

**The effect of language dominance on switching cost
among Hungarian-English bilinguals**

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Preface

One of the main questions of bilingualism research is the nature of how the bilingual brain produces speech and switches between the languages. Bilingual production is based on the inhibition and activation of different languages, and theories have been proposed to account for how it happens (e.g.: Green, 1986). Results have been contradictory about whether the weaker language (L2) or the stronger language (L1) is more difficult to inhibit (e.g.: Meuter & Allport, 1999; Christoffels et al., 2007; Mosca & De Bot, 2017). The aim of the present research is to gain insight into bilingual language control in language production; how language switching happens; and how language dominance, the language history, frequency of use, proficiency and attitude influence the language switching cost.

This paper presents the results of an experiment conducted among Hungarian - English bilinguals ($N = 43$). The participants completed the evaluation of their language dominance and a picture-naming task inducing language-switching. To assess language dominance, the Bilingual Language Profile questionnaire was used (Birdsong et al., 2012) and its results were analysed together with the reaction times during the picture-naming task. The effect of language balance and imbalance, accommodation to code-switching, target word frequency and extralinguistic factors on language switching were considered. Results suggest that language dominance is strongly associated with performance at the language switching task, and so is word frequency; extralinguistic differences and accommodation to the task proved to be non-influential factors.

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CHAPTER 1: INTRODUCTION

Bilingualism (i.e.: the use of two languages on a daily basis by the definition of Grosjean (1989)), and the speech production of bilinguals is a widely researched topic in linguistics. According to bilingual speech production models (such as Green, 1986) when planning speech, the two languages in the brain of a bilingual are both active to a certain extent (for an overview, see Kroll et al., 2012). When selecting words, the word forms of both languages are active and are competing for selection, and it requires effort to inhibit the word from the non-intended language. However, as it takes effort to inhibit one language, it also takes effort to reactivate it when needed. The Inhibitory Control Model (Green, 1986) states that the more dominant one language is for the speaker, the more effort is needed to inhibit it, hence the more effort is needed to reactivate it. Thus, for a bilingual whose dominant language is Hungarian, it would take a longer time to switch to English, and then, it would take longer time to switch back to Hungarian, than for a bilingual whose languages are balanced. One of the motivations of this research is that most studies have focused on typologically similar language pairs (e.g.: English, Dutch, German, Spanish) (see for instance: Santesteban & Costa, 2016; Mosca & de Bot, 2017; Declerck et al., 2019); however, little is known about Hungarian-English bilingual language production (Navracsics, 2004).

In order to answer the main research questions, first, participants will fulfil a questionnaire (Bilingual Language Profile by Birdsong et al. (2012)) focusing on their language history, use, proficiency, and attitude in Hungarian and English. This questionnaire provides data about the language dominance of the participants, which will then be used during the analysis of the results.

As the second phase of the experiment, participants complete a computer-based picture-naming task which allows their reaction times to be measured. In this task they will be asked to name the presented picture as quickly and accurately as possible. The pictures presented are of everyday objects, animals, body parts, etc. Participants have to face altogether 80 trials, during which the order of the target language is not predictable; there are trials where the required answer is in different language than the previous one (switch trials), and where the answer is the same language as the previous stimulus (repetition trials). Participants see each picture twice, once in Hungarian and once in English.

In this paper, the above-mentioned experiment focusing on the relationship of codeswitching (language switching) and language dominance of Hungarian-English bilinguals

will be presented. First, the theoretical background will be reviewed based on existing literature, featuring an overview of bilingualism, speech production models and the experimental data. Based on the literature, research questions will be formed, and the hypotheses will be created. To answer the research questions, the design of the experiment will be presented, and its participants, instruments, and procedure will be discussed. Finally, the results of the experiment will be presented and discussed, and conclusions will be deducted based on the results and by comparing them to data from other experiments.

1.1 Bilingualism

In order to extend the knowledge on the switching cost of bilinguals, first it has to be determined who is considered a bilingual. There have been various definitions of bilingualism developed in the last half century, from strictly referring to individuals who have the skills of a native speaker in two languages (Bloomfield, 1933; Thiery, 1978), to the “lighter” definitions such as language users who possess at least one language skill out of reading, writing, speaking, and listening (Haugen, 1969). In this paper, however, the definition by Grosjean (1989; 1997) will be used as a working definition, and those individuals who use two languages on a daily basis will be considered bilinguals.

As bilinguals use two languages on a daily basis, it is often the case that the two languages are used for different purposes. The result of this is that the proficiency of bilinguals is not the same in the two languages in all areas and is often domain-specific (i.e.: if one only uses one language during work, and another at home, they might not be able to use the languages in the other domain). It might also be the case that the traditional language skills (reading, writing, speaking, listening) are used to different extent in the two languages. These phenomena are summarised in the complementary principle by Grosjean (1997, p. 165), which states the following:

Bilinguals usually acquire and use their languages for different purposes, in different domains of life, with different people. Different aspects of life require different languages.

As an implication of the complementary principle, it can be stated that a bilingual should not be considered as two monolinguals in one person (Grosjean 1989; Malt & Sloman, 2003), since their language skills are different in the two languages. This also indicates that bilinguals do not produce and perceive speech as if they were monolinguals, and research also shows that switching off one of their languages completely is not possible (Kroll et al., 2006;

2012; Marian & Spivey, 2003). Rather, bilingualism is dynamic (Hernandez et al., 2005; Kroll et al., 2012): the languages of a bilingual influence one another in both directions (cross linguistic influence (CLI)) (Jared & Kroll, 2001; Kroll & Stewart, 1994; MacWhinney, 2005); the proficiency of the language user can change based on training, immersion (Lambert & Freed, 1982; Linck et al., 2009), or attrition (Bátyi, 2015; Schmid, 2010).

To be able to handle two languages, bilinguals need a developed control mechanism, and it has been found that indeed, they have an increased cognitive control compared to their monolingual peers (Abutalebi & Green, 2008; Hasegawa et al., 2002). It has also been observed that bilinguals have advantages in certain areas of cognition, such as ignoring irrelevant information, conflict resolving or switching between tasks (Bialystok et al., 2009). Bilinguals have better metalinguistic skills (Bialystok, 1988) and working memory as well (Bialystok et al., 2014). The influence of bilingualism does not fade with age, furthermore, bilinguals are diagnosed with diseases connected to dementia 4.5 years later than monolinguals (Bialystok et al., 2007; Craik et al., 2010).

1.2 Speech production models

Nevertheless, it is not a negligible achievement that bilinguals are able to produce and comprehend speech and writing in more than one language. The issue of speech production has been one of the focal interests of psycholinguists for several decades as it is the most observable part of speech behaviour. In this paper, the most widely used model of speech production will be discussed, which was developed by Willem J. M. Levelt in 1989. The Speaking Model gives a thorough description of how monolinguals produce spoken language, based on analysing speech errors and hesitation markers (e.g.: filled or silent pauses). The model is a blueprint and is based on the available empirical evidence back in the late 80s. Since then, several research including brain imaging studies have validated the components and working mechanisms of the model (e.g.: Indefrey, 2007). However, as the focus of the paper is the population who handle two languages in the mind when speaking, bilingual models will also be elaborated on. These bilingual speech models were based on Levelt's original model, complemented with the phase at which the language selection happens.

Levelt's Speaking Model (1989; 1992; 1993; 1995; 1999, as in De Bot & Bátyi, 2022) consists of three main components: the conceptualiser, the formulator, and the articulator. These are the processing components (illustrated with boxes), which are connected to the

knowledge components (illustrated with ellipses), such as the mental lexicon. The Speaking Model can be seen in Figure 1.

