Phonological change in Slovene-English late consecutive bilinguals

A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Linguistics

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Acknowledgements

This thesis is my contribution to knowledge, in particular to the field of second language acquisition and first language phonological change. However, more importantly, this thesis is a result of the support that I have received from various people, who have not only supported me along this challenging journey, but also believed in my abilities to succeed. Therefore, this is my opportunity to acknowledge your contribution to my work.

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Abstract

Within the individual, one possible cause of sound change in a given language is the acquisition of another language. In recent years, there has been a shift in studies of bilingualism, as linguists have started to investigate not only the influence of a first language (L1) on a second language (L2), but also the impact of L2 on L1. Following the Speech Learning Model (Flege 1987), changes in the L1 production of bilinguals would happen at the level of individual phonemes, so that some sounds may become more similar to L2 equivalents, while others become more dissimilar. According to Chang's (2012) model of phonetic drift, on the other hand, changes happen at the level of the system as a whole. The present study aims to test the predictions of L1 and L2 theories with reference to the L1 production of late consecutive Slovene-English bilinguals.

Seventeen Slovene-English bilinguals, who acquired Slovene language in childhood and moved to England in late adolescence or adulthood, were recorded reading word lists and passages in English and Slovene, which had been selected to include all the vowel sounds of the two languages. The recordings were analysed acoustically, and the vowel formant frequencies were compared with similar data from monolingual speakers of Slovene and English. To relate the acoustic data with perceptual evidence, monolingual speakers of both languages listened to the recordings of the target bilingual group and rated the degree of foreign-accentedness. The aim was to predict the extent of any changes in the bilinguals' Slovene speech, relative to Slovene monolinguals, on the basis of intralinguistic factors, e.g. similarity between particular sounds in the two languages, and extralinguistic factors, e.g. age at arrival in the UK.

The results of the production experiment indicated that the extracted vowel formant frequencies (F1, F2 and F3) of bilinguals to some extent differ from monolingual norms. Additionally, some evidence that L1 sound change does take place was evident in the analysis of individual vowel sounds and corroborated by the global accent rating task (GAR), since the Slovene monolingual speakers tended to rate the bilinguals as non-native speakers of Slovene. The degree of changes in L1 was also correlated with extralinguistic factors of AOA and LOR.

To my mother, Zlatka Nolimal and my father, Milan Nolimal

Contents

List of Figures

List of Tables

Nomenclature

F_0: Fundamental frequency

F1: First vowel formant (in this study also labelled as VowF1)

F2: Second vowel formant (in this study also labelled as VowF2)

F3: Third vowel formant (in this study also labelled as VowF3)

GAR: Global foreign accent rating

Hz: Hertz

L1: First language

L2: Second language

LOR: Length of residence

AOA: Age of arrival

Stdev: Standard deviation

SLM: Speech Learning Model

PAM: Perceptual Assimilation Model

PAM-L2: Perceptual Assimilation Model for Language Learners

OPM: Ontogeny Phylogeny Model

L2LP: Second Language Linguistic Perception

NLM: Native Language Magnet Model

SS: Standard Slovene

SSBE: Southern British English

SEM: Slovene-English bilingual male speakers

SEF: Slovene-English bilingual female speakers

EM: Southern British English male speakers

EF: Southern British English female speakers

Declaration

I confirm that the thesis submitted is my own work and that appropriate credit has been given where reference has been made to the work of others.

Mihaela A. Nolimal

Chapter 1: Introduction

In recent years there has been an increasing awareness that when someone learns a second language (L2), not only will their pronunciation of that language be affected by their first language (L1), but also their pronunciation of the L1 will be affected by the L2. Traditionally, applied linguistic research focussed on how a person's first language (L1) influences their learning of a second language (L2). However, crucial research led to a change in this view, and the L1 is now thought to be much less significant than it once was. In recent years, there has been a shift in the area of interest. Due to increased language contact in migrant situations, more linguists investigate the impact of the L2 on the L1, particularly in L2 speakers with a high level of proficiency. Specifically, an increasing number of studies are showing that the L2 can have an effect on the L1; in particular, language(s) used by individuals (at micro level[1]) in migrant situations are in constant flux, due to the continuing acquisition of L2 and/or loss or attrition of their L1. Consequently, this chapter outlines the main aims and objectives of this study by providing research questions and hypothesis, which will guide this thesis's investigation.

Before reviewing the theoretical background and models of L1 and L2 change and providing the theoretical framework for this thesis (Chapter 2), it is necessary to define the term 'bilingual' that will be consistently used throughout this study. The end-point for an L2 learner was always deemed to be native speaker ability, from which L2 learners almost always fall short. It is crucial to understand that bilinguals have somewhat different abilities to monolingual speakers. They may have a less substantial vocabulary size, or they may not have equal expertise in all domains of language use, however, they have different capabilities that are advantageous. As an illustration, they have more flexibility in language use and an ability to distance themselves from the substance of language. For example, they can separate labels from meaning (Cook, 2003). Specifically, bilinguals are able to separate semantic representations and word meanings. Additionally, Bassetti and Cook (2011) suggest knowing two languages will

[1] In this thesis the micro level term is referring to the areas of microlinguistics, which deals with change that takes place within the individual's language (in areas of semantics, pragmatics, syntax and phonology). In contrast, the area of macrolinguistics deals with how the language functions in larger social context (Enfield, 2005).

enhance cognitive abilities, such as problem solving and executive processing. Using two languages also means using two conceptual systems, which enriches bilinguals. Consequently, for the purposes of this study, the term 'bilingual' will be used for any L2 learners who learned a second language (L2) in either childhood or adulthood.

When researching the possible restructuring and change in the mind of a bilingual, it is logical to address how language is organized within it. One of the possibilities for the organization of a bilingual mind suggests the idea of two developed independently represented (i.e. 'separate') language systems that are possibly innate, universal and may be uniquely accessed in response to the context (Paradis, 1985). However, the literature (Schmid, 2004a) is more in favour of a 'shared' system in which both languages are activated, and a certain amount of interaction is expected at all times, regardless of the context. The evidence for this conclusion comes from psycholinguistic studies (Linck *et al*., 2009) using tasks such as cross-language priming and lexical decision making that show the influence of the currently unused language for both comprehension and production of speech. Nevertheless, some deviation may occur among 'different' types of bilinguals. Early bilinguals (in some literature also referred to as compound bilinguals) are reported to have far more independent systems, in contrast to late bilinguals (in some literature referred to as coordinate bilinguals), who have far less control over their organization.

Assuming the above organization, several studies in the area of L1 phonological change focused on early simultaneous bilinguals: L2 learners who learnt a second language in childhood (Caramazza *et al*., 1973; Watson, 1990; Khattab, 2000; Bullock & Gerfen, 2004b; Gordeeva, 2006; Sundara *et al*., 2006; Celata & Cancila, 2010). These studies generally indicated that 'the earlier, the better', as far as the learning of a second language is concerned. Mostly, early simultaneous bilinguals surpass their late consecutive bilingual peers (individuals, who started learning L2 in adulthood) in both areas of speech perception and speech production. The most common indicator is foreign accented speech, which is consistently more apparent and present in late bilinguals (Flege *et al*., 1995, Flege, Yeni-Komshian & Liu, 1999).

However, most of the early simultaneous bilingual studies had to deal with the problem of deciding whether atypical features of the subjects' L1 phonology are due to L1 phonological change or due to the fact the sounds under investigation had not been acquired to start with (Köpke & Schmid, 2004). Therefore, according to de Leeuw (2009), the first language phonological change (in her work referred to as 'attrition') in the late consecutive bilinguals is not comparable to the changes in the L1 of early

simultaneous bilinguals due to the fact that the first language has not yet been fully acquired and the changes occur prior to language stabilisation. The present study avoids this problem by focusing on late consecutive bilinguals who have learnt a second language in adulthood after fully acquiring their first language (cf. Flege, 1987; Flege & Eefting, 1987; Major, 1992; Sancier and Fowler, 1997; Mennen, 2004; Schmid, 2004a; Celata & Cancila, 2010; De Leeuw, 2009; Mayr *et al.*, 2012).

To further understand the underlying organisation in the mind of a bilingual speaker, and concepts and discussions within this study, it is necessary to define and distinguish some phonetic and phonological issues. In particular, the relation to phonetic and phonological similarity. This is discussed in detail in Chapter 2.3, however a brief outline is provided to set out the distinction early in the thesis. The primary issue is drawing the line between phonological and phonetic abilities. For example, phonetic is concerned with the processes by which phonological representations are turned into acoustic signals and vice versa. The notion of learning L2 speech production and perception thus involve not only learning L2 phonological system, but also its acoustic patterns, which will pose difficulties in the phonological development of a bilingual speaker (Bialystok, 1991). Consequently, previous research suggests there is often a mismatch between these phonetic and phonological levels. Chang (2015: 200) suggests that most of these inconsistencies can often be resolved in the same way in favour of phonological similarity, due to "high-level information weighing more heavily than a low-level information." In other words, he suggests that phonemic comparison may depart from acoustic comparison, as this 'high-level information' will prevail in cases of conflict. However, Chang (2015) acknowledges that cross-linguistic linkage may not always follow the phonological level, in particular at the early stages of L2 acquisition where low-level information may be needed to link L1 and L2 sounds. As the bilingual gains more knowledge in L2 phonology, this cross-linguistic linkage may change and develop, and high-level information may prevail. Nevertheless, it remains unclear how or under which underlying mechanism this takes place during the course of L2 learning. For the purposes of this study, the assumption of phonological level being superior to phonetic level will be further considered and explored.

Taking into account the above discussion and the above findings, this study aims to examine the extent to which this could be a shared system and possibly the development of this shared L1 and L2 phonological system of Slovene-English late consecutive bilinguals, thus shedding light on the organization, interaction and cross-linguistic linkage of it. In particular, it investigates what occurs when two phonological

systems exist within adult speakers. Consequently, it has implications for the theoretical frameworks of Flege's (1987) Speech Learning Model (SLM), Chang's (2010) idea of Phonetic Drift, Best's (1995) concept of the Perceptual Assimilation Model (PAM), which was further developed by Best & Tyler (2007) to account for L2 learners as the Perceptual Assimilation Model for Language Learners (PAM-L2), the Phonological Interference Model (PIM) developed by Brown (2000), and the Ontogeny Phylogeny Model (OPM) proposed by Major (2001). All these models are relevant to this thesis and facilitate progressing the discussion as to how, when, or if L1 phonological change occurs in late consecutive bilinguals and will be discussed in more detail in the following chapters. This way, this study does not only contribute to our theoretical understanding of how the L2 may influence L1 phonology, but it also has implications for the general knowledge of first and second language production and perception in adult late consecutive bilinguals. Moreover, by providing additional evidence to the field of L1 phonological change, the aim of the study is to bridge the gap between the previous studies in other domains of language (morphology, syntax and lexis). Furthermore, this study also takes into consideration intralinguistic and extralinguistic factors with the aim of broadening our understanding of the continuous language development under the influence of numerous variables.

In order to approach and examine the L1 phonological change systematically, the next section outlines the main objectives of this study by presenting the research questions and subsequent hypotheses.

1.2 Research questions and hypotheses

The primary aim of this study is to analyze the change of the L1 phonological system in Slovenian-English late consecutive bilinguals and shed light on the organization and interaction (with L2) within the common phonological system, while reviewing and taking into consideration previously proposed theories and models in a cross-sectional approach to examination.

This was firstly done by analyzing the vowel production of Slovene-English late consecutive bilinguals and comparing them to monolingual norms. Secondly, the change in the L1 phonological system was measured by employing the global foreign accent rating task, in which monolingual speakers of both languages were assessing the foreign accented speech and deciding whether or not the previously measured L1 phonological change is perceivable to the monolingual speakers. The second aim of the

current study is to investigate internal factors, such as phonological similarity between vowel sounds, and external factors such as age, gender, length of residence and age of arrival. All these factors may influence the L1 phonological change and may affect the outcome of it.

Based on the above intentions of the study, the thesis was structured with the aim of addressing and answering research questions systematically. The first research question seeks the answer to the question of whether or not there is evidence of phonological change in the first language vowel system of Slovene-English late consecutive bilinguals. Specifically, 'How do late consecutive bilinguals compare to monolingual groups of Slovene and English?' The bilinguals' vowel system is analysed through the production and perception experiments, where specific acoustic properties, such as vowel formants will be examined. Additionally, assuming there is evidence of change, 'Does this happen in certain vowels more than others?' and 'Are these changes following the process of assimilation, dissimilation or a mixture of both?' As the entire vowel system of both Slovene and English language is under investigation here, the vowel formant frequencies are examined for each individual vowel and compared to the vowel formant frequencies of Slovene and English monolingual speakers.

Research question 1: Is there evidence of phonological change in the L1 Slovene vowel system of late consecutive Slovene-English bilinguals?

a) Does this happen in certain vowels more than others?

b) If there is a variation between vowels, what phonetic or phonological factors may determine the change for any given vowel?

c) Are these changes uniform or only prominent in certain individuals?

d) Which extralinguistic factors may determine this particular change?'

This study not only examines the production of Slovene-English bilinguals but also investigates the possible changes in perception of this particular bilingual group. Therefore, the second research question aims to seek the answer to whether the changes in the production system are perceivable to native monolingual listeners of both groups (Slovene and English). In particular, the global accent-rating task is utilized; the listeners were asked to make a substantial number of judgments to validate the occurrence/absence of a foreign accent. Additionally, assuming the change is

perceivable to monolingual listeners, the underlying reasons for such change were sought.

Research question 2: Are the changes in production perceivable to the monolingual listeners?

a) Are the changes prominent in some speakers more than others?
b) What extralinguistic factor(s) may determine the extent of the change in a particular speaker?

Taking into consideration previous literature and above research questions the following hypotheses were made:

1. **Hypothesis:** *The Slovene-English late consecutive bilinguals will show signs of first language phonological change.*
2. **Hypothesis** *Slovene-English late consecutive bilinguals will be identified as native speakers of Slovene, even if showing signs of L1 phonological change.*

These research questions and subsequent hypotheses will guide this thesis to contribute to the theoretical understanding of current L2 models and theories. This thesis also aims to provide empirical evidence, not only to the field of second language acquisition and first language phonological change, but also to the field of theoretical linguistics on the Slovene language by providing theoretical and empirical evidence that will aid future research. The next section provides a brief structural overview of this thesis.

1.3 Outline of the thesis

As previously stated, this chapter (Chapter 1) provides a brief introduction to the area of research. Additionally, it outlines the main aims and objectives of this study by providing research questions and hypothesis, which will guide the investigation of this thesis.

Chapter 2 will place the current study within the theoretical framework of first language phonological change and discuss possible constraints that may be applicable. Specifically, it examines the current theoretical frameworks and models of first language phonological change that were derived from the L2 theoretical frameworks and models which partially addressed the conditions and processes under which first

language phonological change may be possible. Additionally, Chapter 2 reviews the current literature concerning the extralinguistic variables AOA (age of arrival), language contact, LOR (length of residence), education, gender, and language aptitude. It outlines the significance of these variables to the current study. Furthermore, it reviews the scarce literature on the vastly under-described Slovene language, consequently aiming to fill this gap in knowledge. Only a handful of studies have been published or translated into the English language. The chapter thus considers the phonetic and phonological similarity of the Slovene and the English language and the possible impact of this intralinguistic variable on L1 phonological change. Subsequently, the phonological similarity experiments are presented with the aim of investigate the measured acoustic similarity and testing the perceptual similarity of the Slovene and English vowel systems. These experiments were conducted prior to the production and perception experiments in Chapter 3 with the aim of testing previous proposals that suggested that the phonological change could be predicted by measuring the acoustic distance between (vowel) sounds. In order to confirm the validity of the measured acoustic similarity results, the tested perceptual similarity experiment was conducted. The participants were asked to identify a single stimulus (a vowel sound) in terms of an L1 category and subsequently provide a 'goodness of fit' rating. The overall discussion of these findings follows with the aim to review the impact of acoustic and perceptual similarity (intralinguistic factors) on the L1 phonological change of Slovene-English late consecutive bilinguals. Specifically, the discussion aims to account for any changes that may occur on the level of individual vowel sounds, which is evident from the production part of the experiment.

Chapter 3 presents the methods and procedures used to gather the data in production part of the experiment and Global foreign accent-rating task (GAR). Specifically, the methods and procedures are outlined in the production part of the experiment, where the vowel system of both Slovene and English monolingual speakers is examined and then compared them to the vowel system of Slovene-English late consecutive bilinguals, particularly their production of the vowel sounds on a whole-vowel-system level. Additionally, the methods and procedures are outlined in Global foreign accent-rating task (GAR), where the perception of foreign accented speech in Slovene-English late consecutive bilinguals is examined. The aim of this experiment was to determine whether potential changes found in the production part of the experiment are perceivable to monolingual speakers of either language (Slovene and English).

Chapter 4 reports on the findings of the production and perception experiments, as well as it discusses the relevance of these findings and significance of the current linguistic theory in relation to the results obtained. Specifically, it reports and discusses the results obtained from the acoustic analysis of the Slovene-English vowel space by comparing the first three vowel formants (F1, F2, F3) to the monolingual vowel systems of Slovene and English, which is followed by the analysis of individual vowel sounds. This individual vowel analysis aimed to examine whether or not L1 phonological change has manifested on specific vowel sounds. It also reports the results the GAR task. Finally, mixed effect model analysis aims to establish which extralinguistic factors appear to most significantly impact the L1 phonological change of Slovene-English late consecutive bilinguals. Additionally, it synthetizes and discusses the results of both the production and the perception part of the experiments in relation to the previous literature in the area of first language phonological change. It considers both aspects of a bilingual's speech (production and perception) in a systematic way and the impact that both intralinguistic and extralinguistic factors may have on the L1 phonological change.

Finally, Chapter 5 summarizes the main findings of this study, in particular the significant contributions to the fields of second language acquisition and first language phonological change/attrition, as well as considers the significance of both intralinguistic and extralinguistic factors reviewed in this study. Moreover, it attempts to elucidate the social relations among Slovene-English bilinguals in the diaspora; specifically examining the role of identity. Additionally, it considers the implications of this study for future theory and practice: (1) future directions of L1 phonological studies and (2) implications for future teaching methods and for foreign language (FL) pronunciation instruction, in particular with regard to Slovene-English L2 learners.

As stated above, the next chapter examines the current theoretical frameworks and models of first language phonological change that derived from L2 theoretical frameworks and models that partially addressed the conditions and processes under which first language change may be possible. Consequently, reviewing the current literature concerning extralinguistic variables that have been reported to impact the language change. Furthermore, it reviews and adds to existing literature on the vastly under-described Slovene language, aiming to fill this knowledge gap. Whilst considering Slovene phonology, the phonetic and phonological similarity of the Slovene language and the English language is examined, as well as the impact of this intralinguistic variable on L1 phonological change.

Chapter 2: Theoretical background

The following sections outline the most prominent models of first language (L1) phonological change, which are mostly derived from second language (L2) theoretical frameworks. Each model's main hypothesis and assumptions will be reviewed, the possible differences between these models will be explored and outlined, and relevant existing evidence discussing these models will be considered in relation to this study. Specifically, these sections will explore notions that underline developmental patterns of both L2 language acquisition and L1 language attrition and consider how the similarities between the two could explain these processes. Additionally, the impact of extralinguistic and intralinguistic factors will be considered as a possible influence on any attested changes.

