatically be skewed to the right rather than being normally distributed. Therefore, although the assumption of Normality was violated, this study was still able to continue with an ANOVA rather than a non-parametrical test.

A 2x2x2 ANOVA RMD with the within-subjects factors task (task switching or language switching) and condition (switch or non-switch), and the between-subject factor group (high proficient or low proficient) and the dependent variable accuracy (percentage of correct answers given by the participants) showed the following results: The within-subject factor task was not significant F (1,24) = 3.03, p = .094, η_p^2 = .112. This meant that there was no significant difference between the percentage of correct answers given by the participants on the task switching task (*M*= 97.3%, *SE*= 0.5%) and language switching task (*M*= 96.4%, *SE*= 0.6%).

Results showed that there was a significant main-effect of condition on the percentage of correct answers given by the participants F (1,24) = 19.47, p = .000, η_p^2 = 0448. Participants made significantly fewer errors on non-switch trials (*M*= 97.8%, *SE*= 0.5%) compared to switch trials (*M*= 95.9%, *SE*= 0.6%). This data therefore showed a switch cost.

Results also showed the between-subject factor group was not significant F (1,24) = 0.01, p = .912, η_p^2 = .001. The percentage of correct answers did not significantly differ between the high proficient participants (*M*= 96.8%, *SE*= 0.8%) and low proficient participants (*M*= 96.9%, *SE*= 0.7%).

Results also showed no significant interactions. There was no significant interaction of task*group F (1,24) = 0.18, p = .674, η_p^2 = .007. This meant that the non-significant difference in performance between low proficient and high proficient bilinguals was regardless of the task that they performed.

Results also showed that there was no significant interaction of condition*group F (1,24) = 0.23, p = .639, η_p^2 = .009. This meant that the size of the switch costs did not significantly differ between both groups. The size of the switch cost for high proficient bilinguals was therefore not significantly bigger than the size of the switch cost for low proficient bilinguals.

Moreover, results showed that there was also no significant interaction of task*condition F (1,24) = 0.07, p = .800, η_p^2 = .003. This meant that there was no significant difference in the size of the switch costs between both tasks, in such a way that the size of the switch cost for task switching was not significantly bigger than the size of the switch cost for language switching. The descriptive statistics for these interactions can be found in Appendix D.

Lastly, there was also no significant three-way interaction of task*condition*group F (1,24) = 3.123, p = .090, η_p^2 = .115. The descriptive statistics of this three-way interaction are displayed in Table 4 below, and visually presented in Figure 2 below.

*Table 4. Descriptive statistics of the three-way interaction group*task*condition for the accuracy analysis.*

Group	Task	Condition	Mean (%)	Std. Error (%)
High proficient	Task switching	Switch	96.6	1.1
		Non-switch	98.0	0.6
	Language switching	Switch	94.9	1.0
		Non-switch	97.7	1.0
Low proficient	Task switching	Switch	95.9	1.1
		Non-switch	98.5	0.6
	Language switching	Switch	96.2	0.9
		Non-switch	97.0	0.9

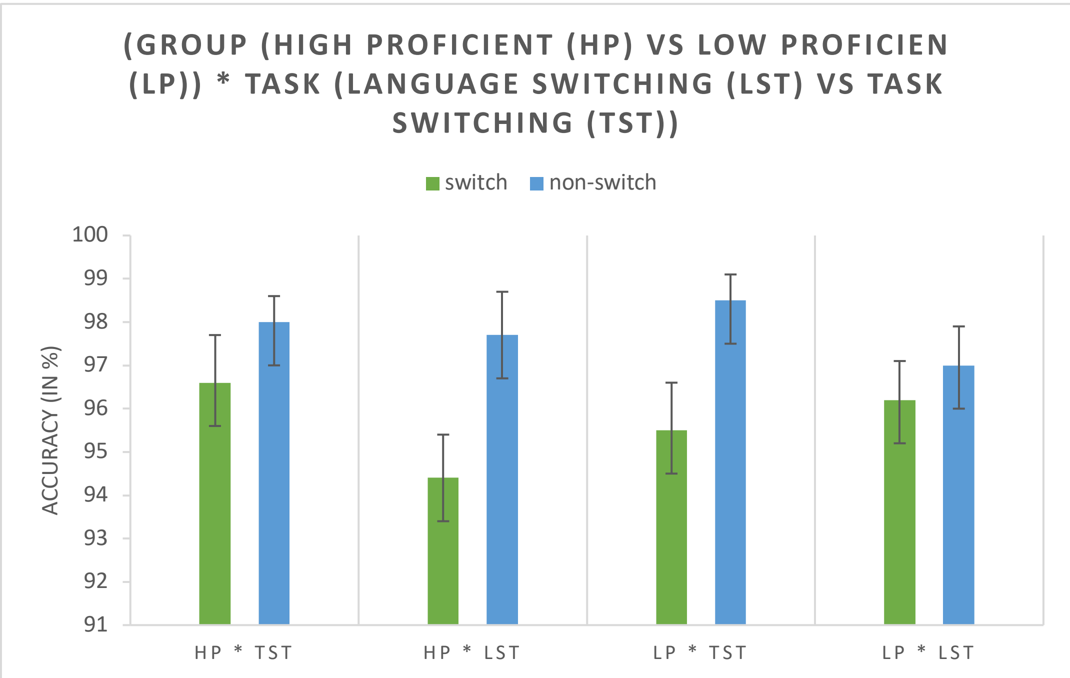

*Figure 2. Visual representation of the three-way interaction group*task*condition for the accuracy analysis.*

4.2. RT analysis

The analysis of the data of the participants' RTs was conducted similarly as for the participants' accuracy data. To compare the participants' RTs, another 2x2x2 ANOVA RMD with the within-subjects factors task (task switching or language switching) and condition (switch or non-switch), and the between-subject factor group (high proficient or low proficient) and the dependent variable RT was conducted. However, before this analysis could be conducted, the assumption for Normality needed to be checked for the RT data.

The data had to be normally distributed to account for the assumption of Normality. Unlike the accuracy data, the data of the participants' RTs were normally distributed, as can be seen in Table 5 below, which meant that an ANOVA RMD could be conducted.

Table 5. Tests of Normality – RT analysis.

Task - Condition	**Group**	**Shapiro-Wilk**	
		df	***p***
Task switching – switch trials	High proficient	12	.085
	Low proficient	14	.816
Task switching – non-switch trials	High proficient	12	.538
	Low proficient	14	.388
Language switching – switch trials	High proficient	12	.660
	Low proficient	14	.897
Language switching – non-switch trials	High proficient	12	.053
	Low proficient	14	.861

*Significance at the $p < 0.05$ level. *$p < 0.05$.*

A 2x2x2 ANOVA RMD with the within-subjects factors task (task switching or language switching) and condition (switch or non-switch), and the between-subject factor group (high proficient or low proficient) and the dependent variable response time (RT) showed the following results: There was a significant main-effect of task on the participants' RTs F (1,24) = 22.18, p = .000, η_p^2 = .480. In such a way that participants responded significantly faster on the task switching task (*M*= 980.82, *SE*= 24.71) than on the language switching task (*M*= 1130.70, *SE*= 36.95).