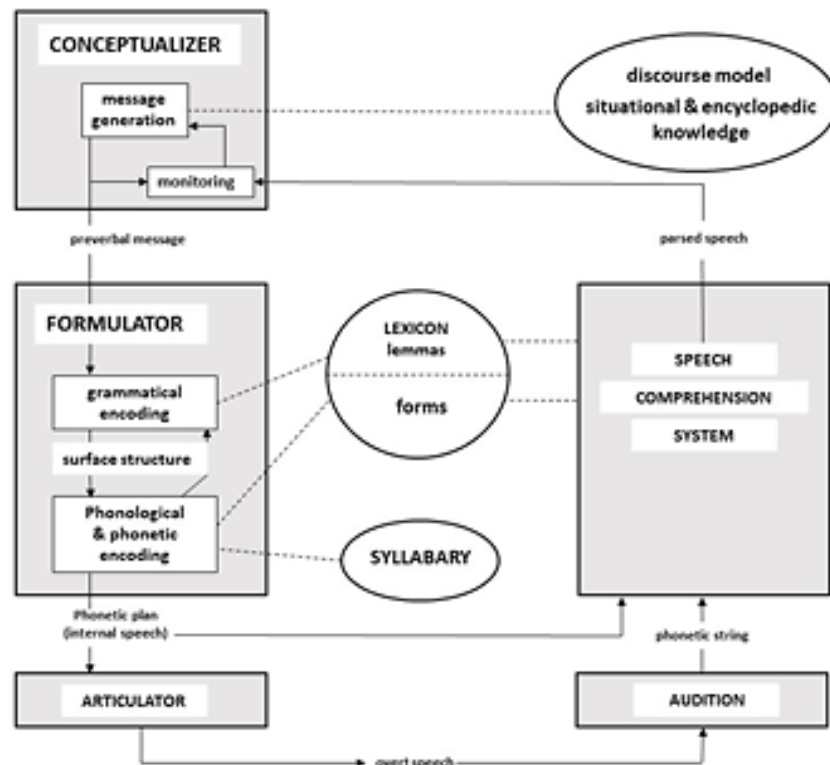


Figure 1. Levelt's speech production model (Levelt, 1989 adapted by De Bot & Bátyi, 2022)

The first phase of speech production is the conceptualisation and planning. It is a pre-linguistic stage, where general decisions are made about what to say, relying on the situational and general knowledge. The conceptualisation phase also involves macro- and microplanning. In macroplanning, linearisation (ordering information) and instrumentality (selecting information) happens; these processes result in the creation of the pre-verbal message, which cannot be considered language yet.

The second phase of speech production according to Levelt's model (1989) is the formulation, in which the formulator and the mental lexicon are involved. There are two distinct processes of formulation: the grammatical (syntactic and morphological) and phonological encoding, connected to different aspects of the desired lexical entries. Lastly, the phonetic plan reaches the articulator and is converted into actual speech.

While attempting to access the intended items from the mental lexicon, there is one "challenge" the speaker has to overcome: spreading activation. Spreading activation, which is an automatic process, means that whenever a lexical item is activated, other nodes connected to it are also activated; for example, if a speaker wants to produce the word "scarf", activating

the concept of scarf spreads and activates lexical items with similar meaning (e.g.: jacket, gloves, cold) and similar sound pattern (e.g.: scar). These nodes are all competing to be selected, and language users have to inhibit the activation of undesired lexical items for successful communication.

1.2.1 Bilingual speech production models

Having discussed Levelt's monolingual speech production model, bilingual models derived from the Levelt's work can now be focused on. To account for the possibility of different languages as outputs of the original model, psycholinguists had to explain which phase language selection occurs at. This resulted in the creation of two different views on bilingual speech production: language selective and non-selective models (Costa et al., 1999; Grosjean, 2013; Hermans et al., 1998; Jared & Kroll, 2001). The first argues that language selection occurs early in the conceptualisation phase, so bilinguals are able to activate one of their languages and ignore the other (e.g.: De Bot, 1992; La Heij, 2005). It also assumes the existence of a "language switch" that bilingual speakers use to switch between their languages (MacNamara & Kushnir, 1971). This idea has does not have too many supporters, since the majority of empirical evidence suggest that bilingual speech production process is language non-selective (for an overview see for instance Kroll et al., 2012).

Language non-selective, or competition for selection models vary in terms of where exactly language selection occurs. Some suggest that language selection happens in the lexical selection phase. In this research, one of the most influential language non-selective models will be discussed and tested empirically, the Inhibitory Control Model (ICM) by Green (1986; 1993; 1998).

The basis of the Inhibitory Control Model is the spreading activation (i.e. when accessing a lemma, other nodes connected to it are also activated and have to be suppressed). Green's model (1986) explains that the same process happens when bilinguals select the intended lemmas in their communication, both languages are activated, and speakers inhibit the languages which is not currently in use. The ICM also assumes that each lexical item has a language tag indicating their belonging to L1 or L2.

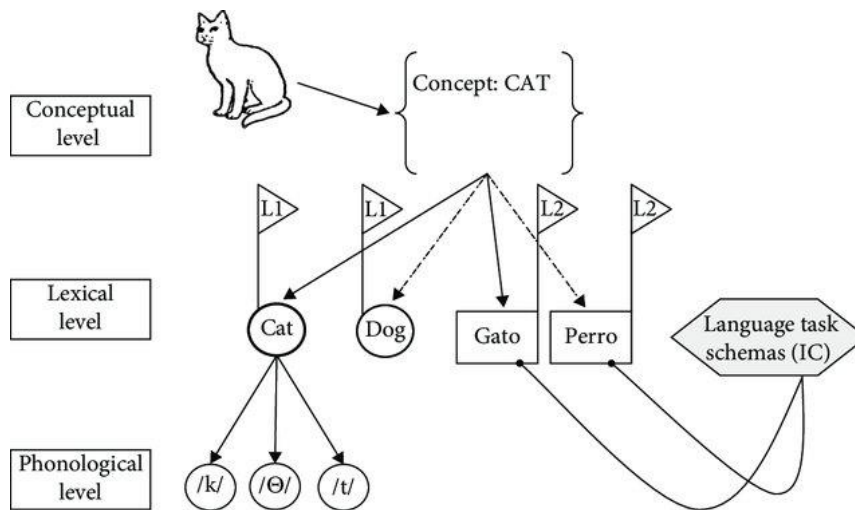


Figure 2. Inhibitory Control Model (Green, 1986)

However, as Grosjean (1989) argued, it is highly unlikely that a bilingual uses their languages for the same purpose and in the same domain of life, thus one of their languages is usually more dominant. Green (1986; 1993; 1998) claims that due to this imbalance, nodes of different languages are activated to various extent, thus the inhibition a bilingual has to enforce differs based on their dominant language. This means that to produce an utterance in the non-dominant language, the speaker has to inhibit nodes which are more active than the desired one; in other words, the more dominant a language is for a bilingual, the more it has to be suppressed to produce another language. To reactivate a language after it was inhibited also depends on its dominance; the more dominant it is, the more its reactivation cost is. This phenomenon is called the switching cost, which, according to Green (1986) is dominance-related, asymmetric inhibition.

1.3 Language dominance

From the ideas of Grosjean (1989) and Green (1986) emerges the notion of language dominance, which should not be considered equal to language proficiency, even if they often correlate (Birdsong, 2006; Gertken et al., 2014). In this paper, the working definition of language dominance will be that of Harris et al. (2006, p. 264), saying:

Language dominance refers to which language is generally most accessible in day-to-day life. It is the language that is most highly activated, and can be the default language for speaking and thinking.

Language dominance, such as bilingualism as a whole is also dynamic, it can shift during the lifetime of a bilingual, regardless of proficiency, e.g.: in case of immigrants (Harris et al., 2006).

Nevertheless, even if the dominance of bilinguals changes throughout their life, their current dominance can be measured and examined. In order to do this, various language dominance tests have been created, which provide a great help for researchers to gain further insights into how the bilingual mind works. The dominance tests to be discussed in this paper are the Bilingual Language Profile (BLP) (Birdsong et al., 2012); Language Experience and Proficiency Questionnaire (LEAP-Q) (Marian et al., 2007), the Bilingual Dominance Scale (BDS) (Dunn & Fox Tree, 2009) and the Self Report Classification Tool (SRCT) (Lim et al., 2008).