2.1 Models of speech perception and production

The models of first language phonological change derived from L2 theoretical frameworks and were developed to partially address the conditions and processes under which first language attrition or change may be possible. Specifically, these models address the phonological changes in the production and perception of L2 learners at various stages of L2 development, and possible L1 changes within these learners as a result of Second Language Acquisition (SLA). In particular, this section focuses on Flege's (1987) Speech Learning Model (SLM), Chang's (2010) idea of Phonetic Drift, Best's (1995) concept of the Perceptual Assimilation Model (PAM), which was further developed by Best & Tyler (2007) to account for L2 learners as the Perceptual Assimilation Model for Language Learners (PAM-L2), the Phonological Interference Model (PIM) developed by Brown (2000), and the Ontogeny Phylogeny Model (OPM) proposed by Major (2001). All these models are relevant, to varying degrees, to this thesis and facilitate progressing the discussion as to how, when, or if L1 phonological change occurs in late consecutive bilinguals. What becomes apparent in the review of these models, is that some may lack the capacity to explain this study's results. However, previous relevant studies have discussed these models and as such it will be remiss of this study not to review them and consider their application. The application of these models to the study at hand will not be discussed in detail until later in this thesis (Chapters 4 and 5).

2.1.1 Speech Learning Model (SLM)

The model that has been developed through research of first and second language interaction and has been extensively reviewed in literature is the Speech Learning Model (SLM), first proposed by Flege in 1987. Primarily, Flege (1995) addressed the acquisition of speech sounds in a second language (L2) through processes of production and perception. However, predictions and assumptions could be made regarding how the L2 will affect the L1, particularly when the L2 gains a more important role in the everyday life of a bilingual or L2 speaker. Consequently, the core aspects of this model, which are outlined below, have been significantly used in studies of first language phonological change and attrition (i.e. De Leeuw, 2009; Chang, 2010).

The basic tenet of the SLM is the observation of how L2 learners produce and perceive new L2 consonants and vowels. SLM clearly states that extralinguistic factors of age or onset of L2 learning as well as language input are highly significant. Specifically, Flege's (2005) model rests on five basic premises:

1. L2 learners can, given adequate and sufficient input, perceive the phonetic properties of L2 speech sounds accurately.
2. Similar to L1 development, L2 speech learning takes time, and is significantly influenced by the nature of the input received.
3. Similar to L1 development, production is guided by the perceptual representations stored in long-term memory.
4. The processes and mechanisms that guide successful L1 speech acquisition — including the ability to form new phonetic categories — remain intact and accessible across one's life span.
5. The phonetic elements that make up the L1 and L2 phonetic subsystems exist in a "common phonological space", and so mutually influence one another.

The fifth basic premise posits the phonetic elements that make up the L1 and L2 phonetic subsystems exist in a "common phonological space", and so mutually influence one another. Specifically, the existence of a 'common phonological space' would suggest the interaction of the L1 and L2 phonological system. According to this view, bilinguals are unable to fully isolate their L1 and L2 phonetic subsystems, which will consequently influence each other, implicitly hinting towards the possibility of L1

phonological change or attrition. However, this influence of the L1 and the L2 is dependent on several factors, such as the nature of the L1 and L2 phonetic systems and the amount of L1 and L2 use (Flege, 2005).

This 'common phonological space, which is according to Chomsky (1965) universal to every single person, is further affected by age-related changes that will dictate the interaction of the subsystems. For example, Flege (1995) suggests the L1 phonetic categories will become more powerful 'attractors' of the L2 sounds (they will not allow new category formation), as the person develops through childhood into adulthood (Walley and Flege, 2000). This suggests that the Slovene-English late consecutive bilinguals will face significant barriers when acquiring new L2 phonetic contrasts due to established L1 phonetic categories. Most researchers now accept this view as accurate, however, there are still a few that argue languages are separated in the mind of a bilingual. This is particularly evident in the studies concerning early simultaneous bilinguals. For example, Genesee (1988), suggested that children have a particular tendency to mix elements of the two languages they are learning, and that this could be interpreted as evidence for an undifferentiated and unitary language system.

Based on the assumption of a 'common phonological space', SLM further predicts that L1 and L2 sounds may be interacting within this space. Flege (2005:88) outlined three main hypotheses that guide these interactions:

1. The greater the perceived dissimilarity of an L2 sound from the closest sound of the L1, the more likely a new category will be formed for the L2 sound.
2. Category formation for an L2 sound becomes less likely through childhood as representations for neighbouring L1 sounds develop.
3. When a category is not formed for an L2 sound because it is too similar to an L1 counterpart, the L1 and L2 categories will assimilate, leading to a "merged" L1-L2

These hypotheses suggest that L1 and L2 categories could merge or assimilate. In other words, rather than L1 sounds assimilating to L2 sounds, they both assimilate in equal measure. However, further work (i.e. Baker *et al.,* 2002), suggests that L1 sounds (vowels and consonants) will be perceptually assimilated to L2 sounds, which will lead to a new speech sound category formation. Further, if L2 sounds are 'too similar' to L1 sounds this category will fail to be established. Consequently, L2 sounds that are 'similar' to L1 sounds will form merged L1-L2 categories in the mind of the learner. Comparatively, L2 sounds that are 'dissimilar' (Flege, 1987) first labelled these sounds as 'new') to the L1 may form new categories, especially in the younger learners. In this case, 'similar sounds' means sounds in the L2 that are akin to the sounds in the L1. It follows that L1 sounds in the 'similar' category might change over time to become even more similar to the nearest L2 sound, as the merged category becomes increasingly established (Figure 1). Specifically, Figure 1 represents the interaction between L1 (pink circles) and L2 (white circles). It is clear that most of the L1 and L2 sounds, due to the similarity between sounds, have merged. However, what could also be observed is a formation of new sounds due to the dissimilarity between them (e.g. /ʌ/ and /ɒ/).

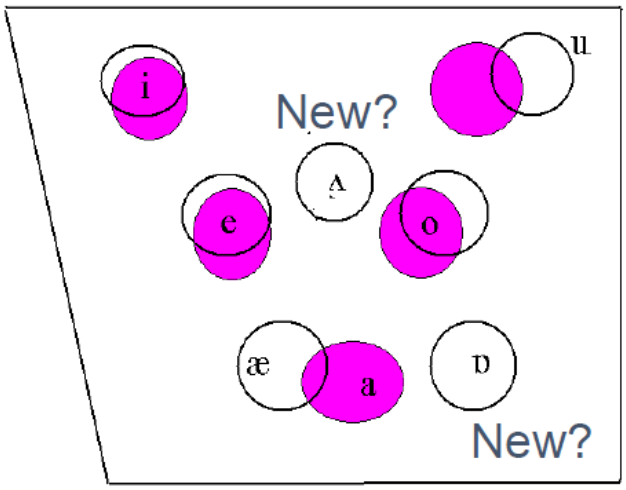

Figure 1: Perceived similarity and dissimilarity between sounds (Flege, 2005: 98)

On the other hand, L2 sounds in the 'dissimilar' category may change over time to become less similar to the nearest L1 sound, in order to maintain the phonetic contrast between them. However, as Flege (2005) points out, observing the processes of

assimilation and dissimilation requires a lot of data and time. Consequently, he suggests that these processes are best observed in a longitudinal study rather than in research comparing groups differing in (assumed) L2 input and use. This interaction between similar and dissimilar sounds was described in terms of *equivalence classification*, that is, a cognitive mechanism in which a "single phonetic category will be used to process perceptually linked L1 and L2 sounds" (Flege, 1995:239). Based on Flege's (1987) prediction of the similarity and dissimilarity of sounds, the question arises as to how far apart do the L1 and L2 sounds need to be in order to be perceived as 'similar' or 'dissimilar' and how the learner arrives at this judgment. To date, studies have been unable to answer these questions. What is clear is that the similarity may be to some extent influenced by the interaction of the phonological and phonetic levels (Laeufer, 1996). It is also clear that there are apparent difficulties in predicting how the system is going to change, if at all.

SLM further predicts that L2 category formation depends on the degree of perceived dissimilarity from the closest L1 sounds and that the interaction of a single common phonological space, in which the consecutive bilinguals are unable to fully isolate their L1 from their L2, is underlined by the two mechanisms of assimilation and dissimilation (Figure 2). Specifically, Figure 2 graphically presents the process of assimilation (red arrows pointing towards each other), dissimilation (black arrows pointing away). During the assimilation process, according to Flege *et al.* (2003), a new phonetic category fails to be established, even though distinct differences between the L1 speech sound and L2 speech sound are apparent. Flege et al. (2003) hypothesized that the category formation would continue to be blocked if the L2 speech sound continues to be identified as an L1 speech sound.

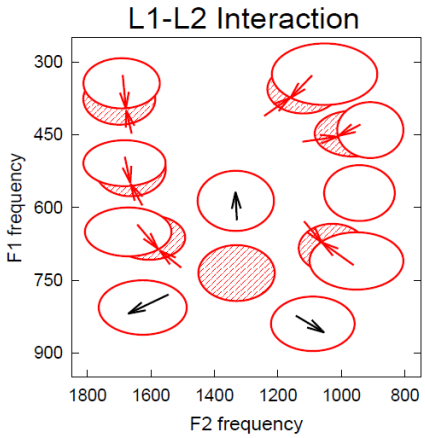

Figure 2: The assimilation and dissimilation process (Flege, 2005: 105)

Evidence supporting SLM is provided in Flege's (1987) study of French-English bilinguals, where VOT (Voice Onset Time) values of the speech sound /t/ were in-between values, in comparison to the values measured in French and English monolinguals. Similarly, MacKay *et al.* (2001) explained their findings in terms of assimilation, as the Italian-English bilinguals they studied diverged from the L1 phonetic norms due to misidentification of English short-lag VOT values. In addition, Mayr *et. al.* (2012) investigated the VOT values and vowel changes of a 62-year-old Dutch-English bilingual monozygotic twin. An identical twin sister that did not immigrate to the L2 country acted as their control and provided them with a unique control setting. The results obtained of VOT values of voiceless plosives displayed assimilatory patterns, as VOT values were different to the monolingual norms of L1 and L2. Nevertheless, the bilingual displayed a 'polarization effect': the shift of L2 sounds, rather than the anticipated L1 sounds. However, the results of this particular study may not be generalizable due to the small sample size (number of participants), as focusing on two individuals is limited, and as such sound assumptions and conclusion ought to be avoided.

Not all studies of late consecutive bilinguals found evidence for the assimilation process. For example, in a study of Quechua-Spanish bilinguals, Guion (2003) found that late consecutive bilinguals produced vowels in both languages with L1-like properties. In contrast, subjects who had started learning Spanish earlier (early and mid-bilinguals) did exhibit 'changes' in their L1, to the extent that the bilinguals' vowels were consistently produced with higher formant values in contrast to the monolingual norm. Guion (2003) offers a possible explanation in terms of the Adaptive Dispersion Theory (Lindblom, 1986), which suggests that the phonetic system organizes itself in response to the need for greater perceptual distinctiveness.

In contrast to the assimilation process, during a dissimilation process a new category or new phoneme is established for an L2 sound. This tends to occur as the bilinguals strive to maintain phonetic contrast between all speech sounds in the common phonetic space (Flege *et al.*, 2003). Specifically, when a new L2 phonetic category is established, this triggers a change in the phonetic space, as the L1 speech category and newly established L2 category shift away from each other in order to maintain the contrast, due to the general pressures to keep categories distinct. According to the SLM model (Flege, 1987), the greater the perceived phonetic dissimilarity, the higher the likelihood of a new L2 category formation. The

dissimilatory effect is most likely to occur in the early simultaneous bilinguals, as they are more likely to have formed separate phonetic categories for the L2 sounds. Supporting evidence was provided by Mack (1990) in French-English early simultaneous bilinguals, where examination of VOT showed evidence of dissimilatory effect and consequently the formation of the new sound categories. Similar results were found in Flege and Eefting's (1987) study of Spanish-English bilinguals, who formed new phonetic categories for the English speech sound /t/.

The evidence contradicting the idea of dissimilation was found in Flege's (1991) study of the early Spanish-English bilinguals, where no evidence was found in shortening of VOT values of /p, t, k/ sounds in Spanish. The discrepancy in results from the previous study (Flege & Eefting, 1987) was attributed to participants' exposure to native-produced English, in contrast to the Spanish-accented English described in the previous study. According to Flege, Schirru & MacKay (2003:471), if this explanation was correct, it suggests that the category dissimilation would 'only occur if a new L2 category would be relatively close in the phonetic space to a pre-existing L1 category'. Overall, Flege *et al.* (2003) concluded that the L1 and L2 shared common phonetic system of early and late bilinguals, is driven by the mechanisms of category assimilation and dissimilation.

Oh *et al.* (2011) suggested two types of the sound dissimilation process. The first type of dissimilation has been noted in the study conducted by Flege, Schiru and MacKay (2003), where early Italian-English bilinguals exhibited more formant movement in English /ei/ vowel production, whereas late bilinguals exhibited far less formant change. The second type of category dissimilation was reported in the study of Flege and Eefting (1987). In contrast to the previous type, it involved a shift of an L1 category, as early Spanish-English bilinguals produced shorter VOT values for Spanish consonants in comparison to the monolingual speakers, whereas late consecutive Spanish- English bilinguals did not. As indicated above, these results are in accordance with the SLM model, which predicts that early bilinguals will undergo category dissimilation and will more accurately produce L2 speech sounds.

Flege (2005) also presented evidence from three studies that support L1 phonological change or attrition, in terms of L2 to L1 interference and labeled it a *reverse interference.* Firstly, Yeni-Komshian *et al*. (2000) tested 240 Korean adults living in the United States. The native Korean speakers were all long-terms residents in the U.S and were selected based on their Age of Arrival (AOA). Both English and Korean monolingual speakers were asked to produce sentences in their respective

languages, and 240 bilinguals produced sentences in both languages. The English and Korean sentences were rated for overall degree of foreign accent by English and Korean monolinguals. The results of the study indicate that the Korean adults who arrived in the U.S. before the age 8 years produced Korean sentences with a foreign accent, thus consequently suggesting that the changes in their L1 production and possible L1 phonological change or attrition.

Secondly, Flege *et al*. (1999) elicited isolated Korean words beginning with the consonants /s/, /s'/, /t^h/ and /t/. After being digitally prepared, the stimuli produced by 240 Korean bilinguals living in the U.S were randomly presented in a separate block to native Korean speaking listeners. The Korean listeners ranked the production of the word-initial consonants on the scale of 1 to 4, 1 representing a wrong consonant to 4 representing a very good pronunciation. According to Flege *et al.* (1999) nearly all 240 Korean bilinguals received lower ratings in comparison to their Korean monolingual counterparts. Again, Flege (2005), considered these results as evidence bidirectional interference and consequent evidence of L1 phonological change or attrition.

Lastly, Flege & Mackay (2010.) examined the production of Italian words spoken by 80 Italian-English bilinguals residing in Canada and compared them to Italian monolingual native speakers. The focus of the study was on VOT of voiced stops /b/, /d/, /g/. In English it is typical for these voiced stops to be realized with short-lag VOT values with no voicing in the closure, whereas in Italian these voiced stops are realized with lead VOT values with pre-voicing (glottal pulsing) during the period of closure, before release. The results of the study indicated that nearly all the 80 Italian bilinguals realized their voiced stops as short lags, which is indicative of the English production of these sounds. Flege (2005) therefore contributed these results to L2 impact on L1.

Overall, what is clear is that the SLM seems to account for a variety of possible outcomes during both L2 acquisition and more relevant to this study - L1 phonological change/attrition. One of the main things that emerges is that we expect a bigger effect for early simultaneous bilinguals and less of an effect for late consecutive bilinguals. However, what is clear and could be hypothesized for this thesis is that Slovene-English late consecutive bilinguals will most likely undergo the process of assimilation, due to the perceived similarity between L1 and L2 vowel sounds. Additionally, the majority of previous research conducted in the SLM has focused on either advanced or native-like proficient L2 learners/late consecutive bilinguals. Therefore, the results of this thesis will test this model's hypothesis, as it will not only focus on advanced learners,

but also on less proficient speakers and empirically contribute to the field of L2 acquisition and L1 attrition.

2.1.2 Perceptual Assimilation Model (PAM)

In contrast to the Speech Learning Model, the Perceptual Assimilation Model (PAM) proposed by Best (1994, 1995) makes basic predictions about non-native speech perception, however, it does not specifically address production. Regardless, the perception and production are often correlated, and late consecutive bilinguals often experience difficulty in producing and perceiving non-native phonological contrasts. Consequently, Best (1994a,b, 1995) tried to account and explain these difficulties in the model. The PAM is based on the premise that some sounds will be easier to perceive and discriminate than others. Consequently, Best (1994a,b) explores the idea of how similarity between L1 and L2 sounds contributes to the assimilation[2] and dissimilation[3] processes.

PAM assumes that the naïve listeners categorize sounds according to phonetic and phonological familiarity. In other words, the phonetic familiarity relates to the physical occurrence such as articulation and acoustics of sounds. While the phonological similarity refers to the qualitative contrast in sounds which can be used to convey contrasts in sound which can be used to convey qualitatively different meanings in any given language, or in all languages (Pierrhumbert, 1990: 375). According to PAM, this familiarity is guided by the articulatory gestures (articulatory similarities or dissimilarities to native phonemes and contrasts) that are used to produce the L1 and are also used to produce the L2 sounds. Thus, PAM strongly resembles a model proposed by Liberman and Mattingly (1985): Motor Theory of speech perception. Similar to Best (1995), Liberman and Mattingly (1985:1) suggested that the "phonetic information is perceived in a biologically distinct system, a 'module' specialized to detect intended gestures of the speaker that are the basis for phonetic categories". What

[2] During the assimilation process a new phonetic category fails to be established, even though distinct differences between the L1 speech sound and L2 speech sound are apparent (Flege et al., 2003).

[3] During a dissimilation process a new category is established for an L2 sound. This tends to occur as the bilinguals strive to maintain phonetic contrast between all speech sounds in the common phonetic space (Flege et al., 2003).

is more, the Motor Theory of speech perception suggests that there is an overlap between the gestures and the acoustic patterns. However, in contrast to PAM, the Motor Theory of speech does not account for any changes in the L2 acquisition, as it primarily focuses on L1 perception. Therefore, it could be said Best (1995) developed and expanded on Motor Theory of speech perception by devising a theoretical framework of PAM.

For example, Best (1995) suggested various combinations that may predict how easy or difficult it may be for a naïve listeners to perceive the differences between any two sounds in a foreign language. The categorization of the non-native sounds was based on the assimilation process, suggesting the sounds may be assimilated as 'good', 'poor' or 'uncategorizable'.