Results also showed that there was a significant main-effect of condition on the participants' RTs F (1,24) = 65.62, p = .000, η_p^2 = .732. Participants responded significantly faster on non-switch trials (*M*= 993.52, *SE*= 25.59) compared to switch trials (*M*= 1117.99, *SE*= 30.54). The data therefore showed switch costs.

Results also showed that there was a significant main-effect of group F (1,24) = 6.43, p = .018, η_p^2 = .211. In such a way that low proficient participants responded significantly faster (*M*= 987.03, *SE*= 36.83) than high proficient participants (*M*= 1124.49, *SE*= 39.78).

Besides the three significant main-effects, the results showed no significant interactions. There was no significant interaction of group*task F (1,24) = 0.30, p = .589, η_p^2 = .012. In such a way that high proficient bilinguals responded slower than low proficient bilinguals, regardless of the task that they performed.

Results also showed that there was no significant interaction of group*condition F (1,24) = 0.21, p = .653, η_p^2 = .009. This meant that the size of the switch costs did not significantly differ depending on whether a participant was high proficient or low proficient. In such a way that the size of the switch cost for high proficient bilinguals was not significantly bigger than the size of the switch cost for low proficient bilinguals.

Moreover, results showed that there was also no significant interaction of task*condition F (1,24) = 3.30, p = .082, η_p^2 = .121. This meant that the difference between the size of the switch costs between the different tasks did not significantly differ. In such a way that the size of the switch cost in task switching was not significantly bigger than the size of the switch cost in language switching. The descriptive statistics of these interactions can be found in Appendix D.

Lastly, there was no significant three-way interaction of group*task*condition F (1,24) = 0.39, p = .540, η_p^2 = .016. The descriptive statistics of this three-way interaction can be found in Table 6 below and are visually presented in Figure 3 below.

*Table 6. Descriptive statistics of the three-way interaction group*task*condition for the RT analysis.*

Group	Task	Condition	Mean (in msec)	Std. Error (in msec)
High proficient	Task switching	Switch	1120.07	46.19
		Non-switch	961.59	31.82
	Language switching	Switch	1260.37	55.08
		Non-switch	1155.93	55.72
Low proficient	Task switching	Switch	986.17	42.77
		Non-switch	855.44	29.46
	Language switching	Switch	1105.37	51.00
		Non-switch	1001.13	51.59

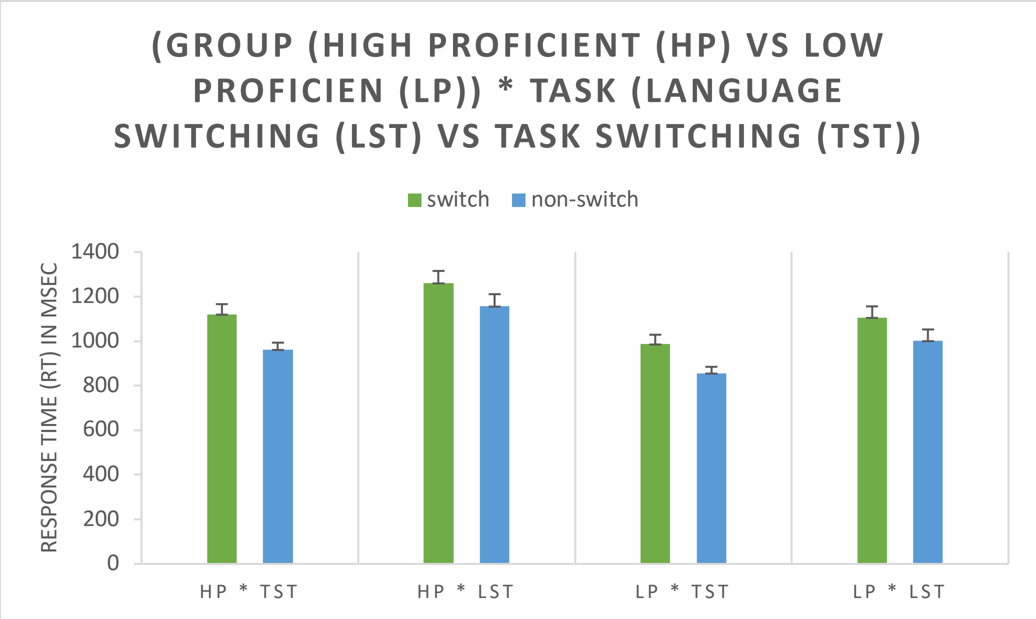

*Figure 3. Visual representation of three-way interaction group*task*condition for the RT analysis.*

4.3. Switch cost (a)symmetry RT analysis

This study also aimed to investigate whether bilinguals scored (significantly) differently on a depending on their cue and depending on their proficiency of the English language. Therefore, this study conducted two separate RMD ANOVAs, one for each task focussing on the dependent variable RT and not on accuracy.

4.3.1. Task switching task

Another 2x2x2 ANOVA RMD with the within-subjects factors cue (<5 or >5) and condition (switch or non-switch), and the between-subject factor group (high proficient or low proficient) and the dependent variable RT showed the following results: There was a significant main-effect of cue on the participants' RTs F (1,24) = 21.47, p = .000, η_p^2 = .472. In such a way that participants responded significantly faster on trials with the cue >5 (*M*=1073.27, *SE*= 40.38) than on trials with the cue <5 (*M*= 1169.03, *SE*= 48.32). Although this analysis was conducted with all three factors, only the relevant factor *cue* is reported here.

None of the interactions showed a significant effect. There was no significant interaction of group*cue on the participants' RTs F (1,24) = 2.06, p = .164, η_p^2 = .079, no significant interaction of group*condition on the participants' RTs F (1,24) = 0.001, p =.982, η_p^2 = .000, and no significant interaction of condition*cue on the participants' RTs F (1,24) = 0.09, p = .773, η_p^2 = .004. The descriptive statistics for these interactions can be found in Appendix D.

Lastly, there was also no significant three-way interaction of group*cue*condition on the participants' RTs F (1,24) = 0.12, p = .730, η_p^2 = .005. The descriptive statistics of this three-way interaction are displayed in Table 7 below, and visually presented in Figure 4 below.