Bilingual Language Profile (henceforth: BLP) is an instrument for assessing language dominance of the participants through self-report in a questionnaire format, created as a standard and guide for researchers of bilingual interaction, cognition, or success (Gertken et al., 2014). It was designed to include and measure the various dimensions of language dominance besides proficiency (Birdsong, 2006; Gertken et al., 2014), such as cultural identification (Marian & Kaushanskaya, 2004), motivation (Piller, 2002), language history and use. The importance of knowing language dominance lies in the fact that it affects “language behavior, cognition and emotion” (Gertken et al., 2014, p. 208), influences patterns of code-switching (Basnight-Brown & Altarriba, 2007), language choice (Dewaele, 2004, Tamamaki, 1993), and even lexical memory representation (Heredia, 1997). Language dominance can be used in education (Brunner, 2010), academic and clinical research (Gollan et al., 2010) or in language therapy (Lim et al., 2008).

In BLP dominance is thought of as a continuum rather than a dichotomous concept (Gertken et al., 2014; Grosjean, 2001). Thus, with BLP it is possible to accurately assess the language profile of bilinguals and observe variation within certain groups such as bilinguals with high dominance or relatively balanced bilinguals.

The BLP questionnaire uses self-evaluation, which is one of the most common methods in dominance profiling (e.g.: Cutler et al., 1992; Rah, 2010; Tokowicz et al., 2004). It is also agreed upon that bilinguals are able to assess their language skills and experience (Bairstow et al., 2014; Flege et al., 2002; Golato, 2002; Gollan et al., 2012; Lim et al., 2008; Marian et al., 2007).

Besides BLP, the merits of other questionnaires should be discussed as well. LEAP-Q is an excellent tool to assess the languages of a bilingual individually, but it provides no information on the relating strengths of the two languages (Gertken et al., 2014). LEAP-Q is also considered rather lengthy and complex; on the contrary, the BDS assesses the language dominance of respondents in only twelve questions (Gertken et al., 2014). The BDS can be an

optimal choice for researchers whose target population is illiterate, simultaneous bilingual (meaning that they acquired the two languages at the same time) (Amengual & Blanco, 2011 as in Gertken et al., 2014), but when applied to late L2 learners (such as the target population of this research), it can result in invalid assessment (Gertken et al., 2014). Lastly, the SRCT is a tool to define the language dominance specifically of Singaporean English – Mandarin communities for clinical purposes (ibid.), which would also not be a suitable choice for the target population of the present paper.

1.4 Experiments on bilingual speech production

In order to support the models of speech production with empirical data, experiments have been conducted on bilingual speech production, codeswitching, and inhibition. To test their hypotheses, researchers designed a wide variety of tasks over the decades of experimenting with bilingual speech production, such as the Stroop task (Stroop, 1935), or Simon task (Simon & Wolf, 1963). One of the most frequently used tasks is the picture naming. Picture naming can be used to induce codeswitches, and it is also a useful tool to avoid presenting the orthographical representation of words (e.g.: if the writing systems of a bilingual's languages are different). Studies measuring switching cost by picture or number naming feature two types of trials: *repetition* (stimuli of the same code, e.g. L1-L1) and *switch trials* (stimuli from different codes, e.g. L1-L2). The expected reaction time to repetition trials is slower than the reaction time to switch trials, as well as the results of switch trials are usually less accurate (Meuter & Allport, 1999).

Current studies on codeswitching and switching cost focus on the switch between dominant and non-dominant languages, registers, modalities, and the potential facilitating power of cognates. Declerck et al. (2019) directs attention to code switching between registers (formal/informal French) and languages (French and English). They conclude that there is a similar control mechanism for the two different types of switching. Researchers are also interested in the codeswitches between sign and non-sign languages (i.e.: bimodal bilinguals) (Emmorey et al., 2008; Morford et al., 2011; Tang & Sze, 2018). In the findings of Tang and Sze (2018), in the language production of bimodal bilinguals the two languages are often present at the same time (code-blending, simultaneous production), and the “traditional” code-switching rarely occurs. It has also been observed that bimodal bilinguals are also prone to CLI (Emmorey et al., 2008; Morfold et al., 2011), even though their languages are not phonologically similar.

Several papers have focused on how cognates affect codeswitching (Bobb & Wodniecka, 2013; Hoshino & Kroll, 2008; Santesteban & Costa, 2016). In these experiments, two types of words are presented to the participants: those that do not share their form in the bilinguals' languages (e.g.: horse – ló) and those that do (e.g.: bomb – bomba). The conclusion of these experiments was that picture of cognates in the bilinguals' languages were named faster than non-cognates, even in cases when the writing system of the languages are different (e.g.: Japanese-English (Hoshino & Kroll, 2008)).

Other language pairs which are markedly different from each other have also been studied, such as Hungarian and English. The speech production of Hungarian-English bilinguals has been explored by the works of Navracsics (see for instance: 2004; 2014), focusing on codeswitching, codemixing, pauses and discourse markers of participants' narration of comic strips, picture or colour naming tasks. Her works also examined the bilingual mental lexicon through various aspects (Navracsics, 2006).

To test the Inhibitory Control Model (Green, 1986; 1993; 1998) numerous studies of dominance-related switching costs were designed. The results were controversial, with some papers observing an asymmetric inhibition pattern (Jackson et al., 2001; Macizo et al., 2012; Meuter & Allport, 1999), while others refuting it (Bobb & Wodniecka, 2013; Fink & Goldrick, 2015; Peeters et al., 2014; Reynolds et al., 2016). However, it was also found that in case the participants were balanced bilinguals (neither of their languages was particularly dominant), the switching cost was also balanced, symmetrical (Christoffels et al., 2007; Declerck et al., 2012; Fink & Goldrick, 2015). Furthermore, with extended practice, the switching cost has been reported to be reduced (Meuter & Allport, 1999) even for unbalanced bilinguals.

The recent paper of Mosca and De Bot (2017) presents a bilingual perception and production experiment to fill the gap in the knowledge on the differences and similarities between the two processes. They conducted two experiments with Dutch-English bilinguals, a lexical decision task (pseudowords versus existing words in Dutch and English) for the perception component and a picture naming task for the production part. In the picture naming task participants had to name the pictures in Dutch or in English (indicated by green or blue background) during single-language and mixed-language blocks, which consisted of repetition (75%) and switch trials (25%). Altogether 14 pictures were used in this experiment in a total of 168 trials. Their data show that repetition trials were named faster in both L1 and L2 than switch trials. They also concluded from the results that balanced bilinguals produced symmetric switching costs, asymmetric reactivation cost was only observed when participants

had a substantial dominance difference between their languages. These conclusions are in line with the study of Mosca and Clahsen (2016) and Christoffels et al. (2007), stating that symmetrical switching cost can be expected if a bilingual is unbalanced but a highly proficient L2 user.

The series of experiments conducted by Linck, Schwieter and Sunderman (2012) are also worth discussing. Their participants were trilingual (L1 – English, L2 – French and L3 – Spanish), and the focus of the experiments was to find out how inhibitory control affects codeswitching. The participants had to perform a Simon task and a picture naming task. Their results show that for multilinguals, switching cost into L1 was higher than the other cases, and the lowest switching cost was into L3, which supports the ICM (Green, 1986).

1.5 Research questions

Even though numerous speech production experiments have been conducted on bilinguals in order to see whether there is a symmetrical or an asymmetrical switching cost (see for instance: Reynolds et al., 2016), oftentimes the languages compared are typologically similar (e.g.: English-Dutch, English-German, etc.). This, however, is not true in case of the present research, where the target population is Hungarian-English bilinguals.

The goal of the present study is to shed light on the connection between language switching and language dominance of bilinguals.

The paper aims at answering the following questions:

- 1) To what extent is language dominance related to language switching in Hungarian-English bilinguals?
- 2) To what extent are extralinguistic factors and accommodation to the task related to language switching in Hungarian-English bilinguals?

The hypothesis of this paper is that the results will support the Inhibitory Control Model (Green, 1986; 1993; 1998); the data from the experiment will show asymmetrical inhibition, so switching to the stronger language is expected to be slower than switching to the weaker one. It is also hypothesised that by the end of the experiment, participants will be accommodated to the task and their reaction times will be faster. More frequent words are anticipated to be reacted to faster as well.