The first Two Categories (TC type) assimilation category (Figure 3) suggests that non-native listeners contrast between phonemes, therefore, assimilating the sounds to different categories. Put simply, the listeners can hear the differences easily, similar to differentiating two sounds in their native language. Best (1993) provides an example of Hindi phoneme [ɖ] possibly assimilating to English [d]; and Hindi phoneme [d^h] possibly assimilating to the English phoneme [ð]. However, other examples of TC type assimilation had been reported in previous studies. For example Figure 3 illustrates three cases of TC type assimilation: (1) L2 English plosive /p^h / may be perceived as L1 Dutch plosive /p/, while L2 English plosive /b/ is assimilating to both L1 Dutch plosives /p/ and /b/; (2) L2 Scottish English vowel sound /i/ assimilating to its counterpart L1 Spanish vowel sound /i/ and an L2 Scottish English vowel sound /ɪ/ assimilating to Spanish vowel sound /e/; (3) L2 Spanish vowel sound /u/ assimilating to both L1 Dutch vowel sounds /u/ and /ɔ/ , while L2 Spanish vowel /o/ is also assimilating to L1 Dutch vowel /ɔ/.

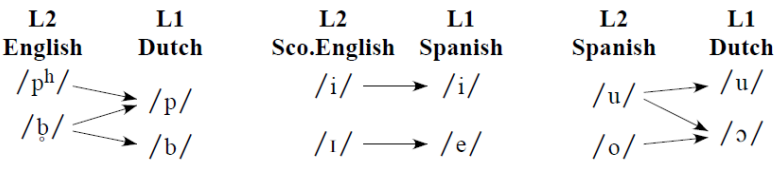

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Figure 3: Three cases of Two Category (TC type) assimilation (Escudero & Boersma, 2002:208)

The terminology used by Flege (1987) in the SLM to address a similar occurrence is the 'old contrast'. Similar to Best's (1993) concept, the idea of 'old contrast' predicts a 'good' category differentiation. Escudero & Boersma (2002) agree with the notion, as they suggest this category assimilation should not present larger difficulties, especially in terms of lexicalization[4]. However, Flege (1987) claims that this category assimilation may be problematic for a native-like production of sounds, as clearly a single sound could be assimilated to the same category, resulting in less accurate pronunciation.

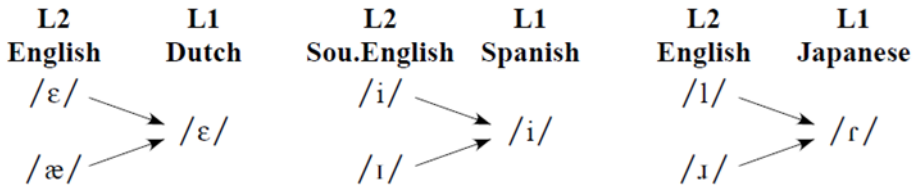

Figure 4: Three cases of Single Category (SC type) assimilation (Escudero& Boersma, 2002:207)

Secondly, the Single Category (SC type) assimilation (Figure 4) predicts that both phonemes may be assimilated equally well or equally poorly. Specifically, the non-native listeners may perceive both phonemes as similar, but neither of the phonemes could be considered as 'better' than the other (Best, 1993). Guion *et al*. (2000b) suggest this would be an example of Japanese listeners' tendency to perceiving English /ɹ/ and /l/ as strange or poor examples of /ɾ/; consequently, the listeners are unable to discriminate among the two sounds (Figure 4). Other examples of SC type assimilation would be L1 Dutch listeners assimilating the Dutch vowel sound /ɛ/ to both L2 English vowel sounds /æ/ and /ɛ/ and L1 Spanish listeners assimilation Spanish /i/ to both Southern British English vowel sounds /i/ and /ɪ/. Again, both these examples suggest poor category discrimination (

Figure **4**), which alludes to skewed or inaccurate production of sounds.

In the SLM, Flege (1995) defined this assimilation process in terms of perceptual equivalence classification.[5] Escudero and Boersma (2002:1) stated that this

[4] Lexicalization is generally defined as a process of adopting words into a lexicon, or a routine process of word formation (Brinton & Traugott, 2005).

[5] According to Flege (1987), the equivalence classification could be defined in terms of the basic cognitive mechanism which permits humans to perceive constant categories in the face of the

assimilation pattern is the most reported one in the literature, mostly because in its 'highly problematic nature for learning', as in the initial stages of learning, speakers may be at a disadvantage due to poor category differentiation.

The third prediction of an assimilation process is Category Goodness (CG type), where a pair of non-native sounds may be assimilated to the same native sound. An example is the Zulu phonemes /k/ and /k'/, which will, in all likelihood, will be both perceived and assimilated to the English phoneme /k/ (Best, 1993) by English L1 learners of Zulu. Finally, if none of the phonemes can be assimilated and are perceived as a 'nonspeech' sounds, Best (1993) suggests a Non-Assimilable (NA type) categorization. An example of this is English listeners perceiving southern Bantu languages, in particular the click consonants within a language (Best, 1993).

Furthermore, Escudero & Boersma (2002) suggested an additional Multiple-category assimilation (MCA), which predicts the perception and consequently assimilation of two L2 sounds to more than two L1 sounds (Figure 5). An example of this category assimilation can be seen with Dutch learners of Spanish, as Dutch listeners may perceive Spanish front vowels /i/ and /e/, as the three short Dutch vowels /i/, /ɪ/ and /ɛ/. Other examples (Figure 5) of the perception and assimilation MCA process could be observed with L2 English – L1 Korean and L2 English – L1 Polish learners.

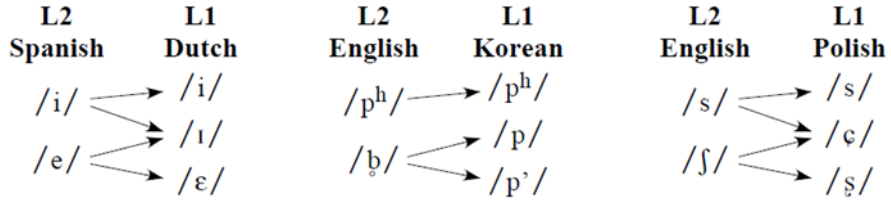

Figure 5: Three cases of Multiple-category assimilation (MCA) (Escudero & Boersma, 2002:210)

In regard to the problems that L2 learners may encounter due to multiple-category assimilation patterns, Escudero & Boersma (2002) identified two possible issues. Firstly, they present the issue of a 'subset problem' that suggests the learners are unable to learn, on the basis of their initial L2 experience, those features which do not exist in their target language (e.g. Dutch vowel sound /ɪ/ does not exist in Spanish).

inherent sensory variability found in the many physical exemplars which may represent a category (Flege, 1987: 49).

Secondly, they claim that even if the learner overcomes this problem of subsetting, the issue of a perceptual subsetting may remain. For example, in the Dutch-Spanish case, the learners will have to 'dispose' of the vowel sound /ɪ/, as they may identify it as the 'odd one out'.

Escudero & Boersma (2002) provided some direct and indirect evidence for these claims in their study of 38 L1 Dutch – L2 Spanish learners, with different levels of proficiency (beginners, intermediate and advanced). The perception task asked the participants to identify the Spanish vowels in the CVC (Consonant-Vowel-Consonant) words by selecting one of the five Spanish vowels that appeared on the computer screen. The results of the study confirmed the existence of multiple-category assimilation (MCA), as the Spanish front vowels /i/ and /e/ were indeed perceived as three short Dutch vowels /i/, /ɪ/ and /ɛ/. Further, to some extent the study suggested Dutch learners "do something" during the process of MCA, as results have shown the learners' tendency to avoid perceiving the vowel sound /ɪ/. Most importantly, the results of the study showed the correlation between proficiency and perception of the vowel sounds; the more proficient the learners, the more likely they are able to differentiate between vowel sounds.

Overall, what is clear from these various types and consequentially presented cases, is the apparent impact of phonetic and phonological similarity that seem to be guiding these processes of L2 sound differentiation. Consequently, the impact of phonetic and phonological similarity between Slovene and English will be discussed later in this chapter. Furthermore, this thesis will aim to explore this further by conducting phonological similarity experiments: measuring acoustic similarity and testing perceptual similarity of Slovene naïve listeners.

What has also been implied, particularly in Escudero & Boersma's (2002) study, is the impact of extralinguistic factors (such as the proficiency level), which may to some extent influence intralinguistic factors (such as phonetic and phonological similarity). Subsequently, studies exploring the impact of extralinguistic factors will be reviewed in the next section.

Furthermore, in order to predict how non-native vowel sounds would be assimilated and address the relative perceptual difficulty, Strange *et al*. (2001) tested the PAM model, while investigating how Japanese listeners would perceive American English (AE) vowels. In their study, twenty-four Japanese listeners were asked to categorize each English vowel sound to one of eighteen vowel categories. After categorization, the listeners were asked to rate these vowels on a seven-point Likert

scale, on the basis of 'category goodness'. Specifically, participants were instructed to rate how well a particular sound fitted a specific category, in this case a vowel sound. The results of the study suggested that not only did the perceptual similarity of the sounds influence the discrimination of vowel sounds, but the identification of the vowel sounds will also be influenced by the context in which these sounds are produced and perceived. As PAM does not allow for the factor of phonological environment of the sounds, it can therefore be perceived as limiting.

Further, Guion *et al.* (2000b) collected cross-language mapping and discrimination data in order to determine how well PAM could be used to predict the learning of English L2 sounds by three groups of Japanese L1 speakers that differed in terms of L2 language experience. In summary, the data, obtained from the first experiment suggests that PAM can indeed predict some of the assimilation patterns. For example, PAM predicted poor discrimination of Japanese-English /ɹ/ and /l/ consonants and the hypothesis was confirmed as Japanese learners poorly discriminated this contrast. Overall, PAM predictions were supported with only one exception; PAM failed to predict for the contrast between /s/-/θ/consonants. These discrimination differences were attributed to how L2 sounds were mapped to the L1 sounds. More specifically, Guion *et al.* (2000b) suggested these differences may be due to the overlap in category assimilation, as the English sound /θ/ was assimilated between two native sounds. Therefore, they suggested a revision of PAM, in order to better predict the discrimination of uncategorized versus categorized non-native sounds and to further account for how uncategorized sounds can be assimilated if they are close in the phonological space to categorized sounds.

Therefore, Best and Tyler (2007) expanded and revised the original model of PAM into the Perceptual Assimilation Model for Language Learners (PAM-L2) and suggested that the perception of the sounds will clearly differ when considering L1 naïve listeners in contrast to L2 speakers who are actively learning and using the language. This expansion of the model will further be explored in the following section, as it may more closely address the changes that may occur in Slovene-English late consecutive bilinguals.

2.1.3 Perceptual Assimilation Model for Language Learners (PAM-L2)

Best and Tyler (2007) expanded and developed the original model of PAM into the Perceptual Assimilation Model for Language Learners (PAM-L2), to incorporate L2 learners. They proposed that the perception will differ in important ways between L1 naïve listeners and those learners who had L2 experience or significant L2 input. This expansion enabled them to more successfully describe the underling mechanisms, which guide perception and production of speech. Originally, the PAM model focused on naïve listeners, functional monolinguals, who are not using the L2 actively, i.e. they are not immersed in the L2 environment. In contrast, the extension of the model to PAM-L2 considers learners who have now acquired some knowledge of the L2 system and are in the process of learning a second language actively (Best & Tyler, 2007).

In order to expand the model, Best and Tyler (2007) reviewed and considered two models that had been most frequently cited in literature: PAM (Best, 1994a, 1994b, 1995) and SLM (Flege, 1987, 1995, 1999, 2002). They noted that PAM (Best, 1994a), has been specifically developed to address the *perception* of nonnative speech, whereas SLM (Flege, 1995) has been specifically developed to address the *production* of L2 speech by L2 learners. Thus, neither model was developed to address both situations: production and perception (even though often assumptions in literature have been made and both models have been cited as though this has been the case). Best and Tyler's (2007) aim was consequently to bring the two models together and explore how they can both be used as a starting point to develop and extend PAM's non-native speech perception framework to L2 learners (Best & Tyler, 2007: 21).

The revised framework made several theoretical proposals (Best & Tyler. 2007: 28) to predict success for L2 perceptual learning. Similarly, to Flege's (1987) SLM, Best and Tyler's (2007) framework of PAM-L2, focuses on L2 perceptual similarity and predicts the degree of difficulty the individual will face while acquiring a second language. It first posits that in order for the L2 sounds to be discriminated accurately, the L2 sound needs to be recognized as dissimilar to the L1 sound. If that does not occur the speech sounds will be discriminated less accurately and merging of the L1 and L2 sounds may occur (Best & Tyler, 2007).

The initial model of PAM successfully predicted how L2 sounds will be perceived by naïve listeners. According to Best and Tyler (2007), from this initial point

onwards we could assume a common L1-L2 phonological system for an L2 learner that incorporates phonetic and phonological levels (for a more detailed discussion of differences between these levels or the lack of distinction in some cases, see 2.3.1 and 2.3.2). Based on this assumption, Best and Tyler (2007) suggested four possible cases of how L2 perceptual learning is processed:

(1) Hypothesis: Only one L2 phonological category is perceived as equivalent (perceptually assimilated) to a given L1 phonological category.
(2) Hypothesis: Both L2 phonological categories are perceived as equivalent to the same L1 phonological category, but one is perceived as being more deviant than the other.
(3) Hypothesis: Both L2 phonological categories are perceived as equivalent to the same L1 phonological category, but as equally good or poor instances of that category.
(4) Hypothesis: No L1-L2 phonological assimilation.

To elaborate on the above instances: in the first case (Figure 6: Example 1), L2 learners will perceptually link their L2 sound to their L1 sound, as they have perceived it as equivalent and, in all likelihood, no further perceptual learning will take place. This hypothesis suggests that the L2 listeners may identify an L2 sound as a good exemplar of an L1 sound; L1 and L2 category may be phonologically equivalent. Until the L2 learner gains additional L2 experience and 'fine-tunes' its perception, it is unlikely these sounds would 'shift'.

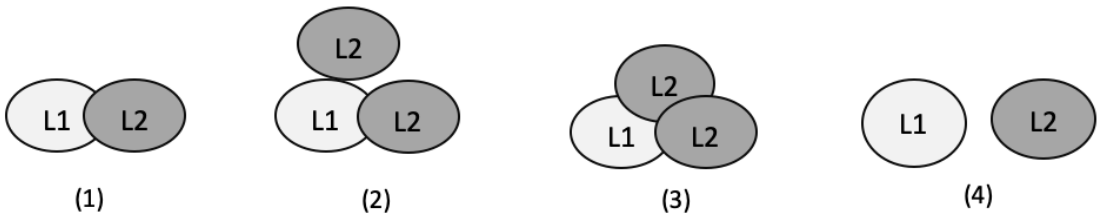

Figure 6: PAM-L2's four possible cases of L2 minimal contrast

The second case (Figure 6: Example 2) strongly resembles the initial proposal made by PAM and its Category Goodness Assimilation contrast (Best, 1994). L2 learners will be able to discriminate L2 sounds well, however not as well as two category assimilation types: one may be perceived a better exemplar. Consequently,

Best and Tyler (2007: 29) hypothesize that over time (through input and perceptual learning) it is reasonably likely that for the 'deviant' sound a new L2 category will be formed, however this forming is strongly dependent on perceived similarity to the L1 category. In this scenario, L2 learners may eventually form a new category for the sound that they had identified to be more 'different' or 'dissimilar', as they may be able to discriminate well between these two L2 sounds. However, similar to the first prediction, L2 learners may perceptually assimilate the L2 sound that is 'more' similar to the L1 category. Best and Tyler (2007) further predict that, in all likelihood, there would be no new category formation for this particular sound.

The third case (Figure 6: Example 3) echoes PAM's Single-Category Assimilation process as well as SLM's (Flege, 1995) proposal of merged L1 and L2 sounds. In this case, L2 learners will perceive new L2 sounds as equally good or equally bad exemplars of L1 sounds. L2 learners in this situation would initially assimilate the L2 sounds to the same L1 category. A new category formation would be dependent on whether or not L2 categories have been perceived as good exemplars. Best and Tyler (2007) expect that it is very unlikely an L2 learner would be able to attune to this type of L2 contrast even with additional L2 input; in this case we would not expect L2 learners to be able to perceptually differentiate between sounds.

In the fourth case (Figure 6: Example 4) L2 learners may not perceive L2 sounds as equivalent to any L1 sounds and in all likelihood a new category will be formed for that L2 sound. In PAM's (Best, 1995) terms this hypothesis would strongly resemble an *Uncategorized category* and in terms of SLM (Flege, 1987), the L2 learners may perceive and identify these sounds as a *new phoneme.*[6] Taking this into consideration, it could be assumed that a new category will be formed (all models consider this process to be relatively easy for L2 learners), as the uncategorized L2 sounds are perceived too close in the phonological space. This density in the phonological space and the need for dispersion could also be explained in terms of *Adaptive Dispersion Theory* (Lindblom, 1986), which suggests that the phonetic system organizes itself in response to the need for greater perceptual distinctiveness. It may also be possible that two L2 phonemes form a single category that may later theoretically be split into two contrasting categories.

[6] During a dissimilation process a new category or new phoneme is established for an L2 sound. This tends to occur as the bilinguals strive to maintain phonetic contrast between all speech sounds in the common phonetic space (Flege et al., 2003). For further discussion see 2.2.1

Furthermore, Best and Tyler (2007) suggested the PAM-L2 model is more applicable to the processes of phonological L2 acquisition as it addressed the perception and consequently the production of the sounds. It explored phonological and phonetic similarity and considers it to be highly influential to the production and perception of L2 speech in L2 learners. This way Best and Tyler (2007) considered cross-language similarities between the L1 and L2, the interaction of the phonological and phonetic level, as well as addressed the main issue of how language learning may affect the perception of phonetic versus phonological information (Best & Tyler, 2007). Therefore, this model differs significantly from the Speech Learning model (SLM) and from the original model of perceptual assimilation (PAM). Moreover, according to de Leeuw (2009) this model goes a step further than SLM, as it explores how the bilinguals will assess the similarity among sounds.

In addition, the PAM-L2 model takes into account the individuals' continuing development of the phonetic and phonological knowledge, as it claims that perceptual learning can occur at any stage, regardless of the age of the learner. It also proposes that the learning mechanisms will be guided by the learner's L2 experience, suggesting the impact of extralinguistic factors.

To some extent, the above hypotheses sound similar to some of the statements previously made in the hypotheses underlying the SLM. For example, both SLM and PAM-L2 "allow" for the potential L2 influence on the L1 due to a common phonological space, suggesting a possibility of L1 phonological change/attrition. Additionally, both SLM and PAM-L2 suggest that L2 learners have access to the same language faculty, to the same mechanisms as during L1 acquisition. Moreover, Best and Tyler's (2007) ideas concur with SLM's (Flege, 2003: 92-93) hypothesis, which states that "processes and mechanisms that guide successful L1 speech acquisition remain intact and accessible across the life span". Similarly, Best and Tyler (2007) emphasize that individuals can easily adapt to "changes in the ambient language environment" (Best & Tyler, 2007:19), which also alludes towards the possibility of L1 language change. This may be due to SLM's and PAM-L2's differing views regarding phonetic and phonological categories. SLM, for example, views phonetic categories as "mental representations", which points to more abstract concepts (Flege, 1995). In contrast, PAM-L2 defines phonetic categories as 'gestural features', in other words, actual sounds themselves. Furthermore, Best & Tyler (2007) partially agree with Flege's (1995) idea of 'common phonological space' where L1 and L2 phonetic subsystems exist. However, Best and Tyler (2007) state that both phonetic and

phonological levels, which are not specifically defined by Flege (1995) "interact in L2 speech learning and that this depends crucially on the relationship between the phonological spaces of the L1 and L2" (Best & Tyler, 2007: 22).