*Table 7. Descriptive statistics of the three-way interaction cue*condition*group for the switch cost (a)symmetry analysis for task switching.*

Group	**Cue**	**Condition**	**Mean (in msec)**	**Std. Error (in msec)**
High proficient	>5	**Switch**	1218.53	70.30
		Non-switch	1068.39	58.72
	<5	**Switch**	1342.86	93.26
		Non-switch	1194.87	55.86
Low proficient	>5	**Switch**	1070.90	65.07
		Non-switch	935.25	54.37
	<5	**Switch**	1148.90	86.34
		Non-switch	989.49	51.72

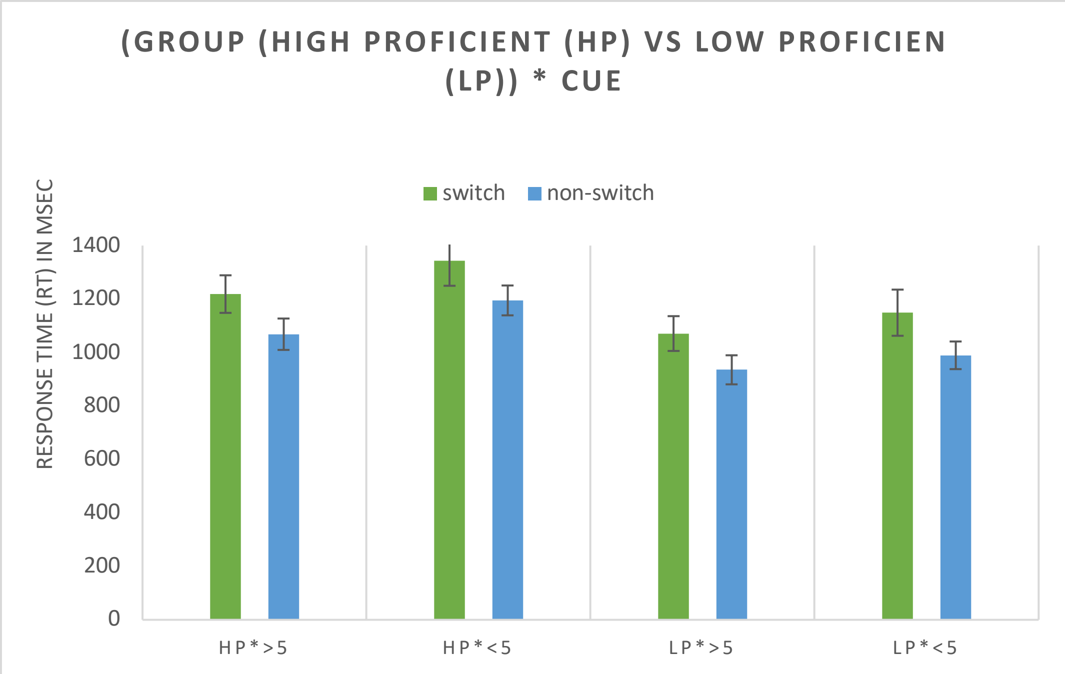

Figure 4. *Visual representation of the three-way interaction cue*condition*group for the switch cost (a)symmetry analysis for task switching.*

4.3.2. Language switching task

Another 2x2x2 ANOVA RMD with the within-subjects factors language (Dutch or English) and condition (switch or non-switch), and the between-subject factor group (high proficient or low proficient) and the dependent variable RT showed the following results: The within-subject factor language was not significant F (1,24) =0.81, p = .376, η_p^2 = .033. In such a way that there was no significant difference in RTs when participants responded on trials with the language cue Dutch (M=1266.37, SE= 54.50) or on trials with the language cue English (M= 1281.64, SE= 57.30). This ANOVA was conducted with all three factors described above, however, only the relevant factor *language* is reported here.

There was no significant interaction of group*language on the participants' RTs F (1,24) = 2.31, p = .141, η_p^2 = .088, no significant interaction of group*condition on the participants' RTs F (1,24) = 1.34, p = .258, η_p^2 = .053, and no significant interaction of condition*language on the participants' RTs F (1,24) = 0.20, p = .661, η_p^2 = .008. The descriptive statistics of these interactions can be found in Appendix D.

Lastly, there was no significant three-way interaction of group*language*condition on the participants' RTs F (1,24) =0.45, p = .0.510, η_p^2 = .018. The descriptive statistics of this three-way interaction are displayed in Table 8 below, and visually presented in Figure 5 below.

*Table 8. Descriptive statistics of the three-way interaction language*condition*group of the switch cost (a)symmetry analysis of the language switching task.*

Group	Language	Condition	Mean (in msec)	Std. Error (in msec)
High proficient	**Dutch**	**Switch**	1447.44	85.31
		Non-switch	1297.70	80.10
	English	**Switch**	1464.92	84.76
		Non-switch	1362.32	87.65
Low proficient	**Dutch**	**Switch**	1200.66	78.98
		Non-switch	1119.67	74.15
	English	**Switch**	1194.92	78.48
		Non-switch	1104.41	81.15

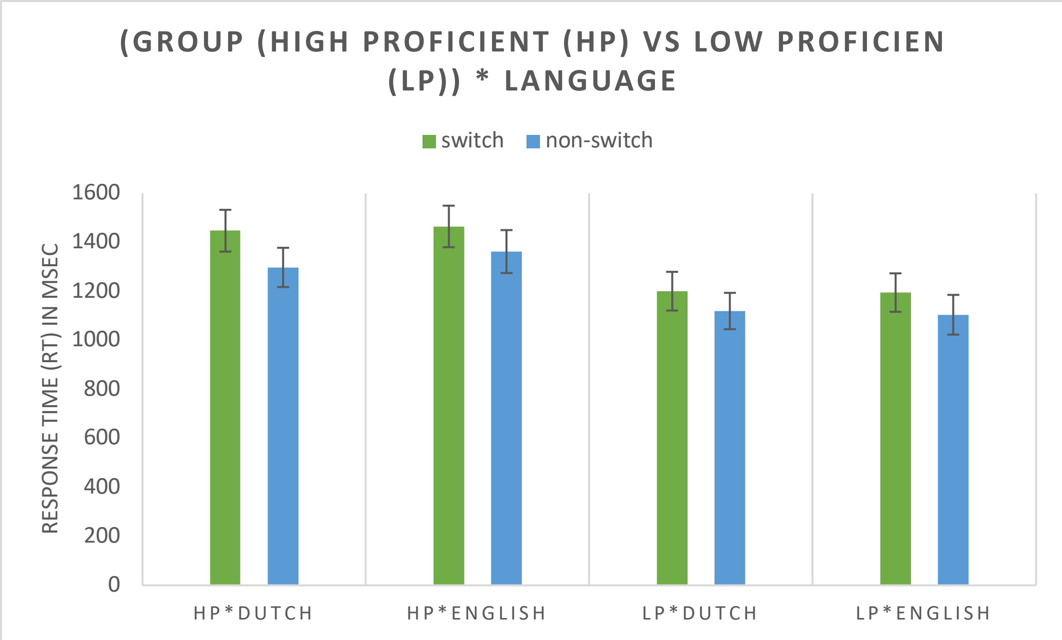

*Figure 5. Visual representation of the three-way interaction language*condition*group of the switch cost (a)symmetry analysis for the language switching task.*

5. Discussion

The aim of this study was to make a more reliable comparison between two bilingual groups with varying proficiencies and their performance on a task switching task and language switching task. 26 Dutch-English bilinguals participated in both switching tasks in which their RTs and accuracy were measured by means of button-press during both tasks. This study hoped to give more insight into the debate of the possibility of a bilingual advantage. Below this thesis will elaborately discuss several outcomes of this study.