CHAPTER 2: METHODS

2.1 Participants

The target population of this experiment was Hungarian-English bilinguals. There were 43 participants in the experiment. The mean age of the participants was 24.58 years ($SD = 6.89$), with the minimum being 18 years and maximum being 54 years. Regarding their gender, 21 (49%) participants were female, and 22 (51%) were male. All participants were currently living in Hungary. The vast majority of the participants ($N = 40$, 93%) were born and raised in Hungary; however, there were three participants (7%) whose country of origin was different (namely: Ukraine (Transcarpathia), United Kingdom, Romania (Transylvania)). Nevertheless, the mothertongue of all participants was Hungarian.

Considering the highest level of education, every participant was enrolled at university. 28 participants (65%) were currently attending university for their Bachelor's degree; 11 participants (25%) had their BA degree as highest level of education. There were also 2 participants (5%) with Master's level degrees, and 2 participants (5%) who have completed their PhDs.

2.2 Instruments

2.2.1 Bilingual Language Profile

The first part of the experiment on switching costs of Hungarian-English bilinguals was a questionnaire based on Bilingual Language Profile (Birdsong et al., 2012). A more thorough discussion of the principles behind choosing this instrument can be found in Section 1.3.

The Bilingual Language Profile questionnaire consists of four modules (19 questions) and one additional section for gathering biographical information. The first module focuses on the language history of the participants, collecting information about the age at which they acquired their languages, years they spent in a country, family, or workplace where their target languages were dominantly used. The second module consists of questions concerning language use. Participants were asked to indicate the percentage in which they use their Hungarian, English, or other languages out of 100% in various areas of their everyday life, such as with friends, family, at school or during talking to themselves. The third module focuses on the proficiency of the participants in Hungarian and English. It includes questions about their writing, speaking, listening, and reading skills, which they had to indicate on a Likert scale from 0 (not good) to 6 (very good). Lastly, Module 4 is dedicated to language

attitude, with questions about with what culture do the participants identify themselves, which language they want to be considered a native speaker of, etc. Their answers had to be indicated on a scale from 0 (not at all) to 6 (to a great extent).

The biographical module of the original Bilingual Language Profile questionnaire was modified to provide valid information about the Hungarian participants. First, participants were presented with the necessary information about the experiment, the contact information of the author and the supervisor of the paper and were asked if they accept the terms. Then they were asked about their age, sex, current place of residence and country of origin. It was also required to give their highest level of formal education, which was modified to the appropriate levels of the Hungarian education system. The complete questionnaire used can be found in Appendix 1.

The questionnaire was administered on Google Forms in English. The questionnaire was distributed to the participants of the experiment online, completed questionnaires were then assessed and the dominance scores were calculated by the author of the paper.

In order to calculate the language dominance of the respondents, the BLP assigns weights to the different components to account for the different number of questions. The instructions of calculating the language dominance scores are provided on the BLP website (Birdsong et al., 2012). The scores of the two languages are subtracted from one another; in this case, the English score is subtracted from the Hungarian score. This way, those participants whose language dominance score is positive are more dominant in Hungarian, while respondents with negative score are more dominant in English. The maximum value of one's language dominance is +218.

In this section, the dominance score of the participants will be presented. The mean score of the participants was +59.39, meaning that on average, they are rather dominant in Hungarian. However, there is a great variance in the scores ($SD = 33.72$). There were 3 participants with dominance in English (P5 with -28.33; P9 with -18.25 and P32 with - .18). The highest dominance score on the Hungarian side was P49 with +126.68; and there were 5 other participants with scores close to +100.

Based on the scores, participants were grouped into five different categories, shown in Table 1.

Title	Score	Participants #	Hungarian dominance #	English dominance #
Balanced	0-19	5	3	2
Slight dominance	20-39	8	7	1
Medium dominance	40-69	10	10	0
Medium strong dominance	70-94	14	14	0
Strong dominance	95+	6	6	0

Table 1. Distribution of participants by language dominance

2.2.2 Picture naming task

The second stage of the experiment consisted of a picture naming task, where participants were asked to watch videos and say the name of the presented pictures as fast and accurately as they can. There were four videos altogether: two single-language practice blocks in English and in Hungarian, and two mixed-language videos to induce code-switching.

All four videos were specifically designed and created for the purpose of the research. The videos began with 3000ms of blank screen before the picture naming sessions started. Before each picture, participants saw a short intermission, which consisted of a fixation point for 200ms and blank screen for 400ms, during which an audio signal was played so that it ended precisely when the picture was shown after the intermission. Pictures were shown for 3000ms, during which time participants had to name it in the required language. The required language was signalled by the colour of the background of the pictures (yellow background for the Hungarian language and blue background for the English language), as shown in Figures 3 and 4. After every fourth trial, a blank screen was shown for 3000ms.



Figure 3. Example of stimulus (English)



Figure 4. Example of stimulus (Hungarian)

The single-language blocks featured 4 – 4 trials, and the mixed-language blocks included 40 – 40 trials. The pictures in the mixed-language sessions were organised into ten groups, each with four words. Every group had different combination of the two required languages so that the order of languages are not predictable for the participant, as shown in Table 2.

List#1	List#2
2221	1112
2121	1212
1112	2221
1221	2112
1212	2121
2212	1121
1121	2212
1211	2122
2112	1221
2211	1122

Table 2. Distribution of target languages

The pictures used in the experiment were created by the International Picture-Naming Project (IPNP) by the Center for Research in Language (CRL) at the University of California (see for instance: Székely et al., 2005). In the experiment pictures illustrating nouns, such as everyday objects, animals, body parts were included. All pictures were black-and-white drawings of the target word. The procedure of selection was implemented manually, based on various factors. Firstly, cognates or similar sounding words were eliminated (e.g.: guitar-gitár; panda-panda). Then, the classification of words into levels (e.g.: A1, A2, B1, etc.) of English Profile (2015), based on the Common European Framework of Reference (CEFR) (Council of Europe, 2001), was taken into consideration. Lastly, the database of IPNP was used to select words with similar frequency in both languages (n.d.). The frequency of the English words was examined in the British National Corpus (n.d.); the Hungarian words were searched for in

Magyar Nemzeti Szövegtár (n.d.). There was no significant difference between the frequencies of the words in the two languages, $t(39) = -.41$, $p = .68$. There was no attempt to match the words on the basis of the number of syllables or characters in either of the languages.

The instruments used for the picture-naming task can be found in Appendix 2. The list of selected words by their target name in English and Hungarian can be seen in Appendix 3, together with the level at which they are learned based on CEFR (Council of Europe, 2001) and their respective frequency. The target names (or dominant names) are used in reference to the IPNP, in which these names emerged from the data; these names were dominantly used by the participants and were not preselected. The words selected for the experiment were mostly A1 (52%, $N = 21$), A2 (30%, $N = 12$) and B1 (15%, $N = 6$) level, one word (“pumpkin”) was not found on the list (English Profile, n.d.).

2.3 Procedure

As the first step of data collection, a pilot experiment was conducted among 8 participants. Based on their feedback, the list of stimulus words was altered, and the instrument was finalised.

During the data collection phase, first, participants were asked to complete the Bilingual Language Profile questionnaire online. Then, they were contacted to organise the completion of the picture-naming component. In the picture-naming experiment, participants were informed about their task, what the video will look like, and that their answers will be recorded. The language of instruction was Hungarian.

Participants first completed the practice sessions. They had the opportunity to practice the single-language blocks as many times as they wished, until they felt confident with recognising the required language based on the background colours. The mixed-language blocks, however, could only be completed once.

CHAPTER 3: RESULTS

After data collection, the analysis of the results will be presented. To start the analysis, first, the reaction times were measured with the software Praat and administered to Excel. Then, the software R was used to provide invaluable insights into the results. Only reaction times which featured the target word from the responses were used for the analysis. Instances where participants did not respond to the stimulus or did so in the non-target language were excluded. If the response featured a word semantically similar to the target word in the target language, the response was accepted (e.g.: “rat” for the target word “mouse”, or “kitty” for “cat”).