Similarly, to the SLM, many researchers sought to explore PAM-L2's claims. Guion *et al.* (2000b) reported that the results of three groups of Japanese speakers varying in L2 (English) language experience, showed statistically significant evidence that the more experienced learners were able to better perceive and discriminate the L2 contrast. However, not all contrasts were reported to improve with gaining L2 experience. These results may be attributed to the cross-language linkage that indicate certain contrasts will be more difficult to perceive then others, regardless of the L2 input.

Corresponding to PAM studies, not all studies found evidence in favor of PAM-L2. For example, Jeske (2012) found that the results of his study on L1 Spanish speaker's perception of L2 English vowels, failed to be interpreted in the framework of PAM-L2, as the PAM-L2 framework inadequately predicted levels of discrimination difficulty for L2 vowel contrasts for L1 Spanish learners of English (six out of ten). However, due to a small sample size (five male, seven female) the results are questionable. Additionally, the use of a self-identified questionnaire for the monolingual speakers, who identified themselves as users of Standard American English (they were clearly from different dialectal regions), makes the methodology of the study rather problematic.

Later, Bundgaard-Nielsen *et al.* (2011) suggested that the L2 learners' perception and consequently production may also be guided by the L2 vocabulary size. In their study of Japanese-Australian English L2 learners, Bundgaard-Nielsen *et al.* (2011)) investigated the influences of L2 vocabulary size on the L2 vowel perception, adapting a 'whole vowel system' approach; considering how all vowels in the L2 system may be mapped onto the L1 vowel system. Implementing the whole vowel system approach (similarly to Guion, 2003), in contrast to the subset analysis that focuses on a single set of phonemes, enabled Bundgaard-Nielsen *et al.* (2011) to make valid and non-biased conclusions.

Best *et al.*'s (2011) assumption of L2 vocabulary size influencing L2 vowel perception was guided by the idea investigated in numerous previous studies (Flege *et al.*, 1995; Ingram & Park, 1997; Tsukada *et al.*, 2005), which suggested that the difficulties encountered by L2 learners may be reduced by the increase of L2 proficiency. However, these studies failed to establish under what mechanisms these

changes, in the perception and production, would occur. The results of Best *et al.*'s (2011) study on Japanese-Australian English L2 learners suggest that the L2 learners with a larger L2 vocabulary size may be more consistent with their vowel assimilation patterns in comparison to the L2 learners with smaller vocabulary output. Specifically, the perception of L2 vowels is guided by the L1 vowel inventory, meaning that the L2 learners with a smaller L1 vowel inventory are more likely to identify a specific L2 sound as 'similar' or 'identical' to the one in their L1 (Iverson & Evans, 2007), consequently 'merging' the sounds (Flege, 1987). This suggestion would be compatible with the hypothesis made by PAM-L2. Furthermore, their results confirmed the hypothesis that a larger L2 vocabulary could be associated with more consistent L2 vowel identification (Bundgaard-Nielsen *et al*., 2011), as the L2 learners with the bigger L2 vocabulary managed to phonologically reorganize the L2 phonological system, meaning they were able to perceive more accurately the L2 sounds. Nonetheless, Bundgaard-Nielsen *et al.* (2011) do not suggest that the L2 learners will create completely new categories for L2 sounds due to a bigger vocabulary size, though they do suggest that due to the 'forceful linguistic pressure' exerted by the L2 vocabulary, L2 learners will be broadening their vowel inventory.

As presented, previous studies (Best & Strange, 1992; Flege, 1989; Best, Traill *et al*., 2003; Best & Halle, 2010) found evidence that the listeners' native language will influence how the sounds will be perceived; either with relative difficulty or relative ease. However, to date, no studies have explored, predicted or analyzed the relationship between Slovene and English perceptual similarity and the overall organization of their phonological system. Therefore, the aim of the section titled Intralinguistic factors, will be to explore the phonetic and phonological similarity of the Slovene and the English phonological systems, measure acoustic distances between the target vowel sounds and support these results with a perceptual similarity test of L1 naïve Slovene listeners.

Overall, PAM-L2 could be used as a suitable model of predicting how Slovene-English late consecutive bilinguals in this study would undergo the process of L1 phonological change, particularly at higher levels of L2 proficiency. This is due to the assumptions of L1 and L2 phonological categories interacting in a common phonological space, similar to Flege's (1995) proposal in the SLM model. Nevertheless, the question of how the phonological and phonetic levels interact and how differences are resolved has not been fully addressed in the PAM-L2 theoretical framework, as PAM-L2 does not address the issue of phonological and phonetic inconsistencies, that may occur and have been reported in the previously discussed studies (e.g. in particular

when it is impossible to distinguish between the two). Furthermore, neither PAM nor PAM-L2 can adequately predict the possible effect the L2 will have on the L1 phonological space.

2.1.4 Phonological Interference Model (PIM)

According to Brown (2000), previous research of L1 phonological inference on L2 acquisition, primarily focused on the phonemic categories of language. However, Brown's (1998, 2000) Phonological Interference Model (henceforth PIM) is based on the generative framework that assumes phonemes themselves have an internal structure. The model, therefore, aims to explain how the influence of L1 phonological knowledge impacts L2 acquisition. Brown (1998: 136) hypothesizes that if the L1 grammar lacks phonological features that differentiates a particular non-native contrast, the learner will be unable to perceive or acquire a novel L2 phoneme. Interestingly, this model strongly considers the idea of a universal phonetic category and Universal Grammar (UG) proposed by Chomsky in late 1950s.[7] In other words, L1 grammar may be preventing the learners from acquiring non-native phonemes.

At the initial stages of speech perception, Brown (1998) suggests that all acoustic processing is automatic and is applicable to all humans. The model proposes a hierarchal structure of speech perception: a two-level process where phonological structure mediates the perception of speech sounds. Brown (1998) uses the term *feature geometry* for this structure (graphically presented in Figure 6). The theory of *feature geometry* proposes that phonemes consist of distinctive features which are organized into a systematic hierarchal structure (Brown, 2000). Specifically, Brown (1998: 150) suggests that a learner's acquisition of *feature geometry* in L1 acquisition causes the gradual decline in the ability to acoustically discriminate non-native contrasts and L1 grammar maps the L2 input on to existing L1 phonological categories, effectively eliminating cues in the acoustic signal that could potentially trigger further acquisition. This is in stark contrast to both SLM and PAM (-L2) models that suggest acoustic signals will be mapped according to the language specific representations. Additionally,

[7] The fundamental ideas of UG suggest that language is innate: it is not based on external input but is guided by specific properties inside a person's mind (a common set of rules). Initially, this theory was proposed for L1 acquisition and only later adopted for L2 acquisition (Bylund et al, 2010).

in contrast to SLM, Brown (1998) rejects the idea of 'merging' speech sounds, as he claims L2 sounds will be mapped onto L1 sounds (Figure 7).

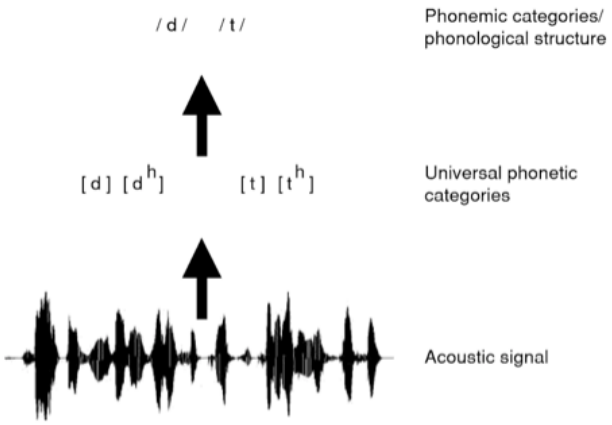

Figure 7: Brown (1998) proposal for speech perception (Pennington, 2006:118)

The PIM model further differentiates between three primary types of non-native contrast that the L2 learner may acquire (Brown, 150-152):

1. Each member of the contrast is similar to distinct segments in his or her L1.
2. Neither member of the non-native contrast is (or corresponds to) a phoneme in the learner's native language.
3. One of the members of the non-native contrast is a phoneme in the learner's L1.

Brown (1998:150) suggests that in the first type of non-native contrasts, learners can discriminate between L1-L2 sounds if a non-native contrast exist in their L1 language; in other words, the same phonetic contrast exists in the L1 and L2. The learners will be able to categorize the non-native phonemes into their L1 phonemic categories and no new phonemic category will be formed. In other words, L2 sounds will be mapped onto L1 sounds. This is in stark contrast to Flege's (1987) proposal of L2 sounds that are 'similar' to L1 sounds, which will form merged L1-L2 categories in the mind of the learner. According to Flege (1987) it follows that L1 sounds in the 'similar' category might change over time to become even more similar to the nearest L2 sound, as the merged category becomes increasingly established. In contrast to

Brown's suggestion, Flege's L2 learners are unable to discriminate between L1 and L2 sounds and a new category is established.

The second type posits that no relevant contrast exists in learners' L1. In other words, if UG is available, learners will be able to acquire new sounds. However, if UG is not available, learners will be able to perceive the sounds, but will not be able to form new phonemic categories. Both Brown (1998) and Best (1993) provided an identical example of in Zulu clicks being acquired to English speakers. However, Best (1993) explained it in terms of an assimilation process of Category Goodness (CG type), where a pair of non-native sounds may be assimilated to the same native sound. Additionally, this type could be also compared to Flege's (1995) hypothesis of phonetic dissimilarity: the greater the perceived dissimilarity of an L2 sounds from the closest sound of the L1, the more likely a new category will be formed for the L2 sound. To an extent, it could be said that all three models allow for the possibility of dissimilar sounds being acquired by L2 learners.

In the last, third type of non-native contrasts, Brown (1998: 151) employs the previously mentioned idea of *feature geometry*: the speaker's language specific *feature geometry* channels the acoustic signal into native phonemic categories, in effect blocking the perception of certain non-native contrasts and the L1 Feature Geometry will direct the acoustic signals for the two segments into one L1 native phonemic category. This could again be compared to Best's (1993) idea of the Single Category (SC type) assimilation, which predicts that both phonemes may be assimilated equally well or equally poorly. Specifically, the non-native listeners may perceive both phonemes as similar, but neither of the phonemes could be considered as 'better' counterpart than the other (Best, 1993). It could be said that both Best (1993) and Brown (1998) propose poor category formation in this context.

Brown (1998) provides evidence to support above hypothesis in two experimental studies, where she investigates the acquisition of /l/ and /r/ by Chinese and Japanese speakers and the acquisition of the /l–r/, /b–v/ and /f–v/ contrasts by Japanese speakers. Based on her findings, she concludes that learners' L1 grammar may actually impede access to UG, preventing the L2 learner from acquiring a non-native phonemic contrast.

Overall, as Brown (1998) suggests that L2 sounds will be acoustically mapped to L1 sounds. Consequently, it could be posited that L1 will not be affected and no L1 phonological change will take place. On the other hand, it could be posited that whilst the categories would not be affected, the acoustic quality of the sound might be (for

example, fundamental frequency (F_0), which may form a basis for L1 phonological change. Therefore, if no changes in L1 Slovene-English vowel frequencies are found, this model will not be of particular significance to the study at hand.

2.1.5 Ontogeny Phylogeny Model (OPM)

An additional, L2 model that may be able to explain and account for the change in Slovene-English bilinguals, is Major's (2001) 'Ontogeny Phylogeny Model' (OPM). In contrast to the previously discussed PIM model (Brown 2000), Major's Ontogeny Phylogeny Model (OPM) aims to describe the principles under which L1-L2 systems form and merge, as well as addressing the changes that may occur in the L1 as a consequence of exposure to the L2. Similar to Brown (2000), Major posits that there are three components to this L2 'interlanguage' (IL): L1, L2 and language universals[8] (U).

Major (2001) outlined four propositions or so-called *Corollaries* that underpin this model and consider the above three constructs:

1. *Chronological Corollary*
2. *Stylistic Corollary*
3. *Similarity Corollary*
4. *Markedness Corollary*

The Chronological Corollary proposes that IL develops chronologically and there is a non-linear relationship between L1, L2 and language universals (U). In particular, as the L2 increases, L1 decreases and U increases and then decreases. These relationships are graphically depicted in Figures 8 – 13.

[8] Major (2001) broadly defines language universal to include learnability theory, markedness, underlying representations; rules and processes; constraints; and stylistic variation.

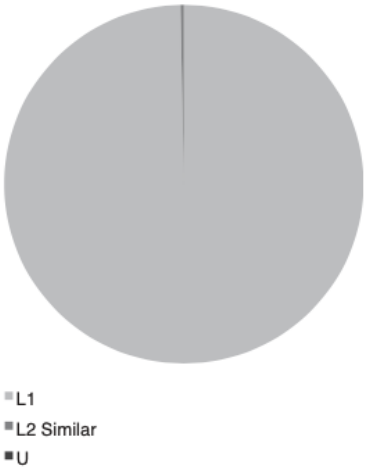

Figure 8: OPM Stage 1 of L2 acquisition (adapted from Gass, 2013: 188)

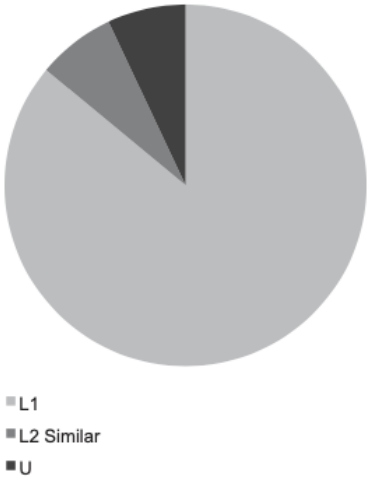

Figure 9: OPM Stage 2 of L2 acquisition (adapted from Gass, 2013: 188)

As shown in Figure 8, at the beginning of L2 acquisition process the influence of the L1 is particularly strong, suggesting that the process of transfer is most common at the initial stage of acquisition. This would further imply that at the later stages of L2 acquisition (Figure 12), the influence of L1 and U is far less significant and L2 becomes a more significant factor.

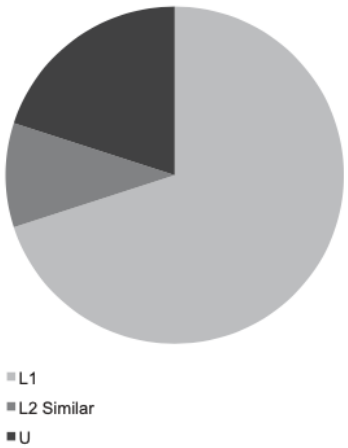

Figure 10: OPM Stage 3 of L2 acquisition (adapted from Gass, 2013: 188)

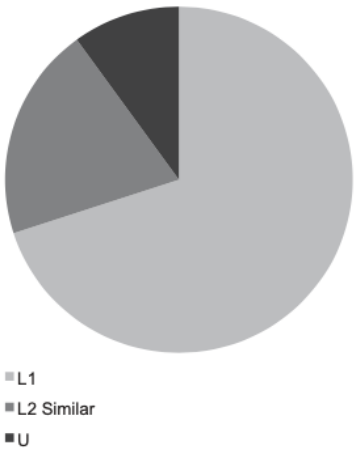

Figure 11: OPM Stage 4 of L2 acquisition (adapted from Gass, 2013: 188)

The OPM's The Stylistic Corollary (Major, 2001: 93) posits that interlanguage can also vary stylistically. Specifically, as the style becomes more formal the L2 increases, L1 decreases and U increases and then decreases. In other words, the more formal the style the more target-like accuracy is achieved. Additionally, the L2 learners usually have more accuracy in pronouncing isolated words than in conversations, due to the tendencies of L2 speakers reverting to L1 patterns of speech. In comparison, to other corollaries this corollary is far less relevant to the current study due the study's methodological approach – the participants' responses were measured in a formal task (this is further discussed in Chapter 3).

The Similarity Corollary, similar to the Chronological Corollary changes chronologically: L2 increases slowly, L1 decreases slowly and U increases and then decreases slowly. This suggests that the role of L1 is significantly more prevalent than U, when compared with less-similar phenomena. In other words, the less similar the phenomena (or the more dissimilar) the more important the role of U is compared to L1 (Major, 2001:100). The underpinnings of this corollary strongly resemble the proposal made by Flege in his SLM: *the greater the perceived dissimilarity of an L2 sound from the closest sound of the L1, the more likely a new category will be formed for the L2 sound.* Both models, OPM and SLM, propose that the more the sounds are dissimilar, the more the influence of L1 is reduced. However, SLM proposes a new category formation as a result of this decreased L1 influence, whereas OPM suggests that the formation of the new sound category will be underpinned or guided by the principles of U. Flege's (1995) theoretical phonetic framework does not explicitly employ U.

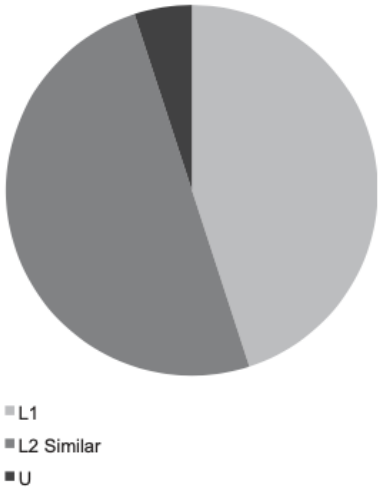

Figure 12: OPM Stage 5 of L2 acquisition (adapted from Gass, 2013: 188)

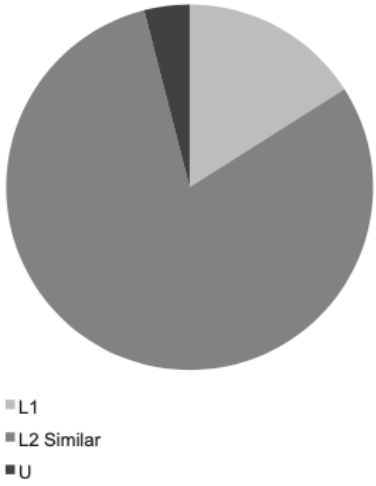

Figure 13: OPM Stage 6 of L2 acquisition (adapted from Gass, 2013: 188)

Of particular interest is the last Markedness Corollary, as it proposes that in the marked phenomena the IL develops chronologically with L2 increasingly slowly, L1 decreasing at a normal rate and then decreases slowly and U increases rapidly and decreases slowly. Consequently, it can be inferred that except for the earliest stages of L2 acquisition, the role of U is much greater than L1, in comparison with less-marked phenomena (Major, 2001:85). According to Yavas and Byer (2014), the influence of U will continue until the later stages of SLA when more native-like structures replace those affected by U. This suggests that in the process of first language attrition, U will have a diminished influence.