5.1. Switch costs

The data of the accuracy and RT analyses showed switch costs in both task switching and language switching, which is in line with most other studies focussing on language switching (i.e. Jackson et al., 2001; Alvarez et al., 2003; Costa & Santesteban, 2004) and task switching (Prior & MacWhinney, 2010; Branzi et al., 2018). The BIA+ model provides an explanation on the matter of switch costs during language switching in terms of RTs (Dijkstra & Van Heuven, 2002). However, results showed that participants were slower on non-switch trials compared to switch trials in general, not solely during the language switching task. Can a similar mechanism also explain these switch costs in terms of task switching?

It can be argued that during a perceptive task switching task a comparable mechanism like the BIA+-model is set into work, but instead of nodes that contain languages (in this case English or Dutch) there are nodes that contain the cues given for this task switching paradigm (so in this case either <5 or >5). In other words, when conducting the task switching task, participants experience no interference in processing during non-switch trials because of the activation of the node that contains the same cue as the trial before. However, during switch trials participants experience interference in processing, because another node (with the other cue) has to be activated. This could consequently lead to slower RTs on switch trials in task switching, which consequently leads to switch costs in task switching.

5.2. Proficiency

A decent measurement of proficiency was essential for conducting this study, whereas proficiency is one of the independent variables used in the analyses. Therefore, this study used the lexTALE as an objective measurement of the participants' proficiency (Lemhöfer & Broersma, 2012), in combination with a subjective measurement, which was an abridged version of the LHQ 2.0 (Li et al., 2014).

As described in the method section, the discrepancy between the high proficient and low proficient group was (mainly) based on the lexTALE scores. The high proficient bilinguals scored 76.25% or higher, the low proficient bilinguals scored lower than this percentage. Lemhöfer and Broersma (2012) associated which ranges of lexTALE scores are associated with which Quick Placement Test (QPT) score ranges (2001) and with the CEF proficiency levels as indicated in the QPT description. This prediction was based on the lexTALE scores of the Dutch group in their experiment and can be seen in Table 9 below (Lemhöfer & Broersma, 2012).

Table 9. Relation between general English proficiency levels based on the Dutch group in the study conducted by Lemhöfer and Broersma (2012).

CEF Level	CEF Description	QPT score	lexTALE score
C1 & C2	**Upper & lower advanced / proficient user**	80% - 100%	80% - 100%
B2	**Upper intermediate**	67% - 79%	60% - 80%
B1 and lower	**Lower intermediate and lower**	Below 66%	Below 59%

Table 9 above shows that the percentage 76.25%, the score that this study used as the discrepancy between high proficient and low proficient, is considered to be comparable to the B2 CEF Level, indicating that the high proficient group in this study is indeed very high proficient. This, as seen above in Table 9, means that these scores partly fall within the range of 80% - 100%, which are comparable to the C1 & C2 CEF level.

Although there is no doubt that the high proficient group is indeed high proficient, the low proficient group, however, might not be that low proficient. Almost all scores of the lexTALE fall within the 60% -76.25% range. This is comparable to the B2 CEF level, which is the upper intermediate level. This raises the question whether the difference between the proficiencies of both groups is large enough to call this distinction between both groups high and low proficient, or whether this distinction is better described as high and higher proficient. This small discrepancy between bilingual groups might be an explanation for some of the obtained results.

Another important observation to take into account is the large difference in years of experience in the English language (see Table 2). The high proficient group (*M*=19.69, *SE*=1.38) has significantly more years of experience than the low proficient group (*M*= 12.21, *SE*= 0.86). These years of experience are directly linked to the difference in age between both groups, as the high proficient group (*M*=28.69, *SE*= 1.07) is significantly older than the low proficient group (*M*= 23.07, *SE*= 0.86). These two variables could have a large effect on the proficiency of the participants and looking at these differences the gap between both proficiency groups might not be as small after all.

Data showed that low proficient bilinguals were faster than high proficient bilinguals during both tasks. A reason for this difference between groups could be that one group is more hesitant than the other, which consequently leads to slower RTs for this group. Proficiency data of the participants from the LHQ (Table 2) revealed that the difference in age between both groups was significant. The high proficient bilingual group (*M*=28.69, *SE*=1.07) was significantly older than the low proficient bilingual group (*M*=23.07, *SE*=0.86). The low proficient, younger group could have responded faster and more impulsive because of their age rather than their experience with the English language or experience in switching between Dutch and English.

5.2.1. Proficiency and language switching

Interactions of analyses taking into account proficiency showed no significant results. It is, however, still interesting to look at these data. The language non-selective lexical access point of view states that a bilingual co-activates both languages while reading, in spite of the input language (Libben & Titone, 2009; Lagrou et al., 2011), which could consequently lead to a good ability to switch between these languages (Meuter & Allport, 1999; Prior & Gollan, 2011). This would result in smaller switch costs for language switching for the high proficient bilinguals than for the low proficient bilinguals. However, data of this study showed that the size of the switch costs in terms of RTs between both groups on language switching was almost similar (see Figure 3), and switch costs for accuracy were smaller for low proficient bilinguals than for high proficient bilinguals during language switching (see Figure 2).

These results could again be explained by the proficiency data of the participants from the LHQ. The data in Table 2 revealed that the difference between both groups regarding their switching behaviour between Dutch and English did not significantly differ, in such a way that high proficient bilinguals (*M*=4.38, *SE*=0.29) did not switch significantly more than low proficient bilinguals (*M*=3.64, *SE*=0.36).

Furthermore, both groups did not switch very often as the mean of both groups indicated that their switching behaviour was *average*. This meant that, in terms of switching, both groups were equally capable of switching, and did not have that much experience in switching between languages, which could be an explanation for the non-significant obtained results. The data of these analyses therefore support the claim made earlier that proficiency levels between both groups might be comparable, as the size of their RT switch costs during language switching was almost similar. This result replicates the result found by Costa and Santesteban (2004) for language switching in highly proficient bilinguals.

This study found no significant effect of language. All interactions were also not significant. According to Green's IC model (1998) unbalanced bilinguals experience asymmetrical switch costs. So, in the case of this experiment, it would mean that switching into Dutch would take longer than switching into English for the group of low proficient bilinguals. The outcomes of this experiment, however, showed that the size of the switch costs for the low proficient group in Dutch are slightly smaller than the size of the switch costs for the low proficient group in English. Asymmetrical switch costs are therefore not found for the low proficient group of bilinguals in this experiment (as shown in Figure 5).

These outcomes contradict the assumption made by Green's IC model (1998), and results found by previous studies (Meuter & Allport, 1999; Costa & Santesteban, 2004). These results, however, are in line with the results found by Jackson et al. (2001). They also did not find any asymmetrical switching costs in their study, but rather "non-switch benefits" as they call it. In other words, Jackson et al. (2001) found that their participants experienced an advantage in the size of the switch costs for remaining within a language but were equally slow when switching from one language to the other. As can be seen in Figure 5, the low proficient bilinguals indeed showed switch costs.