Based on the reaction times, databases were built for the analysis. In the databases, the average values of reaction times of participants were calculated based on various factors. This way, the mean value of reaction times for the different target languages, trial types or word frequency was acquired. This data was used for t-tests and correlation analyses. In the following section, the results of the aforementioned analyses will be presented. Since the mothertongue of all participants was Hungarian, and for the sake of simplicity, L1 will denote Hungarian in all cases, and L2 will denote English, even if the dominant language of the participants would require a different notation. Thus, in the analysis, L1 will be synonymous with Hungarian, and L2 will equal to English, regardless of the dominance of the participants, except when stated otherwise.

The average reaction time of the 43 participants was 1149.05 milliseconds, when both languages are included. Looking at L1 and L2 separately (Figure 5), no significant difference was found between the reaction times to the Hungarian (L1) ($M = 1150.62$, $SD = 164.85$) and English (L2) ($M = 1147.49$, $SD = 153.38$) stimuli, $t(42) = .22$, $p = .83$.

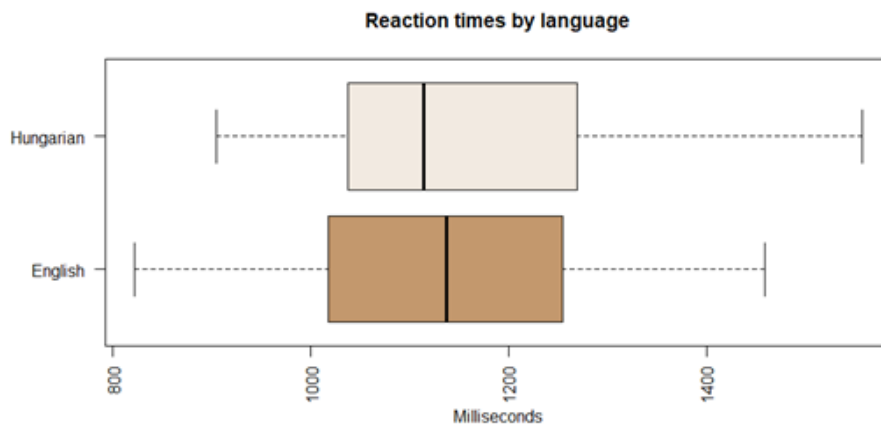


Figure 5. Reaction times by language

Since all words were presented in both languages, it was also measured whether there is a considerable difference between the reaction times for each variant of the words. No significant difference could be found between the production each word in L1 ($M = 1152.34$, $SD = 120.7$) and in L2 ($M = 1151.21$, $SD = 141.76$), $t(39) = -.05$, $p = .95$. This is reported by Figure 6.

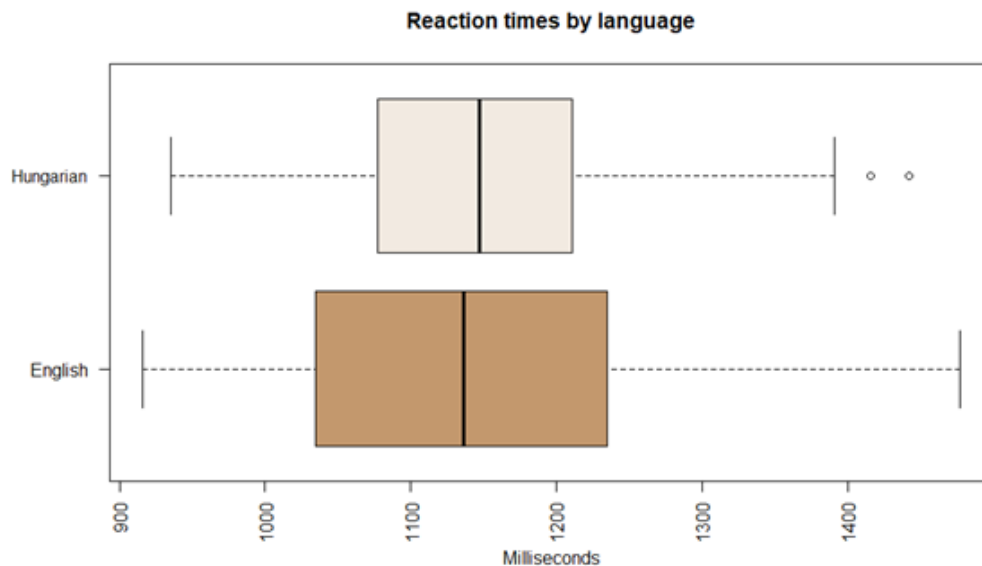


Figure 6. Reaction times per word by language

Next, switch trials (from L1 to L2 and from L2 to L1) were examined, to see if it takes more time for participants to code-switch than to produce the same language. Interestingly, no significant difference could be discovered between the switch trials ($M = 1156.82$, $SD = 161.87$) and repetition trials ($M = 1138.88$, $SD = 148.57$) either, $t(42) = -1.61$, $p = .12$. The relationship of the trial types can be seen in Figure 7.

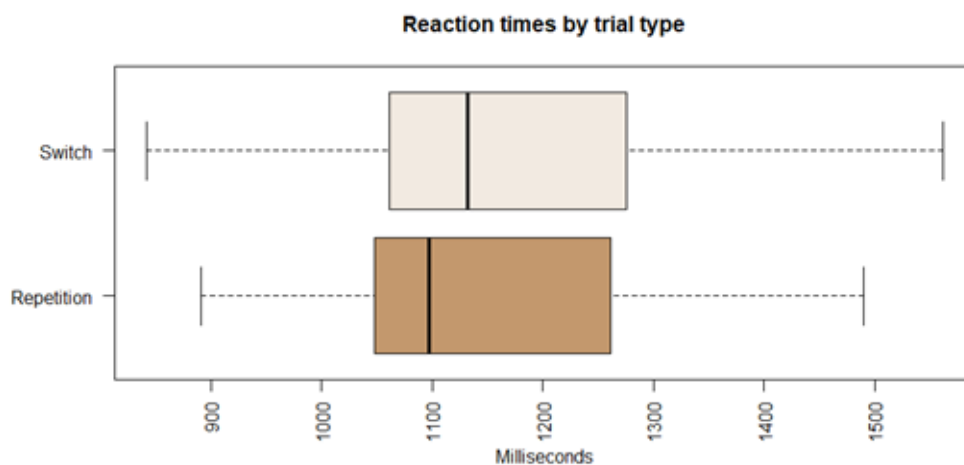


Figure 7. Reaction times by trial type

Looking at switching to the different languages, interestingly, no significant differences can be found between switching to Hungarian ($M = 1165.94$, $SD = 173.06$) and switching to English ($M = 1149.04$, $SD = 163.94$), $t(42) = -1.18$, $p = .24$. If the data of the three participants who are more dominant in English than in Hungarian are excluded, the results are even less significant, and on average participants still switch slightly slower to Hungarian ($M = 1162.22$, $SD = 167.94$) than to English ($M = 1153.68$, $SD = 178.2$), $t(39) = .59$, $p = .56$.

By calculating the switching cost (subtracting the reaction times of repetition trials from switch trials in each language), no significant differences were found in Hungarian ($M = 32.92$, $SD = 83.61$) and in English ($M = 2.9$, $SD = 106.61$), $t(42) = 1.63$, $p = .11$. The next step towards finding the answer to the research question was to calculate the difference between the switch trials to the different languages. This way, it can be clearly shown to which language participants switch to with more ease, and it can be contrasted to their dominance score. The averages of switching to English were subtracted from the mean values of switch trials to Hungarian. Thus, if the result was negative, it indicated that the switch to English was slower than the switch to Hungarian; and if the result was a positive number, switching to Hungarian was slower than the switch to English. This data is shown in Figure 8.

Even though there were only 3 participants out of 43 who showed dominance in English, the difference between the switch trials to L1 and L2 was more evenly distributed. The score of 42% of the participants ($N = 18$) was negative, indicating that they switched to Hungarian faster than to English, while 58% of the participants ($N = 25$) switched faster to English. On average, the difference of switch trials between the two languages was 16.9 ms ($SD = 93.87$). The minimum value (fastest switch to Hungarian compared to the switch to English) was -204.88 ms, and the maximum value (fastest switch to English compared to the switch to Hungarian) was 209.51 ms. In Appendix 4, the gender, language dominance, and difference between L1 and L2 switching of each participant is included, which will be further analysed.