Similar to Flege's (1995) SLM model, OPM describes the principles under which bilinguals' L2 phonologies may merge and therefore the changes would be evident in this study's L1 of Slovene-English bilinguals as a result of the L2 influence (English). However, Major's (2001) model does not explicitly outline how L1 sounds may be mapped to L2 sounds; it only makes general claims disregarding fine-grained phonetics. It could be claimed that it lacks phonetics and phonological specifics. Specifically, James (2003: 269) notes that Major's (2001) proposed framework could be seen as "generalization" and "hypercorrection", as researchers we are not offered specific answers to questions such as 'how' and 'why' particular 'components' increase and decrease or in James's (2003: 269) criticism why these components are "appearing" and "disappearing" from the prosed model.

Major (2001) argues that this is a strength rather than a weakness of the model, as this provides the researcher with a framework that allows for general individual observations. However, similar to Brown's PIM model, without a clear theoretical framework, it is difficult to apply this model to any results obtained from this study, especially in an attempt to explain and describe any changes found in Slovene -English bilinguals' speech perception and production. Therefore, it is unlikely that Major's (2001) OPM model would be able to explain the observed data in the study.

2.1.6 Second Language Linguistic Perception (L2LP)

An alternative L2 model that has been reported in the literature is Second Language Linguistic Perception (L2LP), which was initially developed from the Linguistic Perception model (LP). Based on LP, Escudero and Boersma (2004) and Escudero (2005) proposed an extension: an L2 version of the linguistic perception model. The three main hypothesis of L2LP model consists of (Pennington, 2006: 126):

I. Full copying of L1 perception grammar and lexical representations as the basis of the new perceptual system for L2
II. Full access to all mechanisms for L1 learning
III. Full proficiency in both L1 and L2 under conditions of high usage in both

According to Escudero (2005: 85) the L2LP model offers both theoretical and methodological explanation, as it is composed of five theoretical ingredients that are at the same time a sequential methodology for testing and evaluating the model's predictions and explanations. Figure 14 summaries these five theoretical ingredients or components.

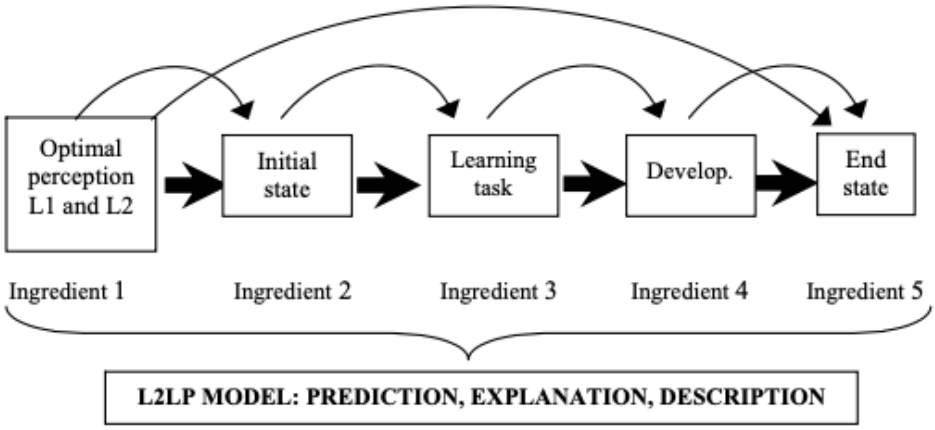

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Figure 14: L2LP's five theoretical ingredients (taken from Escudero, 2005: 95)

As evident from Figure 14 and in stark contrast with other models reviewed so far, the L2LP model provides a more detailed theoretical framework as it outlines the possible outcomes for each stage of L2 acquisition and addresses all three different states of L2 perception. Additionally, it provides researchers with a methodological proposal: a step-by-step guide as to how to complete an L2 sound perception study (Figure 15).

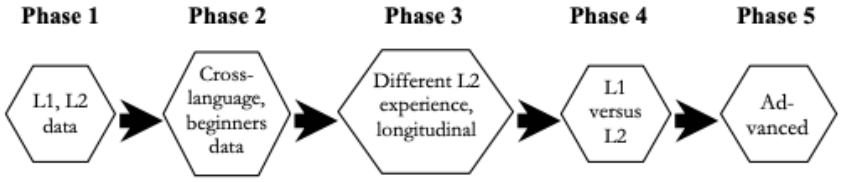

Figure 15: The L2LP's methodological proposal (taken from Escudero, 2005:97)

The first ingredient or component of the model suggests that in order to account for L2 sound perception, a thorough analysis of the optimal perception ought to be completed in each of the languages involved (Figure 16). It further states that these optimal L1 and L2 perceptions are guides by so-called *optimal perception hypothesis* (Escudero, 2005; Escudero *et al*., 2009), which posits that human listeners maximize their probabilities of understanding speakers by making perceptual decisions that match their intended message (Escudero, 2005: 88). In order words, it suggests that bilinguals

will initially perceive and produce L2 sounds as equivalent to the L1 sounds, suggesting the results of L1 acquisition will represent the initial state of L2 learning and shape the acoustic similarity, as well as perceived differences in speech sounds (van Leussen & Escudero, 2015). Consequently, perception will be strongly dependent on the environmental input (more specifically the production environment) due to the fact an optimal listener manifests a sound perception that matches the production of the sounds in his/her environment (Escudero, 2005:88).

The second ingredient of L2LP model refers to the onset of L2 learning (Figure 16). This onset is underpinned by cross-language perception. In other words, the L2 learners will categorize the sounds of the target L2 in the same manner they categorize the sounds of any foreign language (Escudero, 2005: 98). This ingredient very much resembles the proposals made by Best's (1995) PAM, where naïve listeners categorize sounds based on how easy or difficult it may be to perceive the differences between any two sounds in a foreign language. In contrast to the SLM, which focuses on the individual sounds, L2LP as well as PAM both focus on the perceptual development of sounds and the mechanism underlying category formation. Due to this process, Escudero (2005) proposes there will be a full copying of L1 perceptual mapping on to L2 initial perception. This proposal is similar to the one proposed earlier by Brown's (2000) PIM, which suggested that L2 learners will transfer their L1 feature geometry to their IL (L2 maps onto L1), as well as Major's (2001) OPM, which suggested that in the initial stages L1 grammar will be used as a starting point for L2 acquisition (again L2 maps onto L1).

Escudero (2005:105) refers to the third ingredient in terms of an L2 learning task that results from the differences between the initial L2 and the target L2 perception (Figure 16). To elaborate, even if L1 and L2 phonologies have the same number of phonological representations or sounds, researchers have commonly observed the cross-language perceptual differences and this degree of mismatch will constitute the L2 learning task. The aim of all L2 learners will be to bridge this mismatch.

L2LP	Prediction	Explanation	Description
Optimal L1 & target L2	Human beings are optimal listeners	Optimal listeners handle the environment maximally well	L1 and L2 optimal category boundaries: Location & shape
Initial state	= Cross-language perception	Full Copying	L1 boundary location and shape
Learning task	= Reach the optimal target L2 perception	L2	Bridging mismatches between L1 and target optimal perception
Development	= L1-like	Full GLA Access	Category formation and boundary shifts
End state	Optimal L1 perception and optimal L2 perception	Input overrules plasticity Separate grammars	Language activation modes, through language setting variables

Figure 16: Summary of five ingredients of L2LP model (Escudero, 2005: 122)

The penultimate and forth ingredient of the L2LP model focuses on L2 development (Figure 16). For the L2 learning task to be successfully accomplished, the L2 learner will either need to create new perceptual mappings that will lead to new phonological representations or adjust the existing perceptual mapping (Escudero, 2005: 109). This suggests that learners will follows the same mechanisms as in the L1 acquisition process and consequently L2 ultimate attainment is possible. Escudero (2005) hypothesizes that this is due to the learners having full access to the GLA (Gradual Learning algorithm) that enabled them to acquire L1 perception. The definition of the GLA strongly echoes those mechanisms drawn from Universal

Grammar (UG) first proposed by Chomsky (1965). This proposal could therefore be compared to the one made by OPM (Major, 2001), who suggested that L2 acquisition is not only guided by L1 and L2, but also by a set of universals (U). However, in contrast to Escudero (2005), Major (2001) did not provide a specific methodological framework that researchers could apply in order to test its hypothesis.

Escudero (2005: 114) described the final ingredient as the L2 end state and proposes three possible outcomes of every L2 learning (Figure 16). These outcomes are very much dependent on L2 input (the richer the input the more L1-like), cognitive plasticity and activation of language modes. Most importantly, Escudero (2005) proposes two separate perception grammars, which is crucial, as it 'permits' an option of ultimate L2 attainment, however it also suggests that L1 perception and consequent production will not be affected: at the 'end state' of L2 learning, L1 will not be affected. Specifically, Escudero (2005:121) claims that L2 learners in an L2 monolingual mode will exhibit an L2 perception similar to that of monolingual native listeners. Consequently, the is no fossilization in L2: L2 develops without affecting the L1. This is in stark contrast to the previously discussed models, which all supported the idea of connected L1-L2 phonologies (e.g. Flege's (1995) SLM), and consequently 'allowing' for the possibility of L1 phonological change or attrition.

Additionally, in contrast to SLM which focuses on the individual sounds, L2LP similar to PAM, focuses on the perceptual development of sounds and the mechanism underlying category formation. However, Escudero (2005:5) does posit three possible learning scenarios or L2 sound categorization: 1) *new* 2) *similar* and 3) *subset*. First two scenarios could easily be compared to Flege's (1995) SLM proposal of *similar* and *dissimilar (new)* sounds: in a *similar* scenario L2 learners are confronted with L2 phonemes that have counterparts in their L1, whereas in a *new* scenario, L2 learners are confronted with L2 sounds that do not exist in their L1. Escudero (2005) proposes an additional learning scenario of a *subset* in which L2 learners are confronted with L2 phonemes that have more than one counterpart in their L1 and consequently they form a subset in the L1. However, in stark contrast to SLM and other previously discussed models, L2LP proposes the idea of two separate perceptional systems hence the previously mentioned idea of an alternative model to L2 acquisition and L1 attrition. This would suggest, for example in a *similar* scenario, that two L2 phonemes would be

perceptually mapped to two L1 phonemes (graphical comparison presented in Figure 17.

Figure 17: Comparison of L2LP and SLM

Regardless, of the significant contributions, both theoretically and methodologically, the L2LP model fails to predict more specific outcome of L1 change. Therefore, this model will be of particular importance to the study at hand if no significant differences are found between monolingual (Slovene and English) and Slovene-English bilingual speakers. If statistically significant differences between the groups in question are observed, this model fails to predict the outcome.

2.1.7 Native Language Magnet Model (NLM and NLM-e)

In the realm of phonetics there are three influential models that aim to explain L2 sound perception: Best's (1994) PAM, Flege's (1987) SLM and Kuhl's (1993) Native Language Magnet Model (NLM). The NLM model was first developed with the aim to explore how native phonemic categories will be developed from childhood into adulthood.

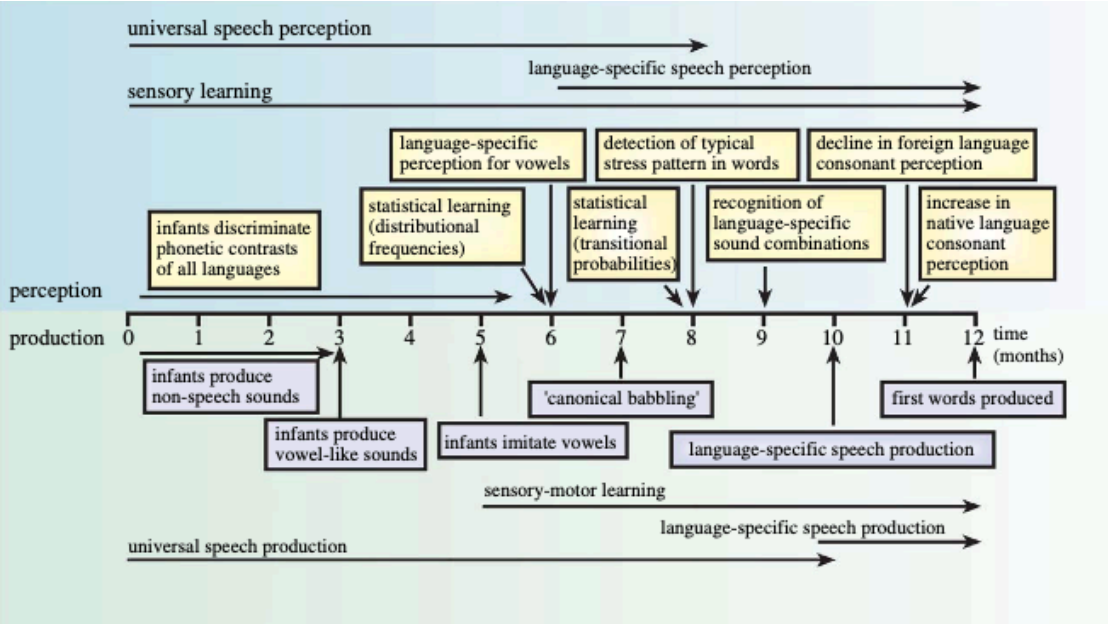

Figure 18: Universal timeline of infants' perception and production of speech in the first year of life (taken from Kuhl *et. al.*, 2008:980)

In the original NLM Kuhl outlined three specific phases of speech perception in infants (Kuhl *et al.,* 2008: 983):

(1) In phase 1, infants are capable of differentiating between all the sounds in human speech (graphically presented in Figure 18)
(2) In phase 2, infant's sensitivity to the distributional properties of linguistic input produces phonetic representations based on the distributional 'modes' in ambient speech input (graphically presented in Figure 18)
(3) In phase 3, this distortion of perception, termed *perceptual magnet effect,* produces facilitation in native language and a reduction in foreign language phonetic abilities (graphically presented in Figure 18)

In other words, Kuhl *et al*. (2008) suggest that adult L2 listeners would have difficulties developing new non-native phonemic categories, as native categories have a magnet-like effect, which makes it difficult to discriminate between native and non-native sounds (Kuhl *et al*., 2008). This is in stark contrast to the previously discussed models of SLM and PAM-L2, which both 'allowed' the possibility of phonetic

categories evolving over the life span as a result of linguistic experience. Additionally, NLM, proposes that the L1 language-specific filter will make the acquisition of an L2 much more difficult because future learning is constrained by the initial mental mappings that have committed neural structure. Therefore, learning to perceive L2 sounds is constrained by the initial mapping, i.e., the native-language sound mapping, that has taken place. Moreover, this constraint operates independently of any critical period. However, it is still claimed that the older the learner is, the more neural commitment she has to the native language mappings. The native-language mental maps thus interfere with the creation of new mappings for the new language input (Escudero, 2005: 137).

Although the NLM proposes that L2 learners can create new mappings for the perception of L2 sounds, it is not clear whether the creation of such new mappings is achieved through the same means as in L1 acquisition or through some other mechanisms. Kuhl (2000: 11856) suggests that the creation of L2 mappings differs from that which occurs during L1 acquisition, and that therefore other ways of achieving development may be needed. However, no other types of learning mechanisms are proposed (Escudero, 2005: 140).

Furthermore, the NLM argues that complex neural perceptual maps underlie sound perception and that such neural mappings result in a set of abstract phonetic categories. Adult perception is seen as language specific because it is shaped by earlier linguistic experience. Unlike the PAM proposal, the NLM claims that perceptual representations are stored in memory. Perceptual mappings differ substantially for speakers of different languages so that the appropriate perception of one's primary language is completely different from that required for other languages. Kuhl emphasizes that perception is language specific, claiming that "no speaker of any language perceives acoustic reality; in each case, perception is altered in service of language" (Escudero, 2005: 130).

The NLM model was further revisited and extended to NLM-e (Kuhl et al., 2008: 979 - 1000) that incorporates five 'new' principles taking the original NLM as the basis of their development:

(1) Distributional patterns and infants-direct speech are agent of change
(2) Language exposure produces neural commitment that affects future learning
(3) Social interactions influence early learning at the phonetic level
(4) The perception-production link is forged developmentally
(5) Early speech perception predicts language growth

The second principle is particularly interesting to the study at hand as it proposes that early exposure to the L2 language will shape bilinguals' ability to learn new phonetic categories. To this extent it is echoing Flege's SLM notion of 'earlier is better', as early simultaneous bilinguals will produce more-native like properties of L2 language (Flege, 1987). Furthermore, their concept of NLNC (Native Language Neural Commitment) proposes that the process of language exposure will result in physical changes, which makes acquiring new categories in adulthood difficult (Kuhl *et al*., 2008).

According to Escudero (2005: 132) the SLM assumes the same learning processes and mechanisms as those proposed by the NLM and NLM-e model: the ability to accurately perceive featural patterns in the input and to categorize a wide range of segments (Flege, 2003). However, no formal proposal for the mechanisms behind the learning of L1 perception can be associated with this model, apart perhaps from the claim that perception is dominated by 'equivalence classification', a mechanism that leads to the classification of acoustically different tokens into the same abstract category (Flege, 1995).

2.1.8 Phonetic drift

Most language interaction models of the ones discussed so far defined phonological change in terms of 'attrition' or 'cross-language influence'. However, Chang (2010) described the phenomenon of phonological restructuring of the L1 system in terms of *phonetic drift*, i.e. changes in the L1 system that do not imply the loss of L1, as the bilinguals' L1 production does not necessarily deteriorate. Specifically, Chang (2010) investigated the phonological change of English-Korean late consecutive bilinguals, with the focus on novice L2 learners. This contrasts with the majority of previous studies that limited themselves to either advanced or native-like proficient learners. The aim of his study was to investigate why and how phonetic drift occurs, considering the sociolinguistic factors and more specifically the influence of the L2 experience during second language acquisition.

Chang's (2010) first research question aimed to answer whether or not late consecutive bilinguals, who were only exposed to the L2 language for a few weeks and were at the initial stages of L2 acquisition, would deviate from L1 monolingual norms,

prior to gaining considerable proficiency in the L2. Examining English-Korean stop consonants, specifically the Voice Onset Time (VOT) and Fundamental Frequency (F_0), as well as the first two vowel formant frequencies (F1, F2) tested this hypothesis. These parameters were selected because they appear to be the best indicators of phonological changes that may occur as a consequence of language contact.

Additionally, Chang's (2010) results determined that across both genders, participants 'drifted away' from monolingual norms, even though certain differences did not reach statistical significance ($p>0.05$). The phonetic drift in the stop consonants /p/, /t/, /k/, showed increased differences in the VOT and F_0 over time, as participants were gaining more experience in the L2 (Figure 19). These results are in stark contrast to Flege's (2003) proposal that L2 learners will only, when given adequate and sufficient input, perceive the phonetic properties of L2 speech sounds accurately.