For the high proficient bilinguals in this study, the direction of the switch costs is contrasting to those found for the low proficient bilinguals. The high proficient bilinguals did show asymmetrical switch costs, as the size of their switch costs were larger for Dutch than for English. These results contradict former results found by Costa & Santesteban (2004), who found symmetrical switch costs among a group of high proficient bilinguals.
These results, in combination with the lexTALE scores and the LHQ proficiency data found in Table 2, again indicate that the participants in this study might be more balanced bilinguals than initially assumed.

5.2.2. Proficiency and task switching

The size of the switch costs in terms of RTs for low proficient bilinguals during task switching is smaller than for high proficient bilinguals during task switching (see Figure 3). As stated above, digits contain cognates. It is shown that the *cognate facilitation effect* is larger for low proficient bilinguals than for high proficient bilinguals, as low proficient bilinguals make more use of the translation of these cognates from their L1 to their L2 (Kroll & Stewart, 1994; Libben & Titone, 2009; Lagrou et al., 2011). This could explain the difference in the size in switch costs between these groups, and thus not support the claim that these groups are rather comparable in proficiency.

Prior and Gollan's (2011) study found opposite results, as their more balanced bilinguals showed significantly smaller switch costs during task switching compared to their less balanced bilinguals, the same accounts for the results obtained by Prior and MacWhinney (2010). However, the discrepancy between the participants used in their studies compared to the participants in this study might explain these different results. Prior and MacWhinney (2010) compared bilinguals to monolinguals, which cannot be compared to the comparison made between two bilingual groups in this study.

Prior and Gollan (2011) did compare two different groups of bilinguals, one more balanced group and one less balanced group (based on their switching behaviour). Both groups also spoke different languages as they compared Spanish-English bilinguals to Mandarin-English bilinguals. Not only did the participants in this study speak the same native language and second language, but as indicated earlier, the two bilingual groups in this study seem to have a similar switching pattern (see Table 2). The outcomes of the studies by Prior and MacWhinney (2010) and Prior and Gollan (2011) were significant, and the outcomes of this study were not. This non-significant outcome therefore supports the notion that the two groups of bilinguals in this study are more equal in terms of proficiency than initially expected. In terms of accuracy, the size of the switch costs for the high proficient bilinguals was smaller than the size of the switch costs for low proficient bilinguals during task switching (see Figure 2).

Unlike the absence of the effect of language on the participants' results during the language switching task, results showed that during task switching the effect of cue was significant. Participants responded significantly faster to the >5 cue than to the <5 cue. This is interesting, because language seems to have no influence on the RTs of the participants, whereas task cueing does. This is an interesting topic to further investigate in future research.

5.3. Response modality

The difference in response modality (naming versus self-paced reading and/or button-press) have an effect on participants' switch costs. In language production studies, switch costs have constantly been found (Jackson et al, 2001), with an effect of proficiency on the reduction of the switch costs, as low proficient bilinguals showed asymmetrical switch costs (Green, 1998; Meuter & Allport, 1999; Costa & Santesteban, 2004; Prior & MacWhinney, 2010). In language comprehension studies, however, the results for the performance of bilinguals on switching tasks differed among studies. Some studies did find reduced switch costs for bilinguals (Alvarez et al., 2003; Prior & Gollan, 2011) others did not (Ibáñez et al, 2010; Declerck et al, 2017; Branzi et al., 2018) or found barely any (Geyer et al., 2011). Sometimes these switch costs lack direction (Geyer et al., 2011), other times they show the same (a)symmetrical direction as during language production studies (Alvarez et al., 2003).

The fact that the size of the switch costs in this study are similar regardless of proficiency and task, marks that these results are more in line with other results obtained by switching studies focussing on comprehension (Ibáñez et al, 2010; Declerck et al, 2017; Branzi et al., 2018) rather than on switching studies focussing on production (Meuter & Allport, 1999; Costa & Santesteban, 2004). The differences between the results obtained in this study compared to other studies, could thus for instance also be found because of discrepancies in response modality.

In this study, words and digits were visually presented on the screen, which meant participants had to read the stimuli. An explanation for the obtained results in this study can be explained by assumed processing stages and their durations during word reading proposed by Indefrey and Levelt (2004) seen in Figure 6 below.