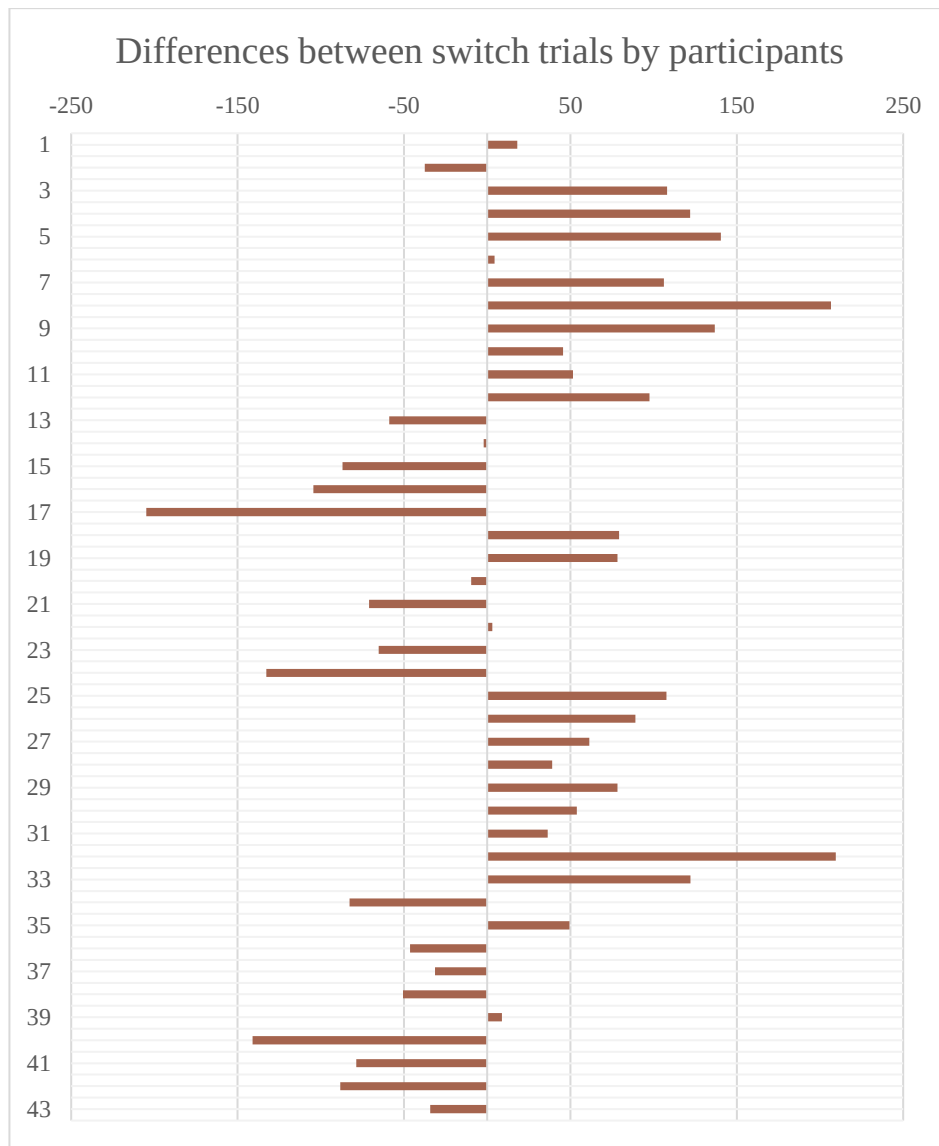


Figure 8. Differences between switch trials by participant

To attempt to answer the research question of this paper, the relationship between the language dominance scores and the differences between the switch trials to L1 and to L2 was analysed. There was a significant, strong negative correlation found between language dominance and the difference between the switch to different languages, $r(41) = -.58$, $p < .001$. This means that the smaller the dominance score of the participants was (i.e.: the more dominant English was for them), the higher the difference between the switch to L1 and L2 was. As a high value of the latter indicates that participants switch faster to English than to Hungarian, it can be concluded that participants produced their stronger language faster.

Figure 9 shows the difference between L1 and L2 switches by the established groups based on dominance scores. As it can be seen, the more dominant English is for the participants (i.e.: the closer the score is to zero), the faster they switch to English. As the

dominance shifts to Hungarian, the difference between L1 and L2 switches also shift towards the negative domain, showing faster switches to Hungarian, the stronger language.

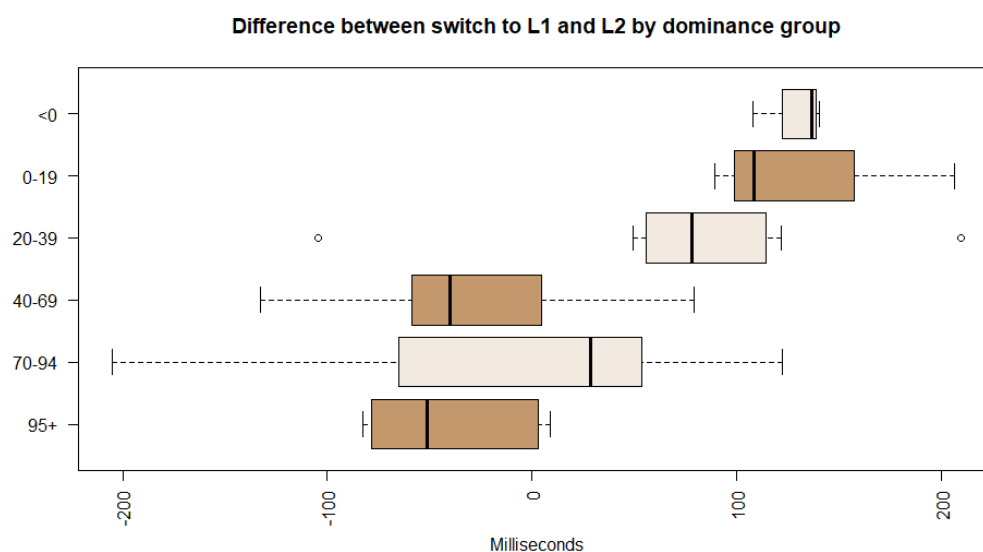


Figure 9. Differences between switch to L1 and L2 by dominance group

The difference between the switch trial to English and to Hungarian was also compared to various other factors, which is reported in Figure 10. Besides language dominance, other factors also seem to have an influence on the difference between the switch trials to the languages. The age of the participants is in a non-significant, weak, positive correlation with the difference of the switch trials, $r(41) = .22$, $p = .16$. This suggests that the older the participants are, the less time it takes them to produce English.

The relationship of the difference between the switch trials and years of learning English is also similar. There was a non-significant, medium, positive correlation found between these factors, indicating that the longer participants have been learning English, the faster they may switch to it, $r(41) = .30$, $p = .054$.

The relation between the difference of switch trials and the components of the Bilingual Language Profile were also examined. To be able to compare the results, for each component, the score given for the English answers were deducted from the score for the Hungarian answers. This means that if the result is low (negative), the participant is more dominant in English than in Hungarian, or if it is close to zero, the participant is a balanced bilingual in that domain. Figure 10 shows that the strongest correlation is between “Switch difference” and dominance in language proficiency, $r(41) = -.55$, $p < .001$. The second one, showing significant, medium, negative correlation is language history, $r(41) = -.44$, $p < .01$. Thirdly, language use also has a significant, medium, negative correlation with the difference between

switch trials to L1 and L2, $r(41) = -.36, p < .05$. This data can also be observed from the correlation of L1 use and “Switch difference”, $r(41) = -.27, p = .07$; and L2 use and “Switch difference”, $r(41) = .43, p < .05$. The negative correlations, such as between language proficiency, language history, language use and L1 use and “Switch difference” suggests that the more dominant one is in English, the faster they can switch to English. The only correlation that was positive was between L2 use and “Switch difference”, which indicates that the more one uses English, the faster they can switch to it.