Furthermore, the vowel drift did not only occur on the level of individual sounds, but rather acted as a global shift in formant frequencies across the whole vowel system, bringing vowel categories more closely together. Chang (2010) referred to these phenomena in terms of a *cross-linguistic vowel space*, where both L1 and L2 vowel spaces are interlinked and show high levels of connectivity, similarly to Flege's (2003:93) terminology of a "common phonological space", where phonetic elements that make up the L1 and L2 phonetic subsystems exist. In a 2011 paper, Chang (2011:430) even suggested that this phenomenon is systematic, as:

"instead of [sounds] drifting in disparate directions, the English vowels moved upward in similar fashion, approximating the Korean vowel system in accordance with basic differences between the two languages' vowel inventories. Thus the movement was systematic, rather than a sum total of assimilatory changes in individual L1 vowels."

This observation proposes an interesting avenue of research for the current study, as it would be intriguing to observe whether Slovene-English late consecutive bilinguals also display changes on a macro level[9] and whether the same direction of movement – vowel rising – would be observed (Figure 19).

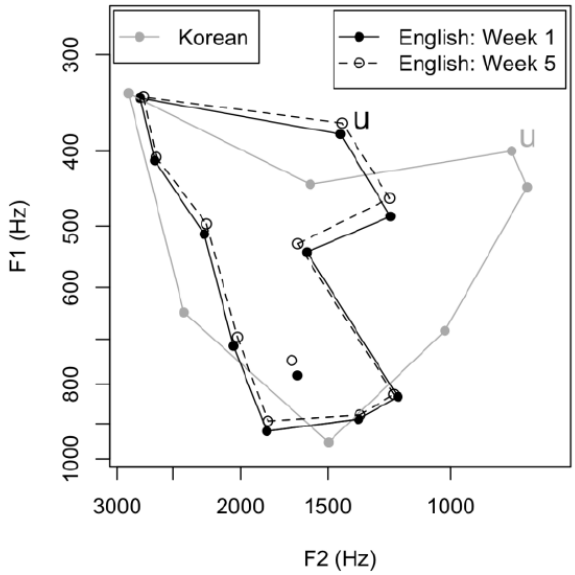

Figure 19: Phonetic drift in Chang's study (2011: 430)

The evidence supporting Chang's (2010) language interaction model and his idea of phonetic drift can be found in Herd *et al.*'s (2015) study of English learners of Spanish who were acquiring Spanish in an English-dominant environment and learners who were acquiring an additional language in an L2-dominant environment. Overall, both groups exhibited changes, or in Chang's terms phonetic drift, in both consonants and vowels. However, more statistically significant differences (changes in their vowel frequencies) and further evidence supporting the ideas of phonetic drift, was found among learners of Spanish, who were emerged in an L2 speaking environment. This would suggest that extralinguistic factor(s) play a significant role in language change, and intralinguistic factors may be of a secondary nature.

However, it must be pointed out that this was not the first time that such a phonological change has been observed and noted in the literature. Similar to Chang's (2010) study, Guion (2003) explained the study's results in terms of *Adaptive Dispersion Theory* (Lindblom, 1986), which suggests that the phonetic system organizes itself in response to the need for greater perceptual distinctiveness.[10] The

[9] Specifically referring to the changes to occur on the level of entire vowel system

[10] Guion (2003) used the terminology of a 'gestural drift' when describing this effect in his work.

reorganization of the phonetic system will consequently result in the cross-language dispersed organization of the phonological system; both L1 and L2 sounds will move away from each other in order to maintain phonetic contrast. This process is similar to the one previously described by Flege's SLM, where during a dissimilation process a new category or new phoneme is established for an L2 sound, as the bilinguals strive to maintain phonetic contrast between all speech sounds in the common phonetic space (Flege *et al*., 2003). Additionally, this reorganization would be supporting the idea of a shared L1 and L2 phonological system, where all sounds are interlinked or connected to some extent – a similar notion that was already explored in SLM (Flege, 1995), PAM (Best, 1994), PAM-L2 (Best and Tyler, 2007).

In Chang's (2010:162) case the phonetic drift 'resulted in decreased cross-language dispersion', in contrast to the expected L1 vowels shifting away from L2 vowels. Therefore, Chang claimed that his results are 'not amenable to an explanation in terms of dispersion maximization', as when the mean acoustic distance between English and Korean vowels was calculated for each time point, it was found that this index of cross-linguistic vowel spacing did not increase over time for either female or male learners though he does not provide alternative explanations of his results (Chang, 2010:162).

Similar to Flege (1995), Chang (2010) also concerned himself with the idea of assimilatory versus dissimilatory phonetic drift. Based on the degree of similarity among sounds, Chang (2010) posits that the L1 phones would either drift towards the closest L2 phones (assimilatory effect) or away from them (dissimilatory effect). According to Chang (2010:71), dissimilatory phonetic drift could be anticipated especially in early bilinguals, who, according to Flege's concept of SLM, are likely to have formed separate phonetic categories for L2 sounds. In contrast, assimilatory drift could be anticipated in late consecutive bilinguals, who learnt L2 later in life and are, therefore, less likely to have formed separate L2 categories, following similar principles of SLM. When comparing average (mean) formant values of the English and Korean vowel systems, Chang (2010) indeed found the drift to be of an assimilatory nature, therefore, consistent with Flege's (1987) ideas initially introduced in the SLM.

Similarly, to the previous studies that considered other influences, in particular sociolinguistic factors, Chang's (2010) research suggests that L2 experience is one of the leading factors influencing L1 production. Previous research suggests a significant amount of L2 experience is needed for the phonological change to be evident. However, it remains unclear as to how much L2 experience is needed for these changes to become

apparent. Chang's work provides us only with approximate time-frames as his participants (late consecutive bilinguals) had been exposed to an L2 language for only a few weeks.

Overall, the collected evidence suggests that the Slovene-English late consecutive bilinguals under investigation in this study would be expected to undergo the process of L1 phonological change (or 'phonetic drift') even with a minimal exposure to the L2. Additionally, as the target group is bilinguals, who learnt an L2 later in life, assimilatory phonetic drift is very likely to be anticipated.

The questions arising from Chang's (2010) view of phonetic drift, rather than phonological change, are 'where the end point of phonetic drift can be placed?'; 'when would one start addressing it in terms of 'permanent' phonological change?'; is it an irreversible change in contrast to the 'subtle phonological restructuring in the L1 as a consequence of L2 experience'?' (Chang, 2010:249). The study at hand will aim to answer some of these questions, as it will not limit itself to novice, advanced or proficient L2 learners, but will examine all, in order to either provide further evidence in support of previously discussed theories/models or provide evidence that will contradict previous findings, adding much needed empirical evidence to the field of L1 phonological change.

Generally, the idea of phonetic drift bases its concepts mostly on the evidence gathered from the production of bilingual speakers. However, the perception and production are often correlated, and late consecutive bilinguals often experience difficulty in producing and perceiving non-native phonological contrasts.

2.1.9 Summary

The table below summarizes the key literature findings of this part of the chapter: it recaps and outlines each model's prediction for both L2 acquisition and L1 attrition.

Model	Explanation	Predictions for L2 acquisition	Predictions for L1 attrition
Speech Learning model (SLM) Flege (1987, 1995)	**Perception and production** Age factor Single common L1-L2 phonological space L1/L2 phonetic categories evolve over the life span	Early = More native-like Late = L2 sounds similar to L1 sounds (equivalence classification) No perfect / optimal bilingual No monolingual modes	Based on perceived phonetic distance (must be assessed empirically through cross-language mapping experiments) – cross language phonetic distance data needed However, based on the general predictions, we could propose: Late = L1 sounds similar to L2 sounds
Perceptual Assimilation Model (PAM) Best (1995)	**Perception**	Not explicit	Not explicit

	Naïve listeners categorize sounds according to phonetic and phonological familiarity.		
Perceptual Assimilation Model for Language Learners (PAM-L2) Best & Tyler (2007)	**Perception** Common L1-L2 phonological system Perception of phonetic elements L2 proficiency and experience	Late L2 learners = L1 phonology impacts L2 perception; L2 vocabulary size correlated with L2 speech learning Early L2 learners = language mode influences perceptual categorization of L1 and L2 contrast (Best, 2014)	Based on perceived phonetic distance (must be assessed empirically through cross-language mapping experiments)– cross language phonetic distance data needed
Phonological Interference Model (PIM) Brown (1998)	**Perception** L2 sounds map to L1 L2 contrast will not merge into L1 category UG plays a role	L2 sounds map to L1 Redeployment of L1 features L1 structure reused for L2 phonemes	Not explicit, however we could infer that L2 sounds map to L1 and consequently L1 is not affected
Ontogeny Phylogeny Model (OPM)	**Perception and production**	L1 and U play a significant role at the initial stages of L2	Possibly intermediate (between L1 and L2)

Major (2001)	Non -linear relationship between L1, L2 and U (language universals) Connected L1-L2 phonologies Chronological development	acquisition – however clear mechanisms not outlined	Connected L1 and L2 phonologies At the later stages of L2 acquisition and L1 attrition = diminished significance of L1 and language universals (U)
Second Language Linguistic Perception (L2LP) (Escudero, 2005)	**Perception and production** Two Separate perception systems Input > plasticity (age factor) Optimal perception hypothesis Access to Gradual Learning Algorithm (GLA)	L1-like development L2 ultimate attainment possible Auditory-driven Lexicon-driven Category formation, mapping adjustment	L1 is not affected = Optimal language modes
Native Language Magnet Model (NLM and NLM-e) Kuhl (1991, 2000) and Kuhl (2008)	**Perception** Perceptual magnet effect Linguistic experience	L1 maps & L1 categories	L1 is not affected
Phonetic Drift Chang (2010)	**Perception and production**	Merging of L1 and L2 sounds	Rapid phonetic drift and (subtle) phonological restructuring in the

	Perceptual linkage between similar sounds in L1 and L2 Linguistic experience		L1 as a consequence of experience in an L2

Overall, these models in their current states do not provide significant answers as to what will unfold during L1 phonological change in Slovene-English bilinguals, as it is still unclear which extralinguistic and intralinguistic factors may affect the L1 phonological change, specifically in late consecutive bilinguals. Therefore, the next section explores a range of factors that have been reported to be of significance to this L1 change.

2.2 Extralinguistic Factors influencing L1 Phonological Change

Previous studies suggest that a range of intralinguistic and extralinguistic factors may influence the degree of phonological change in late consecutive bilinguals. Pavlenko (2000:196) suggested that these factors could be divided into three clusters: (a) *individual factors* (learner's age and onset of L2 learning, learner's attitude, language proficiency and individual differences); (b) *sociolinguistic factors* (learning context, language exposure and language prestige); and (c) *linguistic and psycholinguistic factors* (language level, typological similarity of L1 and L2, developmental factors). To clearly address this categorization, there is a requirement to define the difference between the intralinguistic factors that will be addressed in the following chapter and the extralinguistic factors under investigation here. The extralinguistic factors refer to the factors that are external to the linguistic system in question (Slovene and English), whereas internal factors refer to the within-language differences or in other words differences between languages (De Leeuw, 2009). An example of a frequently cited extralinguistic factor that has influenced L1 phonological change is the quality and quantity of L2 input, and an example of an intralinguistic factor is the phonetic and phonological similarity of vowel sounds. Broadly, when considering Pavlenko's (2000) classification of factors, *individual* (a) and *sociolinguistic* (b) factors would comprise of extralinguistic factors, whereas linguistic and (c) psycholinguistic would cover much of what constitutes intralinguistic factors.

De Leeuw (2009: 35), while examining German-English late consecutive bilinguals, suggests that the intralinguistic factors are not adequate in accounting for first language phonological change, whereas extralinguistic factors play a significant role in determining the change in the individual. On the contrary, she acknowledged the possibility that extralinguistic factors may cause the changes within the intralinguistic factors and *vice versa*. Specifically, it is unclear which factors may be more influential and be the cause of the change (De Leeuw, 2009).

However, most of these factors have been considered and reviewed in second language acquisition studies. To date, no study in first language phonological change has considered the entire range of intralinguistic and extralinguistic factors – possibly

because it is too complex to cover in a single study. Amongst the factors that have been reported to influence the changes of the L1 bilingual's phonological system and may, in some cases, act as a specific constraint, are the age of L2 learning (the age at which learning of the relevant L2 begins) or arrival (AOA), length of residence (LOR) in an L2-speaking country, language contact with both their L1 and L2, gender, education, profession, and language learning aptitude. The importance of other variables has yet to be established, due to the lack of an adequate control in some studies and because many variables have the tendency to be conflated. Therefore, the aim of the following discussion is to try to establish which of these factors may be the most salient.

To begin, Pavlenko (2000:180) summarized some of the factors that she considered to be influential in the first language phonological change in late consecutive bilinguals: age of participants; age of acquisition (AOA); length of exposure (in the literature also referred to as length of residence - LOR) and; context of acquisition (Table 1). Table 1 also includes the language pairs under investigation, as well as the interpretation or outcomes of these studies. In addition to the list, several recent significant studies have been provided to contrast with those previously conducted.

It is important to note that the outcome of 'convergence' in this context would correspond with Flege's (1987) SLM, as these studies reported the merging of the various phonological categories. The outcome of 'shift' could therefore correspond with Chang's (2010) idea of phonetic drift, where phonetic categories momentarily shift away from the monolingual norms. Overall, when comparing these studies, it is apparent that a common denominator cannot be established and clearly it is difficult to conclude the most significant factors. For example, variation in AOA and length of exposure (often reported differently) make generalizability and comparison difficult in many cases. Nevertheless, it is clear that L1 phonological change does indeed appear in different stages as previously suggested by Sharwood-Smith (2007).

Table 1: A review of factors influencing L1 phonological change (adapted from Pavlenko, 2000:180)

Studies	Languages (L1/L2)	Ages	Age of acquisition	Length of Exposure (in years)	Context of acquisition	Outcome
Andrews, 1998	Russian-English	20-29	6-12	14-17	Natural and formal	Shift
Flege, 1987	French-English English-French	Mean 38 Mean 35	Post puberty	Average 12.2 Average 11.7	Natural and formal	Convergence and shift
Flege & Eefting, 1987	Dutch-English	Adults	12	6+	Formal	Convergence
Major, 1992	English – Portuguese	35-70	22-36	12-35	Natural	Convergence and shift
Williams, 1979	Spanish – English	14-16	11-16	0-3.5	Natural	Convergence and shift
Mennen, 2004	Dutch – Greek	Adults	15-24	12-35	Natural	Convergence
De Leeuw, 2009	German – English German –Dutch	Adults Adults	Average 25 Average 30	Average 38 Average 34	Formal and natural Formal and natural	Convergence Convergence
Chang, 2010	English-Korean	21-26	21-26	0 (up to 5 weeks)	Formal	sShift

Where researchers in previous studies used a variety of designs and methodologies, the results of the studies often appear contradictory. Therefore, the following sections will systematically review factors that have been considered to be influential (AOA, LOR, gender, language contact, education and profession as well as language aptitude through the use of other languages spoken) and examine in detail the influence of these factors in regard to Slovene-English late consecutive bilinguals.

2.2.1 Age of Arrival/Acquisition or the onset of L2 learning (AOA)

The age of arrival[11] (AOA) in the L2 country may coincide with the start of L2 acquisition or exposure to the L2. It can be defined as the age at which the subjects first arrive in a predominately L2 speaking country (Piske *et al.*, 2001). Consequently, as this study examines late consecutive bilinguals at the start of second language acquisition, the terminology used will be age of arrival (AOA). However, it ought to be noted that some participants in this study have been exposed to the L2 prior to being immersed in the L2 environment as it is reported that AOA may become more significant if it does not correlate with the age of acquisition, for example in the case where a bilingual is exposed to the language prior to immigration. What is interesting here is whether late consecutive bilinguals' AOA can influence the degree of accent in their L1. To explore this avenue, evidence from L2 acquisition studies need to be firstly examined.

In L2 acquisition studies, the AOA factor is more significant with early simultaneous bilinguals as their L1 is not yet fully developed and stabilized, in contrast to the system of late consecutive bilinguals, whose L1 is already fully developed. There may be two possible explanations. The first comes from the *Critical Period Hypothesis (CPH),* which suggests that as the brain matures the neural plasticity is lost. With the loss of the brain plasticity, there is also a decline in ability to learn a second language to a native-like proficiency. However, Oyama (1976) and Long (1990) suggested that, rather than referring to the critical period, there may be a so-called '*sensitive period',* where with age, the degree of foreign accentedness increases; specifically, with increasing age of acquisition, the likelihood increases that the learner retains an accent which shows traces of the L1. However, the more likely explanation can be found in

[11] Sometimes also referred to as Age of Learning (AOL).

the work by Flege (e.g. 1987) who suggests that the degree of foreign accentedness will depend on the amount of interaction between L1 and L2. Specifically, the more the L1 system is developed the more likely it will interact with the L2 system (Piske *et al.*, 2000).

Several other studies support this view that 'earlier is better', especially in relation to phonology. This was particularly apparent in Yeni-Komshian, Flege & Liu's (2000) study on 240 adult Korean-English immigrants, who differed in AOA (AOA 1-23). Half of the experimental group was of 12 years or older and half of the experimental group younger. Consequently, Yeni-Komshian, Flege & Liu's (2000) suggested they could be divided into two distinct groups: early simultaneous bilinguals and late consecutive bilinguals.[12] In order to measure both L1 and L2 accentedness, they further divided the experimental group into 10 subgroups based on AOA and included two monolingual (control) groups. In regard to their L2 (English), bilinguals who immigrated early or at a very young age (AOA 1-5) had relatively high pronunciation scores, but they performed different from the monolingual (control) group, whereas the bilinguals who immigrated later (AOA 6-13) were reported to have heavier foreign accents. In regard to their L1 (Korean), the poorest pronunciation was evident in those bilinguals whose AOA was of 1-7 years, whereas the Korean pronunciation of the majority of bilinguals who immigrated to USA after the age of 12 (late consecutive bilinguals) were in par with the Korean monolinguals. Yeni-Komshian, Flege & Liu (2000) argued this is not a proof for an existence of the CP, but rather evidence[13] of a combined system,[14] where both L1 and L2 are continuously interacting (other intralinguistic factors). Interestingly, at the start of the study Yeni-Komshian, Flege & Liu (2000) also aimed to prove an inverse relationship between L1 and L2 pronunciation proficiency. They only partly succeeded, as they have proved this inverse relationship exists in early simultaneous bilinguals (AOA 1-2). However, they were unable to do so with late consecutive bilinguals, as their L1 scores remained relatively unchanged and consistently high.

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[12] Yeni-Komshian, Flege & Liu's (2000) based their claims on the assumptions and studies surrounding CPH. In particular, they reference Lennenberg (1967), who claimed CP is between the ages of 2 and 12 and earlier Penfield & Roberts (1959), who claimed CP is between the ages of 9 and 12. Although, they do acknowledge that numerous later studies disputed these views.