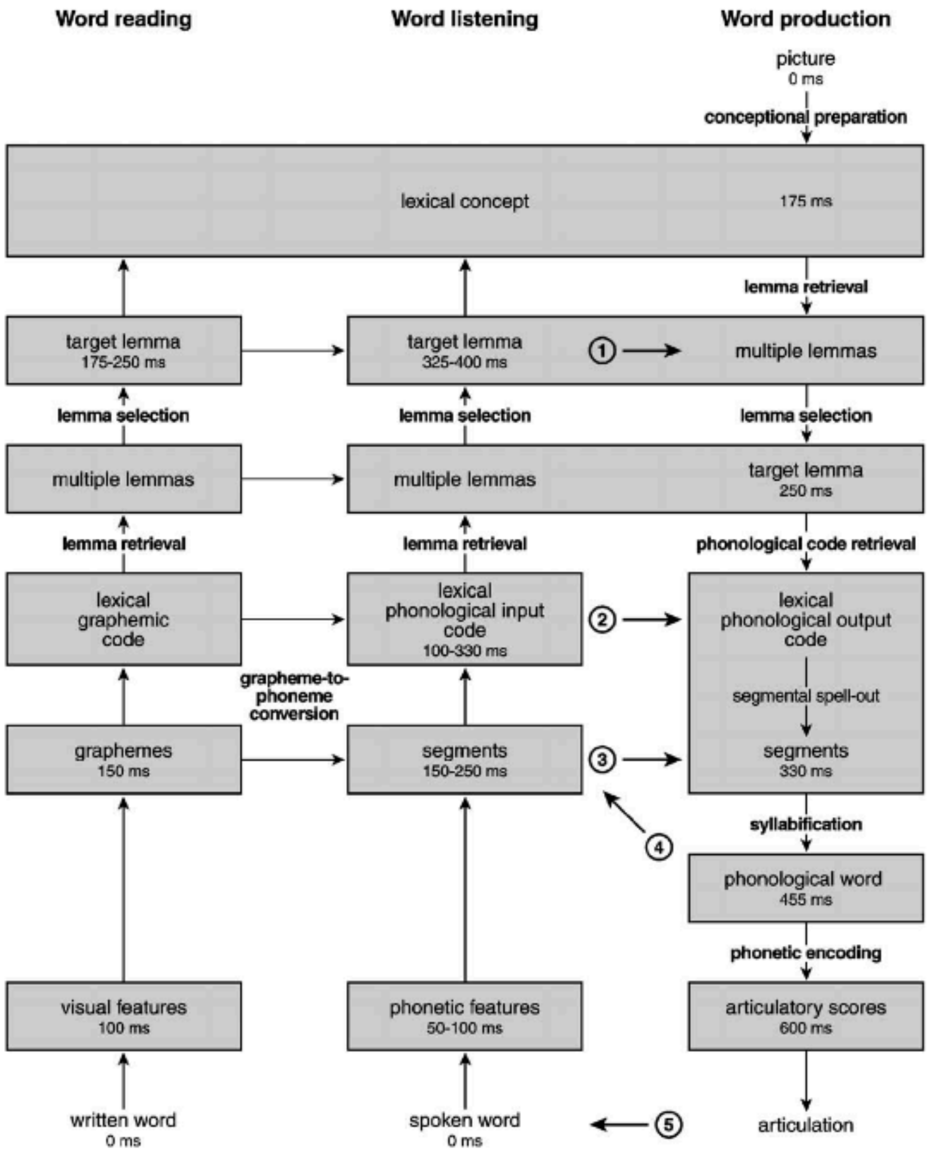

Figure 6. Network of processing components involved in speech production and perception (Indefrey & Levelt, 2004).

This model shows assumed processes of word reading, word listening and word production. The reading of a word takes approximately 175-250 ms, whereas word production takes approximately 600 ms. The difference in time between the routes could explain that one is more difficult than the other, and therefore could explain the small switch costs obtained in studies that contain button-press or self-paced reading, but larger switch costs in studies in which participants have to name the visual input out loud (Ibáñez et al., 2010).

It is important to note though, that although reading in silence differs from reading out loud, there are also similarities. As both during silent reading and reading out loud a participant hears what he/she reads (if this was not the case, then rhyme and/or alliteration would not work for instance). This could indicate that it is mostly the articulatory scores that take time.

5.4. Task switching versus language switching

Participants responded faster during the task switching task than during the language switching task. This difference could for instance be due to the difficulty of the task. Digits represent a certain semantic group, whereas the words do not represent one semantic group (Declerck et al., 2012). Furthermore, digits contain many cognates (*acht* versus *eight; twee* versus *two*) and the words used in the language switching task are non-cognates words. As it is known that cognates speed up the process of recognition because of the *cognate facilitation effect* (Libben & Titone, 2009; Lagrou et al., 2011), the fact that these digits contain many cognates could be a reason for participants to respond faster during the task switching task than during the language switching task.

Declerck et al. (2012) found smaller switch costs in digit naming than in picture naming. This finding encouraged researchers to be cautious when comparing different stimulus types, because these could have a significant effect on the outcome. This study used words rather than pictures, and therefore different stimulus types, but did not find a significant difference in the size of the switch costs between tasks. Like Declerck et al. (2017), this study used two tasks that were very similar to one another. They did not find a difference in the size of the switch costs between both tasks. This could be the reason why this study also found no significant difference in the size of the switch costs between tasks.

Weissberger et al. (2015) found that language switching demands more from the participants than task switching does. Evidence for this notion comes from their brain imaging data. Their fMRI data showed greater brain response in bilinguals during language switching than during task switching, which resulted in larger switch costs in language switching. However, their tasks were a lot less alike than the tasks used in this study or the study conducted by Declerck et al. (2017), which could result in the difference in the size of the switch costs between tasks.

As established before, there was no effect of language on the performance of the participants. Besides proficiency, there are other factors that could have played a role in the lack of effect of language. The stimuli of the language switching task consisted of high frequent, four-letter English and Dutch words. Most of these words were obtained from the first few sets of the PPVT-IV (in Dutch and English) (Dunn & Dunn, 2007). This test is usually carried out with children, and the first few sets therefore contain words that are expected to be familiar for children under the age of ten. This could indicate that both the English and the Dutch words used in this study were too easy (even for low proficient bilinguals), which would explain the absence of an effect of language.

Another reason that language showed no effect in this task could be because of the way the cues were implemented, as participants were always able to see to which language cue the background colour was linked because of the *cheat sheets* that were available to them during the entire experiment (similar to the procedure conducted in the study by Declerck et al., 2012). So not only did the participants had practice trials to get familiarised with the build-up of the experiment, stimuli and background colours linked to these stimuli, during the experimental trials they were always able to check these combinations of language cues with the correct colours. Declerck et al. (2012) also used *cheat sheets* during their digit naming experiment and in this study, there was also no effect of language on the outcome of the results. Cueing might have affected the outcomes of these studies, and it would be interesting to see whether participants still showed no effect of language if the cheat sheets would for instance only be available during the practice trials, rather than during the entire experiment.

A similarity, however, between both these tasks and the tasks conducted by Prior and Gollan (2011) is the timing of the cues. In both cases, the cues were not solely presented before the display of the stimuli, but they were also still visible during the display of the stimuli. The cues however did differ, as they used colour-gradients and small blocks as cues during the task switching task, and flags as cues during the language switching task (Prior & Gollan, 2011). Whereas the cues in this study consisted of colours that represented either a language or <5 versus >5.

Another explanation for the contradicting results could be the difference in content and cueing between the task switching task used in this study compared to the colour-shape task in their study. The colour-shape task that Prior and MacWhinney used, consisted of graphic cues. They used graphic cues together with colour and shapes to avoid as much linguistic information as possible (2010). Although, the task switching task in this study used numbers as stimuli and cues that also consisted of numbers, some would argue that these stimuli and cues are still too linguistic. Besides this, the cues in Prior and MacWhinney's study (2010) were also presented before the display of the stimuli rather than during the presentation of the stimuli. The cues in this study, however, were available to the participants at any time.

Besides the several discrepancies found between Prior and MacWhinney's (2010) study mentioned above, there was also one important similarity. The task switching task from this study is definitely comparable to Prior and MacWhinney's (2010) colour-shape task concerning modality, as they were both measured by means of button-press rather than naming (i.e. digit naming) and were therefore both focussing on perception rather than production.

Paap, Myuz, Anders, Bockelman, Mikulinksy and Sawi (2017) propose two hypotheses in their paper. The first hypothesis is called *the overlap hypothesis.* This hypothesis, in its strongest form, assumes that language switching requires the same mechanism used for general task switching regardless of the direction of the switch, whether it is L1 to L2 or the other way around, and the relative proficiencies (Paap et al., 2017).

The other hypothesis proposed by Paap et al. (2017) is called *the independence hypothesis.* This hypothesis, naturally, states that language switching is not subsidiary to general task switching, and that there is a minimal functional overlap between the two types of switching (Paap et al., 2017).

Research done in the field of bilingualism found contradictory results. Some research has found supporting evidence for the overlap hypothesis (Declerck et al., 2017), whereas others seem to indicate that the independence hypothesis might be true (Paap & Greenberg, 2013). Results of this study however point towards the overlap hypothesis as the results are in line with the results provided by Declerck et al. (2017).