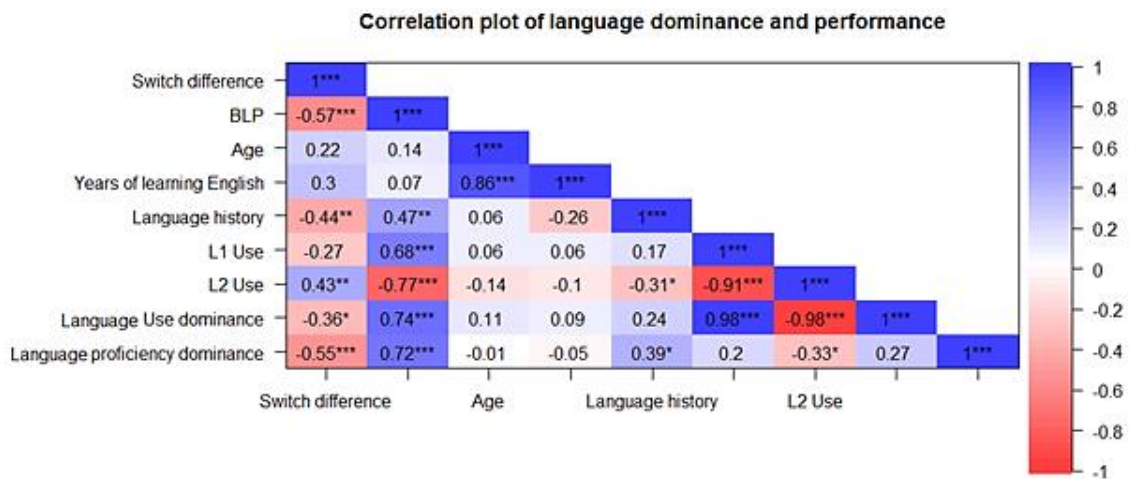


Figure 10. Correlation plot of language dominance and performance

The gender of participants was also taken into consideration. The correlation was even stronger in case of female participants, $r(19) = -.62, p < .01$. In case of male respondents, the correlation between their dominance and language switch trials was also significant, strong and negative, $r(20) = -.47, p < .05$. The difference between female ($M = -5.41, SD = 109.31$) and male ($M = 38.19, SD = 72.6$) participants in terms of the difference between switches to the languages was non-significant, $t(34) = -1.53, p = .13$. This data is shown in Figure 11.

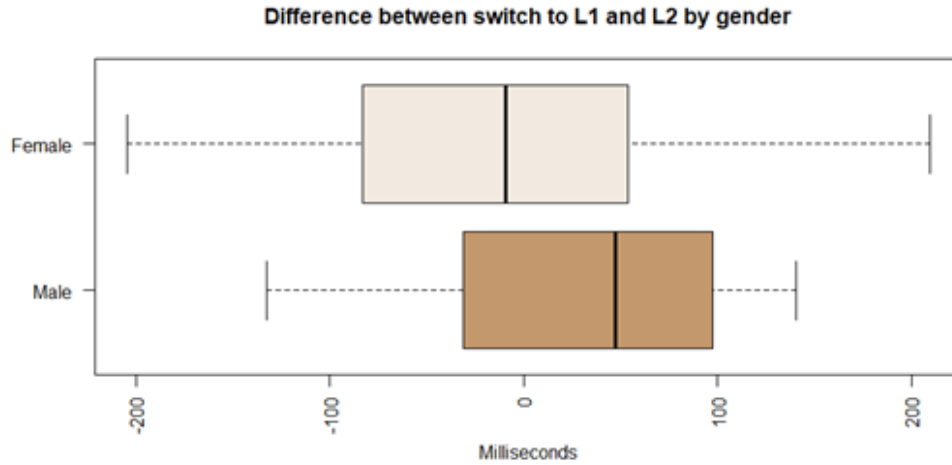


Figure 11. Difference between switch to L1 and L2 by gender

The potential influence of accommodation to the task should also be examined, which was indicated by whether the reaction times of participants became shorter by the end of the experiment. For this purpose, the instrument was divided into four parts, each containing 20 trials. No significant difference was found between the switch trials during the first ($M = 1135.135$, $SD = 194.18$) and fourth part ($M = 1173.341$, $SD = 190.95$) of the picture naming session; in fact, the reaction times became slower, $t(42) = -1.5$, $p = .14$. Figure 12 shows the reaction times of switch trials over the course of the experiment divided into four parts.

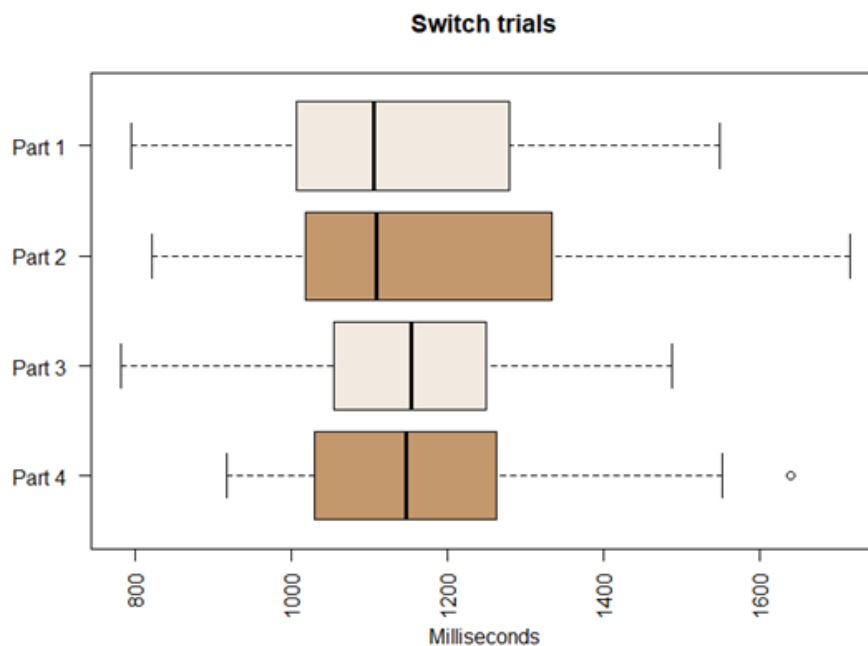


Figure 12. Switch trials during the course of the experiment

Another factor to consider is the frequency of the target words. There was a significant, medium, negative correlation found between the frequency of the target words and the reaction times of the participants, $r(78) = -.27, p < .05$. This implies that the more frequent a word is, the shorter the reaction times were. The frequency of target words might also influence the accuracy of their production. There was a significant, weak, negative correlation between the frequency of words and the errors by words, $r(78) = -.23, p < .05$. This implies that the more frequent a word was, the less errors were made; less frequent words were mistaken more often.

CHAPTER 4: DISCUSSION

The aim of the present study was to conduct an experiment focusing on the relationship of bilingual speech production and language dominance. The main question around which the paper revolves is how language dominance and speech production are interconnected, whether switching to the stronger language is more difficult to the bilinguals than switching to the weaker language, or the opposite way. The hypothesis was that the results will support the former case, thus support the Inhibitory Control Model (Green, 1986). However, empirical studies have reported contradictory results, some concluding that switching to L1 is easier for bilinguals than to L2 (e.g.: Christoffels et al., 2007; Mosca & De Bot, 2017), and other findings supporting the ICM (e.g.: Linck et al, 2012) (for a more thorough overview see Section 1.4). For this reason, in this paper, not only the proficiency or nativeness of the bilinguals were taken into consideration, but also the extent of language dominance. The investigation was done through a picture naming task, the results of which were analysed together with the language dominance of the participants. In this section, the results presented in Chapter 3 will be discussed, focusing on answering to what extent language dominance and other factors influence the language switching of Hungarian-English bilinguals.

The investigation of the extent of language dominance provided interesting results. Based on the results of the Bilingual Language Profile (Birdsong et al., 2012) self-report questionnaire, participants were divided into different dominance categories (Table 1.). There were altogether 3 participants who were more dominant in English than in Hungarian, 5 who can be considered balanced bilinguals; and the vast majority of 36 participants were more dominant in Hungarian to a certain extent.