[13] In their work referred to as *Interference or Interaction Hypothesis (IH)*

[14] Referencing Flege's (1995) SLM hypothesis: with increasing age, bilinguals with have difficulties forming new phonetic categories

De Leeuw (2009) presented similar results to those of Yeni-Komshian, Flege & Liu's (2000). In her doctoral thesis she examined global foreign accent in 34 L1 German-English late consecutive bilinguals and 23 L1 Dutch-English late consecutive bilinguals.[15] She found a similar inverse correlation between AOA and FAR (foreign accent rating) previously mentioned by Yeni-Komshian, Flege & Liu's (2000), as the German-English bilinguals who moved to Canada earlier were the more likely to be perceived as non-native speakers of German. However, in contrast to Yeni-Komshian, Flege & Liu (2000), she did not examine early simultaneous bilinguals in order to be able to compare her findings conclusively. Additionally, analysis conducted by De Leeuw, Schmid & Mennen (2010) suggested that quality and quantity of L1 contact is more significant than AOA and LOR (length of residence).

The findings of a study by Baker and Trofimovich (2005) on early and late L1 Korean-English bilinguals was also in accord with these previous findings: age at the time of L2 acquisition influenced both the degree and the direction of the L1-L2 interaction. The early simultaneous bilinguals were able to produce distinct acoustic realizations of L1 and L2 vowels to a greater degree than were the late bilinguals (Baker & Trofimovich, 2005: 20). Specifically, Baker and Trofimovich (2005) provided evidence that for the late consecutive bilinguals, L2 (English) did not impact the production of L1 (Korean), however L1 had significant effect on their L2.

Numerous studies provided evidence for this view (Flege *et al*., 1999; Oyama, 1976; Long, 1990). However, some studies provided counter evidence: as native-like pronunciation is possible after the 'critical' or 'sensitive' period. For example, Bongaerts *et al*. (1997) found five adult Dutch learners with native-like English pronunciation and Moyer (1999) found an English adult speaker with native-like German pronunciation. However, it should be noted that after closely reviewing the studies it is clear none of these subjects started to learn their L2 after the age of 16.

Similarly, Köpke & Schmid (2004:6) suggest that the degree of L1 change can be 'quite dramatic'; particularly if the L1 attrition process starts well before puberty. Primarily, Köpke & Schmid (2004) are referring to the process of L1 language change in early simultaneous bilinguals. They claim that this significant amount of L1 change is due to the linguistic system not being stabilized. In contrast, previous evidence strongly indicates that late consecutive bilinguals display far less L1 change than early

[15] The assumptions that all participants are late consecutive bilinguals is based on the report that all participants have moved to Canada or The Netherlands in late adolescence or adulthood.

bilinguals. Consequently, Köpke & Schmid (2004:6) call for a distinction between *age of the onset of bilingualism* and *age at the onset of attrition.* Specifically, late consecutive bilinguals, even after decades spent immersed in the L2 environment, seem to show surprisingly low results of L1 change (Köpke & Schmid, 2004:6)

However, the question remains as to what happens when bilinguals who have learnt the L2 continue to use their L1. The answer remains unclear. What is clear from the above review is that L2 acquisition is hampered by L1 (AOA plays a significant role) and L1 attrition in adults is far less evident than in children (Köpke & Schmid, 2004). Thus, L1 change, in contrast to L2 acquisition, shows disjointedness around puberty.

2.2.2 Length of residence (LOR)

The variable almost as frequently examined as AOA, particularly in second language acquisition studies, has been the length of residence (henceforth LOR). Generally, the LOR is a variable that indicates the amount of time spent in a L2 environment. Therefore, it is logical to assume that the LOR in the L2 environment will not only impact L2 acquisition, but also first language (L1) phonological change, as the longer the bilinguals stay in a second language environment, the more likely it is that they will exhibit change.

Despite LOR being one of the most examined variables, previous studies produced conflicting evidence as to whether the increased time spent in an L2 country improves L2 accuracy and changes L1 pronunciation. For example, Laufer's (2003) study of Hebrew-Russian bilinguals assessed various variables and concluded that LOR will have the strongest impact on first language attrition. Whereas, de Bot *et al.* (2007) emphasized that the variable of length of residence in the L2 country can be influenced by other variables such as L1 language contact. Evidently, the variable becomes less significant when a higher degree of L1 contact is received.

Furthermore, the research into LOR foreign accent ratings suggests a non-linear correlation (Piske *et al*., 2001), as near native like bilinguals do not benefit from additional years of experience and do not display any significant changes. For example, de Bot and Clyne (1997) suggested that certain features of a migrant's native language are susceptible to change only in the first years after migration. Figure 20 presents De Bot's (1999) interpretation of possible outcomes of L1 language attrition/change that is highly depended on L1 use. Yilmaz & Schmid (2018) also acknowledged this idea as

they argued L1 may reach a certain level of stability during the L2 acquisition process. However, they argue that after such level is reached frequency of use may become less relevant, and any observed changes in the L1 may be more indicative of the failure to acquire the L2 rather than the ability to access the L1.

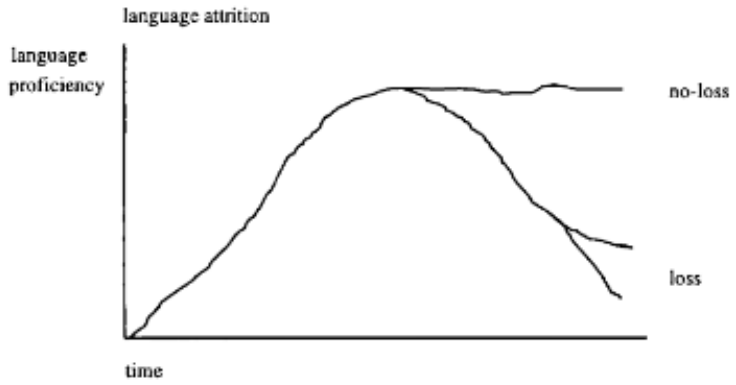

Figure 20: Possible outcomes of L1 attrition (De Bot, 1999:146)

Similar observations have been also noted in previously mentioned work by de Leeuw (2009), who reported similar findings: in her study of 34 L1 German-English migrants where the LOR of 10 years or more was reported, migrants no longer displayed significant effects, again suggesting that the first years after immigration could be the most significant for L1 phonological change.

However, Flege and Liu (2001), while analyzing the Chinese-English late consecutive bilinguals, suggested that the LOR in the L2 country indeed plays a more significant role as the quality and quantity of the L2 native input substantially influenced bilinguals' perception and production. The Chinese-English bilinguals with the adequate amount of input showed positive correlation with the LOR, meaning their performance improved as the LOR increased. Therefore, it is logical to assume a linear relationship between L1 phonological change and the LOR: as the LOR increases (time spent in an L2 environment), the amount of L1 change increases. Specifically, it is likely that L1 change or attrition is "preceded by a reversal and depends on time in a similar way" as does L2 acquisition (Köpke and Schmid, 2004:8).

Overall, what is clear is that the variable of LOR is considered influential only in the initial years after migration, as previous attrition studies find no or very little evidence of change after 10 years, the L1 system remains surprisingly stable (Köpke

and Schmid, 2004:8). Additionally, this variable becomes more significant when little or no L1 contact is present. Consequently, as one of the aims of this study is to explore the effect of sociolinguistic variables on the Slovene-English late consecutive bilinguals, who reported LOR between 1 month and 16 years, this variable may be of particular interest, as it could be compared to the results obtained from the previous studies mentioned above.

2.2.3 Language contact

The theory of the *Subsystem Hypothesis* proposed by Paradis (2007, 2004:28), incorporated the role of language contact as it claims that "every time an item is activated, its threshold is lowered and fewer impulses are required to reactivate it", suggesting more frequently used items will be more available than the ones that are rarely used (*Activation Threshold theory*). In other words, the more contact the bilingual has with L1 speakers the more likely he/she is to be able to retrieve the necessary information. Paradis (2007) further claimed that it is equally applicable to early simultaneous bilinguals as it is to late consecutive bilinguals, due to two independent subsystems that act as one. However, Activation Threshold theory mostly predicts the outcomes for lexical and grammatical items, which suggest that the phonological level may not be affected by this hypothesis. On the other hand, it may be applicable to sounds and sound structures that are less frequent than others.

Although language contact is thought to be one of the more significant extralinguistic factors influencing L1 phonological change, there is limited direct evidence that the amount of L1 language change is dependent on the amount of language being used in everyday life. For example, Köpke and Schmid (2004) claimed that it is difficult to measure the degree of L1 contact as it may be impacted by the individual's attitude towards their first language. Amongst others, two studies that reported a positive correlation between infrequent L1 use and a higher degree of language change in the L1 (de Bot, Gommans & Rossing, 1991; Köpke, 1999). De Bot *et al*. (1991), for example, found direct evidence of the amount of L1 contact and the time elapsed since immigration impacting the degree of L1 change on Dutch immigrants in France. However, they noted that time only becomes significant when there is decreased amount of L1 contact.

In contrast, Jaspaert and Kroon (1989) reported a negative correlation between L1 use (daily) and language change, as some bilinguals performed worse. However,

there may be several reasons for this negative correlation, such as the quality of L1 input that these speakers might have received in the L2 community. Interestingly, Stevens (1999) found evidence in bilinguals' performance. She compared children of immigrants in the United States, who were more likely to receive a higher level of L2 input, as they are usually enrolled in school with the adult immigrants, who are more likely to frequently use their L1.

Further, de Leeuw (2009) suggested that L1 language contact has a more significant effect on L1 change in German-English and German-Dutch late consecutive bilinguals than AOA and LOR. In their study, they also differentiated between two types of L1 contact based on code-mixing: 1) represented communicative settings in which little code-mixing between the L1 and L2 was expected to occur *and* 2) represented communicative settings in which code-mixing was expected to be more likely. They concluded that the second type of contact is the more conducive to maintaining a bilingual's L1. This suggests that the extralinguistic variable of L1 language contact is far more complex and current studies should not only examine the frequency of L1 use, but also the type.

Similarly, Schmid (2007a:150) suggested that language contact after all plays a less important role than was first anticipated, as 'quality of the contact might be more important than the quantity'. This was evident in her study, where she distinguishes between two different types of modes which bilinguals operate under: the bilingual and monolingual mode. In the monolingual mode speakers actively use one particular language; whereas in bilingual mode, speakers use both languages simultaneously and actively. In the latter mode, it is also more likely that the bilingual will employ code mixing (Schmid, 2007a), especially when part of an immigrant community. Köpke (2004), even suggested that the first language change of the bilinguals that are part of an immigrant community may not follow the same principles as first language change in more isolated immigrants, who have none or very little contact with their L1. L1 and L2 use are conditioned by the social context of the individual; for example, younger individuals will be more motivated to fit into the L2 environment, consequently using their L2 more frequently and decreasing their use of L1. Additionally, younger individuals will be more likely to operate in a bilingual mode (using two languages interchangeably), whereas older individuals are more likely to operate in a monolingual mode (Grosjean, 2001).

Most of the studies and conclusions drawn are ambivalent as there are particular difficulties as to how to measure language contact and use. Most researchers rely on

self-reporting, which is not always accurate and may differ from individual to individual. Furthermore, it is difficult to establish what kind of language contact is the most significant. For instance, would, reading a newspaper article be sufficient for maintaining language proficiency or do bilinguals require a more 'active' use of language? This study will aim to answer these questions and will address these factors in its methodology.

2.2.4 Education

Thus far, the factor of level of education has been largely neglected by researchers, likely due to methodological as well as sociocultural issues (Köpke & Schmid, 2004). However, some linguists have attempted to address the significance of it. For example, the impact of the level of education has been examined in the work of Jaspaert and Kroon (1989) in their pilot study of 30 Italian migrants in the Netherlands. The results showed that the likelihood of migrants with a higher level of education to retain their L1 proficiency was high, in comparison to the migrants with a lower level of education. Similarly, Pelc (2001) measured the impact of this factor in L1 Greek – L2 American English migrants, by examining the number of years spent in L1 education and the number of years spent in L2 education. She established that the number of years of education in their L1 environment in Greece significantly impacted migrants' linguistic performance in their L1.

Further evidence was found in Yagmur *et al.*'s (1999) study, where the level of education was an independent variable. This study on Turkish migrants in Australia illustrated that L2 proficiency is intrinsically linked with the level of proficiency in the L1; the higher the level in L2, the higher the level in L1 proficiency (Yagmur *et al*., 1999). Therefore, it could be posited that the variable of education is highly significant because it is subsequently intrinsically linked to the literacy level (Flege & Eefting, 1987; Major, 1992). Köpke (2007:12) supported the idea of literacy and attrition being linked, as she claimed, "less attrition is to be expected in subjects who have had the opportunity to become literate in the L1, especially if they frequently use that skill." Corroborating Köpke's (2007) statement was Herdina and Jessner's (2002:104) study, which found that the "erosion of the system underlying language competence is more likely to affect less well-educated and/or less communicatively oriented speakers." Consequently, further attention should be paid to whether any part of the participant's education has taken place in the L2 country, as this may indicate their proficiency levels

or their L2 literacy level; specifically, this may significantly impact L1 phonological change.

Overall, it appears that the factor of education may be of high significance, particularly in relation to the Slovene-English late consecutive bilinguals, who may have been both educated in Slovenia and continued their education in the UK. Therefore, similarly to the methodology employed by Pelc (2001), this study will, through the use of a sociolinguistic questionnaire and interviews, aim to examine how much of the participant's education has taken place in the L1 and L2 country to establish how this may have contributed to their L1 phonological change.

2.2.5 Gender

In a similar way to other variables, the variable of gender has been previously explored in second language acquisition studies. However, most studies have not identified gender as a significant predictor of L2 foreign accent. Furthermore, so far very few studies have examined the impact of gender on first language phonological change, particularly as an independent variable.

One of the few studies that examined this, was Flege *et al.* (1995) who claimed that previous studies have provided opposing results in regard to the gender impact (Asher and Garcia, 1969; Tahta *et al*., 1981a; Thompson, 1991; Purcell and Suter, 1980). In their study, they suggested that females are more likely to be perceived as native speakers of a second language than males. These conclusions were based on the results of foreign accent rating task that showed female speakers receiving higher ratings than male speakers. Furthermore, the results were analyzed using a two-way ANOVA (Analysis of variance) to explore the significance of the simple effect of gender in relation to age of arrival (AOL). Females received higher ratings than the males matching for the AOL. However, further multiple regression analyses suggested that females that learnt English in childhood may be perceived as less accented in adulthood, but males who learnt English in adulthood will outperform females. Overall, Flege *et al*. (1995) acknowledged the variance in results and suggested other factors may bear higher significance than gender. In contrast to Flege *et al*. (1995) within the context of first language phonological change, Köpke (1999) found no significant differences between the genders.

Overall, due to the lack of conclusive results and a significant gap in existing literature, it is difficult to predict the impact of this factor, particularly in regards to first

language phonological change. Therefore, the results of the present study will significantly contribute to the current gap in knowledge.

2.2.6 Language aptitude

In general, the extralinguistic variable of language aptitude refers to the ability to learn foreign languages. Several 'tests' have emerged claiming to accurately measure language aptitude (e.g. MLAT: The Modern Language Aptitude Test). Even though language aptitude may play a significant role when establishing how well individuals are able to learn a language and equally maintain their L1 competency, the research into the impact of language aptitude on first language phonological change have been vastly neglected, due to the fact that there is no established methodology as to how to measure this factor (de Leeuw, 2009; Meara, 2006).

Therefore, due to considerable variation amongst researchers about what components make up language-learning aptitude, this study takes a novel approach to measuring and exploring one facet of language aptitude, though the number of languages spoken by late consecutive bilinguals. This decision is firstly based on the fact that, since MLAT emergence, more or less successful efforts have been made to produce similar measures for other languages such as Japanese, Polish, Swedish and Hungarian; however, to date, no such test has been created to measure language aptitude in the Slovene language.[16] Secondly, following the most basic definition of language aptitude "the potential to learn languages", one may propose that knowing several languages indicates a higher language aptitude and subsequently presents a good measure of it. However, it is important to note that language aptitude is far more complex than just "knowing" several languages.

Nevertheless, this variable has been examined in second language acquisition studies, however, to date, only one study is regarded as also being relevant to first language change. Bylund, Abrahamsson and Hyltenstam (2010) conducted a study on 25 Spanish-Swedish pre-pubescent bilinguals residing in Sweden. In order to measure language aptitude, they used the Swansea Language Aptitude test (Meara, 2003), with the aim to test the correlation between language aptitude and grammatical intuition and

[16] However, there are other language aptitude measures that are language independent such as LLAMA that contain four sub-components: vocabulary acquisition, sound recognition, sound-symbol correspondence and grammatical referencing (Maera, 2003).

processing. The results evidenced that the bilinguals achieved significantly lower scores than the control group; the difference was statistically significant as they underperformed in contrast to the control group. As a possible variation among individuals' scores, they suggested language use and differing length of residence (LOR: 12-42yr), however, no correlation was found among these variables. Based on these results, they rejected their hypothesis, which predicted a higher level of attrition among the individuals with increased L2 proficiency. Not only do the results suggest that the bilinguals could further develop their L2 proficiency, but they also indicate that bilinguals could retain a high level of proficiency in their L1. To some extent, these results may be incidentally linked to the previously mentioned factor of level of education and literacy, where higher level of education suggested higher level of L1 retention and less L1 attrition or change. Bylund, Abrahamsson and Hyltenstam (2010) also posited that these results should further be confirmed by correlating language aptitude with other language proficiency measures such as production data.

However, due to the lack of evidence, the impact of this variable on L1 phonological change in late consecutive bilinguals is unknown. Nevertheless, two predictions similar to Bylund, Abrahamsson and Hyltenstam' study (2010) could be made: language aptitude is related to L1 proficiency and promotes high levels of proficiency in L2. Based on these predictions, it could be hypothesized that the Slovene-English late consecutive bilinguals, with knowledge of several L2s, will display less L1 phonological change.

2.2.7 Summary

Prior to specifically addressing the procedure and methodology undertaken to examine whether or not Slovene-English late consecutive bilinguals undergo first language phonological change and which of the above extralinguistic factors may be influencing L1 change, it is essential to address the cross-linguistic differences between the two languages in question, consequently addressing the intralinguistic factors that may affect Slovene-English bilinguals. In particular, the next section will aim to review the current literature regarding the phonology of both languages and explore the phonetic and phonological similarities between them.

2.3 Intralinguistic factors influencing L1 Phonological Change

This section of the literature review assesses the impact of intralinguistic factors and cross-linguistic differences between the two languages under examination: Slovene and English; and examines how and if these differences may contribute to L1 phonological change. It firstly reviews scarce literature on the vastly under described Slovene language. Most of the previously published literature that examined Slovene language has not been translated into English, exacerbating the knowledge gap. Therefore, this study will not only fill the knowledge gap by focusing on the Slovene language, but also discuss Slovene work in the English language. Therefore, the first part of this chapter focuses on the Slovene language and in particular the phonological aspects of it.

The second part of this section closely examines the acoustic and perceptual similarity of the Slovene and English language, as it contributes to the underlying intralinguistic factors that may impact the restructuring of the first language vowel system of late consecutive Slovene-English bilinguals. Specifically, it considers a single phonological system of bilinguals and mechanisms (assimilation or dissimilation) that bilinguals may undergo during restructuring of their L1 (see Flege *et al*., 2003).