5.5. Power

Another factor that should be kept in mind during the discussion of the results, is that the sample size for the ANOVA analyses conducted in this study was rather small when it came to the analyses with the within-subject factors (N=26), but definitely for the analyses with the between-subject factor group (high N=12 vs low N=14). This means that although this experiment showed some interesting, and sometimes even contradicting results, the experiment does lack power. To increase this experiment's power, and therefore the possibility of generalizing these results to a population, this experiment should be replicated with a larger sample size, at least for the between-subject analyses. On a side note, it should be said that a lot of studies discussed in this thesis therefore also lack power because their sample size is not always as big as recommended.

6. Conclusion

This study conducted an experiment to compare two groups of bilinguals on their performance on a task switching task and a language switching task, and to see whether proficiency and the different conditions might influence their performance on both tasks.

Analyses conducted in this study showed switch costs, as performance was always slower or less accurate on switch trials (i.e. Meuter & Allport, 1999; Jackson et al., 2011; Declerck et al., 2012; Declerck et al., 2017). The low proficient bilinguals may have responded faster during task switching than language switching, and participants might overall be faster during task switching than language switching, this study showed that there was no significant difference in the size of switch costs between groups and tasks. Both in terms of RTs and accuracy.

This indicates that both groups performed equally on both the task switching and language switching task, and that therefore their proficiency level had no influence on their performance. This study also found no effect of language cue during the language switching task. These results are not in line with what this thesis expected beforehand. However, after re-evaluating the proficiency levels of the different groups of participants, this result is no longer unexpected as their proficiency levels might not differ enough to find an effect of proficiency.

The difference between both tasks had no influence on the participants' performance. This result could indicate that language switching and task switching, if the tasks are similar enough (Declerck et al, 2017), happen by means of the same mechanisms, which provides supporting evidence for the overlap hypothesis proposed by Paap et al. (2017), and is in line with what this study predicted beforehand.

This study provided supporting evidence for the overlap hypothesis (Paap et al., 2017) in the field of bilingualism and switching between tasks and/or languages, because the results found in this study are in line with the results provided by for instance Declerck et al. (2017). The lack of any effect of proficiency on the size of the switch costs can be explained in terms of the discrepancy made between both bilingual groups. Therefore, proficiency had no influence on the size or direction of the switch costs during the tasks conducted in this study, however, it would be encouraged to replicate this study with two groups of bilinguals with a greater discrepancy in proficiency level before it is known for sure that proficiency has no effect on the size of the switch costs during language switching and task switching.

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Appendices

Appendix A. Consent form

TOESTEMMINGSVERKLARING

Naam onderzoek: *Wisselen tussen talen en taken*
Verantwoordelijke onderzoekers: *Denise Mulling & Sybrine Bultena*

Onderzoek
In dit onderzoek ga je 3 kleine experimentjes doen op de laptop en word je gevraagd een korte vragenlijst in te vullen. Dit duurt in totaal circa 20 minuten. Jouw resultaten blijven volledig anoniem en worden alleen voor dit onderzoek gebruikt. De gegevens worden op een veilige locatie opgeslagen voor de duur van het afronden van dit onderzoek.

Verklaring deelnemer
Ik neem vrijwillig aan het onderzoek deel. Ik begrijp dat ik op elk moment tijdens het onderzoek mag stoppen als ik dat wil. Ik begrijp hoe de gegevens van het onderzoek bewaard zullen worden en waarvoor ze gebruikt zullen worden. Ik stem in met deelname aan het onderzoek.

Handtekening: .... Datum:
…………………………………………........

Verklaring uitvoerend onderzoeker
Ik verklaar dat ik de hierboven genoemde persoon juist heb geïnformeerd over het onderzoek en dat ik mij houd aan de richtlijnen voor onderzoekers zoals verwoord in het protocol van de Ethische Toetsingscommissie Geesteswetenschappen

Naam: Denise Mulling

Handtekening: ....

Datum:……………………………….............

Appendix B. Test Protocol

Test protocol

Locatie
De participant moet in een rustige ruimte worden getest waar hij/zij zo min mogelijk wordt afgeleid door de omgeving. Alle testen worden aan een tafel/bureau afgenomen met het gezicht van de participant richting een blinde muur, zodat afleiding minimaal is.

Apparatuur
De testen op de computer worden op een Macbook air 11 inch afgenomen. De test-afnemer neemt deze laptop mee naar de test-sessie. De vragenlijst en het toestemmingsformulier worden beide op papier ingevuld.

Participantnummer
Elke participant krijgt een uniek participantnummer toegewezen door de test-afnemer. Dit nummer begint altijd met het unieke getal van de deelnemer. Daarna volgt er een laag streepje gevolgd door een versienummer (1 t/m 5) en een letter (a of b) welke aangeeft of het versie a of versie b was. Daarna volgt er weer een laag streepje en het participantnummer eindigt met het cijfer 1 of 2, die aangeeft of de participant begonnen is met de task-switching task (1) of met de language-switching task (2).

Bijvoorbeeld, stel dat we te maken hebben met de 15^{e} deelnemer die versie 2a krijgt toegewezen van de language en task switching task, en begonnen is met de language-switching task dan zal het nummer er zo uitzien: 15_2a_2

Uitleg
Voordat de testjes beginnen, zal de test-afnemer kort uitleggen dat de participant verwacht wordt drie korte testjes op de computer te doen en een korte vragenlijst in te vullen (zie de instructietekst in bijlage 1 van dit protocol). Ook wordt er gezegd hoe lang deze testsessie in totaal ongeveer zal duren. De test-afnemer zal de participant ook wijzen op de zogenoemde spiekbrief met de betekenis van de cues die onder de laptop ligt. Mocht de participant deze zogenoemde spiekbrief nodig hebben, mag deze ten alle tijden gebruikt worden.

Volgorde testafname
Het experiment bestaat uit vier onderdelen. De volgorde van het testen staat grotendeels vast. De participant leest eerst het toestemmingsformulier en ondertekent deze. Daarna begint hij/zij met de language-switching task gevolgd door de task-switching task of vice versa. Daarna vult de participant de vragenlijst in en eindigt hij/zij met de lexTALE.

Voor het testen
Voordat het experiment begint, zorgt de test-afnemer dat deze participant voorzien is van een uniek participantnummer. Dit nummer kan voor het testen al ingevuld worden op het toestemmingsformulier en op de questionnaire. Bij de lexTALE en bij de switching taken is het de taak van de test-afnemer om het participantnummer in te vullen voor deze beginnen om fouten te voorkomen.

Tijdens het testen
De vier onderdelen van het experiment moeten achter elkaar worden afgenomen. Dit betekent dat het experiment dus niet op bijvoorbeeld twee verschillende dagen kan worden afgenomen. Ook houdt dit in dat de participant niet tot nauwelijks pauze heeft gedurende het experiment. Zoals eerder vermeld, zijn de participanten vrij om zo vaak als zij willen op de spiekbrieven te kijken. Daarnaast zal de test-afnemer gedurende de practice-trials naast de participant blijven zitten. Mocht het nodig zijn, kan de test-afnemer de instructies nogmaals uitleggen als de participant veel moeite heeft met het experiment.