The next pieces of information to discuss should be the differences between the reaction times in the two languages, and in the two types of trial. The expected results were that participants would respond faster to English stimulus than to Hungarian, and to repetition trials than to switch trials. As figures show, however, there was no considerable difference between reactions to Hungarian and English stimulus. Similarly, there was also no significant difference between the reaction times for the Hungarian and English versions of each word. This might imply that the proficiency of the participants was relatively high; their temporary dominance might have shifted to a more balanced state, and they were functioning in bilingual mode (Grosjean, 2001).

Next, repetition and switch trials were analysed. In this case, as expected, repetition trials were faster than trials where participants had to switch to another language; however, the difference was non-significant. Similar results have been reported in the literature as well (e.g.: Mosca and De Bot in 2017). Focusing on the two languages individually, it was the Hungarian stimulus that showed significant difference between the two trial types; it was much faster for participants to provide the target responses when L1 followed L1 than when they had to switch from L2 to L1. This in itself might indicate asymmetric production, since it took more time for participants to reactivate Hungarian than to suppress English during the repetition trials. In cases of English, there was no substantial difference between repetition and switch trials; it took approximately the same time for participants to provide answers in English after English as after Hungarian stimuli.

Interestingly, the averages of the switch trial reaction times show that it was faster for participants to switch to English than to Hungarian, even if by a non-significant difference. This also suggests that it is easier for participants to switch to L2 than to L1; however, this cannot be concluded based on the mean values only, individual differences and language dominance should be taken into consideration.

As an attempt to answer the research question of this paper, the correlation between the difference of switches to L1 and L2 and the dominance score of participants were calculated. As hypothesised, according to the ICM (Green, 1986), switching to the more dominant language should be slower than switching to the weaker language. However, the results showed a strong negative correlation, indicating that it took participants less time to produce their stronger language than the weaker one. Thus, data from the picture naming experiment and Bilingual Language Profile instrument strongly suggest that performance on the languages is dominance-related, symmetrical, as participants switched more effectively to their more dominant language. The non-significant differences between the switching cost to L1 and L2 also support this argument, indicating that it did not take more effort for the participants to switch to Hungarian than to English compared to the repetition trials in the languages, contrary to the expectations based on the ICM (Green, 1986).

Looking at the results of other pieces of research, this paper is in line with the findings of various other experiments, such as Mosca and De Bot (2017), Christoffels et al. (2007), Macizo et al. (2012), or Hernandez et al. (2013). Even though the design of these experiments is different from that of this paper to some extent, the results in all these cases show a symmetrical switching cost between the two languages of the bilingual. This was observed in

experiments with predictable (Mosca & De Bot, 2017) and unpredictable order of codeswitching (Christoffels et al., 2007), in picture naming (Hernandez et al., 2013) and tasks with other stimuli such as words (Macizo et al., 2012) or numerals (Declerck et al., 2012) and with two languages as well as with trilingual participants (Linck et al., 2012).

In broader context besides focusing on the connection of the results and the bilingual speech production model, the results also show how influential language dominance is on performance. Even though all participants were native speakers of Hungarian and learnt English as a foreign language, through their individual differences in connection with history, use, proficiency and attitude to English and Hungarian, the mental representation of their mothertongue were drastically different. The use of English as a foreign language in certain domains proved to have an influence on the L1 performance of the participants, so much so that for many of them it took more time to produce instances in their mothertongue in the foreign language. In addition, the present case is in the seemingly monolingual country, Hungary, where English-speaking communities are rather difficult to find, and the language is radically different from English. This effect of bilingualism is similar to the findings of Bice and Kroll (2015), which concluded that a new language has influence on the native language even at a very early stage of learning, which the participants of this research have long surpassed.

As part of answering the other research question of the present paper, other potentially influential factors were considered as well during the analysis, such as gender, word frequency, and accommodation to the task. It can be concluded that gender did not have a considerable influence on the results; none of the data analysed showed significant differences when gender was the focus of the analysis.

Surprisingly, accommodation to the task was not an influential factor either, which had been assumed to make language switching faster by the end of the session. The two types of switch trials did not result in visible differences; it did not matter if codeswitches came after a period of repetition trials or after a series of other codeswitches. Reaction times for switch trials were not faster by the end of the experiment either. This contradicts the feedback of the participants, which reported that they felt more confident in language-switching by the finish. Naturally, it is possible that even though participants felt more confident with code-switching, the experiment was a tiring challenge, so confidence was not enough to counterbalance the exhausting nature of the task.

Lastly, the effect of word frequency was also considered, and expected to influence the reaction times so that high frequency would result in low reaction time. Data showed that there is a correlation between the frequency of the target word and the reaction time, indicating that the more frequent a word is, the less time it takes for the participants to produce it. Word frequency was also in correlation with accuracy, suggesting that the retrieval of less frequent words was more challenging for participants. This is in line with the expected results, supporting the hypotheses that word frequency has an influence on reaction time.

CHAPTER 5: CONCLUSIONS

In the previous chapters a picture naming experiment conducted amongst Hungarian-English bilinguals was presented, which was designed to expand our knowledge on the mental process of bilingual speech production, codeswitching and language dominance. The research question in focus was to what extent language dominance and non-linguistic factors influence codeswitching for Hungarian-English bilinguals, and in order to answer it, two instruments were used during the experiment.

First, participants ($N = 43$) fulfilled a questionnaire (Bilingual Language Profile by Birdsong et al. (2012) focusing on their language history, use, proficiency, and attitude in Hungarian and English. This questionnaire provided data about the language dominance of the participants, which was then used during the analysis of the results. On average, participants were dominant in Hungarian; however, some participants were dominant in English, and some of them were balanced bilinguals.

As the second phase of the experiment, participants completed a picture-naming task. In this task they were asked to name the presented picture as quickly and accurately as possible. The pictures presented were of everyday objects, animals, body parts etc. Participants had to face altogether 80 trials, during which the order of the target language was not predictable; there were trials where the required answer was in different language than the previous one (switch trials), and where the answer was the same language as the previous stimulus (repetition trials). Participants saw each picture twice, once in Hungarian and once in English.

The results showed that there was no considerable difference between their performance in Hungarian and in English, nor between switch and repetition trials. The data also showed a strong correlation between the differences in switching to the languages and language dominance, indicating that participants produced their stronger language easier. This suggests that there is a symmetric relationship between language dominance and language inhibition; the more dominant a language is, the easier it was for the participants produce that language.

As for non-linguistic factors, neither gender nor the potential accommodation to the task had a considerable influence on codeswitching. However, there was also a medium correlation between the frequency of the target words and the reaction time, suggesting that more frequent words were accessed faster.

This is in line with numerous other findings as well. Symmetric switching cost during a picture naming experiment with unpredictable order of the required language has been

reported by Christoffels et al., (2007), Costa and Santesteban (2004), Declerck et al. (2012) and Hernandez et al. (2013) among many others.

All things considered, this piece of research supports the theory that during bilingual language production language inhibition is symmetrical. The more dominant a bilingual is in one of their languages, the easier, faster it is for them produce the stronger language, and the more effort it takes to switch to the non-dominant language. However, the frequency of words can also be an influential factor during codeswitching. The experiment did not support the main hypothesis, namely that participants will switch to their stronger language slower; the results show the exact opposite of this assumption. As of the other hypotheses, the reaction time of participants did not get faster with accommodation to the test either; however, it was confirmed that the frequency of a word influences how quickly one produces it.

5.1 Limitations of the study

As any other piece of scientific research, this paper is also subject to potential limitations and further questions which only arose having acquired and analysed the final data. The most influential shortcoming of this paper lies in the fact that the questionnaire on language dominance focuses on an overall score for the two languages in the life of the participants but does not give any information about the language mode the participants are in during the experiment. The temporary shift in dominance or language mode might influence the results, even if there was a strong indication of the relationship between language dominance and switching difference being symmetrical.

Another factor that might have influenced the speech behaviour of the participants was the instrument itself. As the instrument presented the stimulus in fixed intervals, some participants seemed to have settled into a rhythm, and were not prioritising reacting to the stimulus as quickly as possible. Based on this observation, the instrument for picture naming should be revised, should the study be repeated in the future.

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