Duur van het experiment
Het experiment duurt circa 20 minuten.

Na het testen
Als het experiment is afgelopen, bedankt de test-afnemer de participant voor zijn/haar deelname. Ook zorgt de test-afnemer dat de data veilig wordt opgeslagen op de daarvoor bestemde USB. Daarnaast zorgt de test-afnemer dat het toestemmingsformulier en de questionnaire veilig bewaard worden.

Appendix C. Language History Questionaire (LHQ)

L2 Achtergrond vragenlijst

Datum:_______________ ID Participant: ___________________

1. Leeftijd (in jaren) __________

2. Geslacht: Man / Vrouw

3. Opleiding (huidige of meest recent gevolgde opleiding, ook als je deze opleiding niet hebt afgerond).

□ PhD
□ WO: MA / MSc
□ WO: BA / BSc
□ HBO
□ MBO
□ Voortgezet onderwijs
□ Basis onderwijs

4. Ben je dyslectisch? Ja / Nee

5. Geef aan hoeveel jaren je het Nederlands en Engels in totaal al gebruikt.

Taal	**Totaal aantal jaren**[a]
Nederlands	
Engels	

a. Je bent misschien begonnen met het leren van een taal, daarna gestopt met deze te gebruiken en later weer opnieuw gaan gebruiken. Geef alsjeblieft het totaal aantal jaren aan dat je deze taal (hebt) gebruikt.

6. Beoordeel jouw huidige niveau van het Nederlands en het Engels aan de hand van onderstaande schaal. Omcirkel het juiste antwoord.

Nederlands

1	**2**	**3**	**4**	**5**	**6**	**7**
zeer beperkt	beperkt	matig	gemiddeld	goed	zeer goed	moedertaal niveau

Engels

1	**2**	**3**	**4**	**5**	**6**	**7**
zeer beperkt	beperkt	matig	gemiddeld	goed	zeer goed	moedertaal niveau

7. Gebruik je vaak woorden of zinnen van het Nederlands en Engels terwijl je praat? (Als je bijvoorbeeld een zin in de ene taal begint, maar halverwege een woord of frase uit de andere taal gebruikt). Beantwoord de vraag aan de hand van onderstaande schaal. Omcirkel het juiste antwoord.

1	**2**	**3**	**4**	**5**	**6**	**7**
nooit	zelden	soms	regelmatig	vaak	meestal	altijd

8. Heb je langer dan 3 maanden in een Engelstalig land gewoond of in het buitenland gewoond waar je veel Engels hebt gepraat? Omcirkel het juiste antwoord.

Ja / Nee

9. Geef een algemeen percentage (0% - 100%) van jouw gebruik van het Engels op een dag (luisteren, schrijven, lezen, spreken). ______ %

10. Vond je de stimuli tijdens het experiment duidelijk zichtbaar? Ja / Redelijk / Nee

11. Als je nog verdere informatie over jouw taalachtergrond of taalgebruik hebt, schrijf dat dan hieronder op. (Wissel je bijvoorbeeld veel tussen het Nederlands en een andere tweede taal of maak je significant gebruik van een andere vreemde taal).

Hartelijk dank voor het invullen van deze vragenlijst!

Appendix D. Descriptive statistics of the interactions

Descriptive statistics accuracy analysis

*Table X. The descriptive statistics of the interaction Group*Task*

Group	Task	Mean	Std. Error
High proficient	**Task switching**	97.3%	0.8%
	Language switching	96.3%	0.9%
Low proficient	**Task switching**	97.2%	0.7%
	Language switching	96.6%	0.8%

*Table X. Descriptive statistics of the interaction Group*Condition*

Group	Condition	Mean	Std. Error
High proficient	**Switch**	95.8%	0.9%
	Non-switch	97.8%	0.7%
Low proficient	**Switch**	96.1%	0.9%
	Non-switch	97.8%	0.7%

*Table X. Descriptive statistics of the interaction Task*Condition*

Task	Condition	Mean	Std. Error
Task switching	Switch	96.3%	0.8%
	Non-switch	98.3%	0.4%
Language switching	Switch	95.6%	0.7%
	Non-switch	97.3%	0.7%

Descriptive statistics RT analysis

*Table X. Descriptive statistics of the interaction Group*Task*

Group	Task	Mean	Std. Error
High proficient	Task switching	1040.83	36.26
	Language switching	1208.15	54.23
Low proficient	Task switching	920.80	33.57
	Language switching	1053.25	50.21

*Table X. Descriptive statistics for the interaction Group*Condition*

Group	Condition	Mean	Std. Error
High proficient	Switch	1190.22	44.82
	Non-switch	1058.76	37.55
Low proficient	Switch	1045.77	41.50
	Non-switch	928.29	34.77

*Table X. Descriptive statistics of the interaction Task*Condition*

Task	Condition	Mean	Std. Error
Task switching	Switch	1053.12	31.48
	Non-switch	908.51	21.68

Language switching	**Switch**	1182.87	37.53
	Non-switch	1078.53	37.97

Descriptive statistics (a)symmetrical switch costs analysis: task switching

*Table X. Descriptive statistics of the interaction Group*Cue*

Group	**Cue**	**Mean**	**Std. Error**
High proficient	**>5**	1143.46	59.26
	<5	1268.87	70.92
Low proficient	**>5**	1003.08	54.86
	<5	1069.20	65.65

T*able X. Descriptive statistics of the interaction Group*Condition*

Group	**Condition**	**Mean**	**Std. Error**
High proficient	**Switch**	1280.64	80.26
	Non-switch	1131.63	74.31
Low proficient	**Switch**	1109.90	74.31
	Non-switch	962.37	49.25

*Table X. Descriptive statistics of the interaction Condition*Cue*

Condition	**Cue**	**Mean**	**Std. Error**
Switch	**>5**	1144.71	47.89
	<5	1245.88	63.54
Non-switch	**>5**	1001.82	40.01

	<5	1092.18	38.07

Descriptive statistics (a)symmetrical switch costs analysis: language switching

*Table X. Descriptive statistics of the interaction Group*Language*

Group	Language	Mean	Std. Error
High proficient	**Dutch**	1372.57	79.98
	English	1413.62	81.34
Low proficient	**Dutch**	1160.16	74.05
	English	1149.66	77.85

*Table X. Descriptive statistics of the interaction Group*Condition*

Group	Condition	Mean	Std. Error
High proficient	**Switch**	1456.18	82.89
	Non-switch	1330.01	81.34
Low proficient	**Switch**	1197.79	76.74
	Non-switch	1112.04	75.31

*Table X. Descriptive statistics of the interaction Condition*Language*

Condition	Language	Mean	Std. Error
Switch	**Dutch**	1324.05	58.13
	English	1329.92	57.76
Non-switch	**Dutch**	1208.69	54.57
	English	1233.37	59.72