The aim of this section is to firstly present some of the general concepts of phonetics and phonology that directly concern this thesis and consider the overall organization of the bilinguals' phonological system, which may contribute to the overall outcome of Slovene-English late consecutive bilingual's L1 phonological change. Secondly, it examines various types of phonological similarity (acoustic similarity, allophonic similarity and phonemic similarity) and considers the impact of such similarities on language change.

2.3.1 General concepts

It is first necessary to define and understand the relationship between phonetics and phonology, in order to address the question of what intralinguistic factors, or specifically, what kind of phonetic or phonological factors determine the extent and direction of the phonological change for any given vowel. At a basic level, Sommerstein (1977:1) describes phonetics and phonology as:

'Phonology is a branch of linguistics; phonetic is often considered not to be. Phonetics deals with the capabilities of the human articulatory and auditory systems with respect to the sounds and prosodic features available for use in language, and with the acoustic characteristic of these sounds and features themselves. Phonology, in a sense, begins where phonetics leaves off. It is concerned with the ways in which sounds and prosodic features defined by phonetics are actually used in natural languages' (cited in Ohala, 2010: 654).

However, several linguists have questioned this sharp division and basic outline between phonetics and phonology. Flemming (2001:8), for example, argues that phonology and phonetics cannot be distinct, as linguists are faced with the dilemma that much of the phonological representations omit language specific phonetic details. Therefore, he suggests that linguists must either enrich the phonological representation or add a component that will account for these language specific phonetic details. Much of the subsequent work in this area adopted the second, more conservative view in order to retain standard representations (Flemming, 2001:8).

Ohala (1990:1) also suggested that the two disciplines cannot be considered autonomously and the integration of the two disciplines would allow researchers "to explain sound patterns in language in terms that have greater simplicity, generality, empirical verifiability, fruitfulness and convergence". Nevertheless, the lack of the criteria for the distinction between phonetics and phonology makes it sometimes difficult to assign one particular phenomenon to either of the components. Ladefoged (2001) claims that the lack of this criterion makes it especially difficult when testing a hypothesis, as it may be unclear whether the data under examination is relevant or irrelevant to the area of phonology.

Consequently, the question of how strong the relationship between phonetics and phonology is and how phonetics and phonology interact has also been explored. Chang (2015) suggested a hierarchical relationship; the crucial point being that phonology is privileged (higher-ranked) and relative to phonetics (Chang, 2015). Similarly, Flemming (2001) suggested that the 'best' solution to the problem of phonetics versus phonology would be by analyzing both 'phonetic' and 'phonological' phenomena within a unified framework.

This idea that the phonetic and phonological level may be structured in a hierarchal way was further explored by Laeufer (1996), who applied it to the L1 and L2 bilingual system. Laeufer (1996) proposed the organization of the bilinguals' production on: the phonological level at the top, the phonetic level in the middle and

the realization level at the bottom (Figure 21). Based on this model, Chang (2010) provided an example of such a system. The voiceless bilabial stops in English and Spanish could both be represented at the phonological level as /p/. At the phonetic level, there would be a differentiation of the English aspirated [p^h] and the Spanish non-aspirated [p]. The realization level would consist of the actual phonetic characteristics, such as duration of the voicing and how long after release the voicing starts (Chang, 2010).

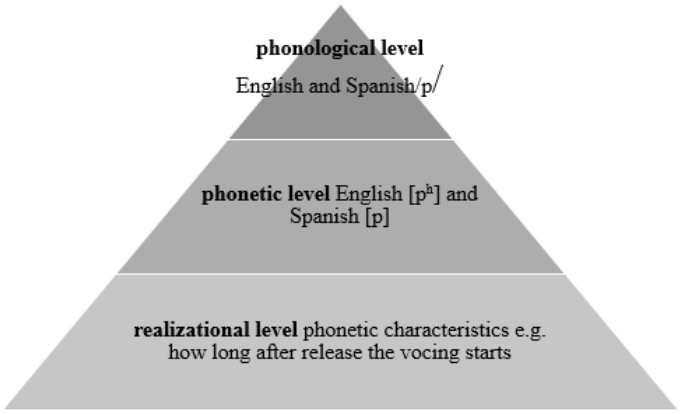

Figure 21: Hierarchal model of English-Spanish bilingual system

Expanding on the idea that the bilinguals' systems may be linked (Mack, 2003), Paradis (2001) previously suggested three main types of bilingual's phonological organization: the coexistent system, merged system and super-subordinate system. He suggested that the organization of the system in a coexistent way (Figure 22a) would typically be observed in very proficient early simultaneous bilinguals that display native-like production in both languages. In this system, it is unlikely that the sounds would be influencing each other (example study Guion, 2003).

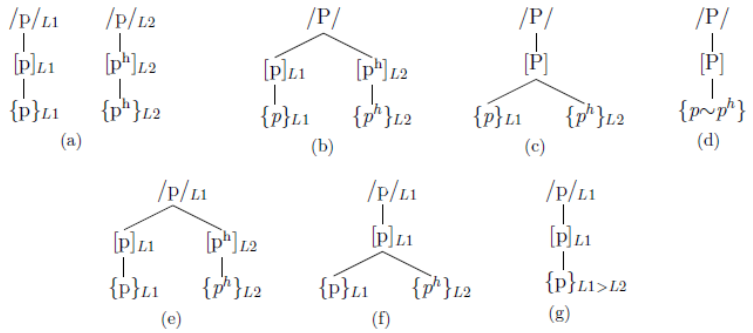

Figure 22: Possible organizations of the bilinguals' phonological system (voiceless stop /p/) based on Laufer (1996:329). The top level represents the phonological level, followed by the phonetic level and representation level is presented at the bottom of the structure (cited in Chang, 2010:52):

(a): an example of a coexistent system;

(b) – (d): example of different types of merged systems;

(e) – (g): example of different types of super-subordinate systems

A merged type of system may be observed in late consecutive bilinguals with a higher level of L2 proficiency. This merged system could be further differentiated on the basis of a perceived distance among the sounds (Figure 22 b-d): if a bilingual perceives a sound in the L2 as relatively distant to the sound in the L1 (Type 1); if the bilingual perceived an L2 sound as relatively close to the sound in the L1 (Type 2) and; if a bilingual perceives L1 and L2 as virtually identical (Type 3) (Laeufer, 1996).

The last organization of the bilinguals' system may be in a super-subordinate way (Figure 22e-g), which may occur with late consecutive bilinguals that had little exposure to the L2 and are less proficient in the L2. In this organization it is likely that only the L1 sound is produced in a native-like way, therefore, Laeufer (1996) and Chang (2010) proposed further differentiation on the basis of how L2 sounds are mapped onto the L1 sounds (See Chang, 2010:52).

Considering the above concepts, it is firstly suggested that the bilinguals' L1 and L2 phonological systems are not entirely separate. Secondly, based on the bilinguals' proficiency level, the late consecutive Slovene-English bilinguals under investigation here would be expected to have their phonological system organized either in a merged or super-subordinate way, as they have first acquired Slovene language before acquiring English. Additionally, the organization of Slovene-English may be depended on the level of L2 proficiency. Nevertheless, due to the absence of supporting evidence in the Slovene literature, it is difficult to accurately predict the overall organization of the two, never-before analyzed and compared phonological

systems of Slovene and English. Therefore, this part of the study aims to contribute to the theoretical understanding and add supporting evidence to the existing literature.

To recapitulate, according to Baker and Trofimovich (2005), a variable that may determine how bilinguals organize their phonological system is a degree of perceived similarity between L1 and L2 sounds or, in other words, cross-language similarity. In the past, there have been several theoretical L2 models that aimed to address this perceptual similarity. Amongst the most critically reviewed are the previously discussed Speech Learning Model (SLM) proposed by Flege (1987), Kuhl's Native Language Magnet model (1991, 1992), and more recently Best's (1995) Perceptual assimilation model (PAM) and Best & Tyler extension of this model - PAM-L2 (2007).

As previously discussed, Kuhl's Native Language Magnet model (NLM) suggests that in childhood, native phonemic categories are developed. Consequently, in adulthood listeners will have difficulties developing new non-native phonemic categories, as native categories have a magnet-like effect, which makes it difficult to discriminate between native and non-native sounds (Kuhl *et al*., 2008). In contrast to SLM (Flege, 1987), NLM predicts an asymmetry for the discrimination, as the prototypes will fail to be developed due the lack of relevant acoustic experience. However, neither of the theories can comprehensively account for variations in non-native discrimination, especially in a case of presence/absence of features in the listeners' language (Best *et al*., 2001).

These shortcomings and theoretical gaps were addressed in Best's (1995) Perceptual assimilation model (PAM) and Best and Tyler's (2007) extension of this model PAM-L2, which incorporated the principles of phonological theory and explored some of the difficulties that the learners experience when producing and perceiving non-native phonological contrasts. The suitability of PAM was also confirmed in Guion *et al*.'s (2000) study on identification and discrimination of the English consonants by Japanese learners, where they found that the PAM is best suited for L2 discrimination. Due to its significance to the perceptual similarity of the sounds, the implications of both PAM and PAM-L2 models will be closely considered in the following sections, particularly when addressing the results of a combined analysis that will measure and test perceptual similarity of Slovene and the English phonological system.

2.3.2 Types of similarity

Late consecutive bilinguals are often disadvantaged in terms of identifying and discriminating second language phonemes, as they are not employed in their first language phonetic system. Therefore, it is no surprise that there has been an increased interest in cross-language comparisons, particularly when monolinguals are acquiring a new language system. This difficultly of discriminating phonemes that late consecutive bilinguals often experience in producing and perceiving non-native phonological contrasts was already addressed in the theoretical framework of PAM-L2 (Best & Tyler, 2007), which explores phonological and phonetic similarity and considers how it can be influential to the production and perception of bilinguals. As previously discussed, Best and Tyler (2007) proposed that the perception of L2 vowels is guided by the L1 vowel inventory, meaning that the L2 learners with a smaller L1 vowel inventory than in their L2 inventory are more likely to identify a specific L2 sound as 'similar' or 'identical' to the one in their L1 (Iverson & Evans, 2007), consequently 'merging' the sounds (Flege, 1995). However, as stated previously, the question of how the phonological and phonetic levels interact and how differences are resolved has not been fully addressed in the PAM-L2 theoretical framework. For example, PAM-L2 does not address the issue of the phonological and phonetic inconsistencies that may occur and have been reported in the previous studies.

This mismatch between phonetic and phonological similarity was (among others) addressed by Chang (2015). He firstly distinguished between three types (subsets) of phonological similarity: objective acoustic similarity, language-specific allophonic similarity and cross-linguistic phonemic similarity. Firstly, the acoustic or measured phonological similarity refers to the actual measured distance between sounds in a phonological space in terms of frequency, duration and amplitude (Raimy & Cairns, 2015: 200). It is objective and not specific to any language (Chang, 2015). An example of such similarity can be seen in the results of Johnson and Babel's (2010) study of speeded discrimination task in which individuals are asked to classify a sequence of stimuli. The results showed native Dutch and English native speakers require additional time to distinguish between acoustically similar sounds [f] and [θ] and acoustically dissimilar sounds [s] and [θ]. Chang (2015) suggests this could be considered as evidence that acoustic similarity surpasses linguistic knowledge (cited in Raimy & Cairns, 2015).

In contrast to acoustic similarity, allophonic similarity is language specific and focuses on within-language comparisons between sounds. For example, a pair of sounds that are allophonically similar may not be contrasted within a language or they may be easily exchangeable in speech production (Johnson and Babel, 2010). Chang (2015), therefore, suggests that listeners of different languages could perceive these pairs of sounds differently. He supports this with the evidence that the English speakers, who contrast [d] with [ð], however may also exchange it with [ɾ] sound in speech production, as they may perceive the [d] sound to be more similar to the [ɾ] sound.

This may resemble Brown's idea (2000) of a Feature based Model (FBM), which suggests that if a learner's native grammar is missing a feature that exist in an L2 or in the target language, the learner may be unable to perceive the non-native distinction in the target language. Even though this idea is logical, many studies failed to find supporting evidence. For example, Barrios *et al*. (2016) who designed two experiments to test the predictions of Brown's (2000) hypothesis, discovered that both experiments failed to find evidence for the predicted difference between /i/-//ɪ/ and /ɑ/-/æ/.

Lastly, phonemic similarity is cross-linguistic and refers to the sounds in two languages. For example, American English and Mandarin Chinese both contain a vowel sound /u/, however, this vowel sound differs substantially in quality and is therefore phonemically closer to the Mandarin vowel /y/. Phonemic similarity may be further described in terms of similarity between two sound structures (Chang, 2009b). It is often central to studies in first (L1) and second (L2) language perception (Best & Tyler, 2007), studies in L1 and L2 production (Major, 1987b) and cross-linguistic interaction in bilingualism (Flege, 1995). The majority of researchers address this aspect of their study in terms of eliciting speech perception or production data. However, Chang (2009b) points out that this data alone may not be sufficient, as the results may not converge. Specifically, he suggests that the bilinguals' phonological system should be considered in a more holistic way taking into consideration multiple variables (i.e. intra and extralinguistic factors).

In contrast to the above studies, Escudero (2005, 2009) reported that the perceptual similarity straightforwardly predicts acoustic similarity. In her model of Second Language Linguistic Perception (L2LP) she suggests 'listeners are optimal perceivers of their native language and that beginning L2 learners start with a copy of their L1 perception' (cited in Boersma & Hamann, 2009:15). Additionally, Escudero (2005) proposes the L2LP model may account for both theoretical and methodological

discrepancies in previous studies. For example, in contrast to PAM and PAM-L2, she suggests auditory perception rather than articulatory perception. Interestingly, she also argues for the idea of separate language systems. In particular, she suggests that the bilinguals' L1 will not be affected by learning a second or additional language and the bilinguals will maintain their optimal L1 perception. This contrasts with the model of SLM (Flege, 1995), which suggested that the L2 development will inevitably affect the L1 perception and consequently production of L1 sounds.

Overall, models of L2 speech often base their predictions on the degree of similarity between the sounds of the learners' first language (L1) and the sounds of the target language (TL) (e.g., Best, 1995; Best & Tyler, 2007; Flege, 1995; Kuhl & Iverson, 1995, among others), yet there is still debate over the best method of assessing cross-linguistic similarity. To establish cross-linguistic differences between the Slovene and English language, as well as the possible impact of intralinguistic factors on the late consecutive Slovene-English bilinguals, this study measured acoustic similarity and tested perceptual similarity of vowels in the Slovene and the English language. The methods and procedures used in these tests are presented in the next section.

2.3.3 Phonological similarity experiments

The aim of this phase of the study is to first present the Slovene background and the cross-linguistic differences between the Slovene and the English language; outline the methods and procedures used to measure acoustic similarity and test perceptual similarity of Slovene and English vowel sounds, in order to address part of the first research question (in bold):

Research question 1: Is there evidence of phonological change in the L1 Slovene vowel system of late consecutive Slovene-English bilinguals?

a) Does this happen in certain vowels more than others?
b) **If there is a variation between vowels, what phonetic or phonological factors may determine the change for any given vowel?**
c) Are these changes uniform or only prominent in certain individuals?
d) Which extralinguistic factors may determine this particular change?'

These experiments were conducted prior to the production experiment and the Global foreign accent-rating task (see Chapter 3) with the aim to test previous proposals that suggested that the phonological change could be predicted by measuring the acoustic distance between (vowel) sounds. In order to confirm the validity of measured acoustic similarity results, a 'tested perceptual similarity experiment' was conducted. The participants were asked to identify a single stimulus (a vowel sound) in terms of an L1 category and subsequently provide a goodness of fit rating. Consequently, the overall discussion of these findings follows, with the aim to review the impact of acoustic and perceptual similarity (intralinguistic factors) on the L1 phonological change of Slovene-English late consecutive bilinguals. Specifically, the discussion aims to account for any changes that may occur on the level of individual vowel sounds, which is evident from the production part of the experiment.

2.3.3.1 Measured acoustic similarity

Prior to outlining the procedure and results of measuring acoustic similarity, it is necessary to review the essential background of the vastly under-researched and under-described Slovene language and present the cross-linguistic differences between the two languages under examination in this study: Slovene and English.

2.3.3.1.1 Slovene Language Background

The majority of European languages and some Asian languages bear certain similarities; therefore, based on extensive research linguists proposed they originate from the same language. They believe these languages go back to the so-called Indo-European proto-language, which was spoken approximately three thousand years ago in the territory between Eastern Europe and Asia. Although the Indo-European proto-language has never been officially recorded, linguists were able to partially reconstruct its features based on the similarities of modern languages. Consequently, linguists suggest that the Slovene language developed from Praslovanščina (the Proto-Slavic language), which developed from the Indo-European language in the 5th century BC (Greenberg, 2006).

The ancestors of modern-day Slovene were assumed to have populated the territory currently known as Slovenia in the second part of the 6th century. However, it

was not until the 10th century that the Slovene[17] language was recorded in a written form. The first official records were written in a form of a Brižinski spomeniki (Freising Folia), followed by a variety of manuscripts in which the Slovene language showed the development of dialects in various parts. Interestingly, to date the Freising Folia remain the oldest evidence of any Slavic language in the Latin alphabet (Greenberg, 2006). For centuries the Slovene language only existed on the level of dialects - as there was no agreed standard - differing from district to district or even from village to village, due to the absence of unifying factors and the presence of disunifying geographical and political forces. Furthermore, the first printed book in the Slovene language, a Catechism, was printed in 1550 (Primož Trubar), followed by the translation of the Bible by Jurij Dalmatin in 1586. Later, although some contributions to the Slovene language were made, most publications were in the German language[18] (the official language at the time). The biggest contribution to the Slovene language was made by France Prešern (1800-1849), who is still considered to be one of the most influential and prestigious Slovene poets, due to his literary efforts and the impact of his work on raising the prestige of the Slovene language. Consequently, Slovene language continued to be 'defined', refined and developed throughout the 20th century up to the standard form known today (Greenberg, 2006).

Presently, the Slovene language is the official language of the Republic of Slovenia and it is the native language of approximately 1.8 million people. According to the last Population census in 2001, there are 1228 Slovenes living the UK, whereas according to the UN population estimate of 2015 there are 2298 Slovenes living in the UK.[19] Linguistically, the Slovene language belongs to the South Slavic language group, where the speech area stretches to the west of Croatia, expanding into Italian, German and Hungarian linguistic territories. The contemporary Standard Slovene is historically a composite of several dialects; particularly the Upper and Lower Carniola with the center in the capital city of Ljubljana. As a result of previously mentioned geographical and political influences, contemporary Standard Slovene is to a certain degree an

[17] It may be necessary to distinguish/define the terms Slovene and Slovenian. Often even Slovenes themselves will use these terms interchangeably, however, the term Slovene commonly refers to the cultural aspects, particularly language, art and music. In contrast, the term Slovenian is commonly related to political and economic dimensions.

[18] Some publications were additionally made in Italian and Hungarian, mostly in western and northeast areas of what is now known as Slovenia.

[19] https://www.ons.gov.uk/census/2001censusandearlier (last accessed on 01/02/2018)

artificial language found in grammar books and needs to be taught and learnt at schools and universities. Most educated people will be able, when asked, to produce a form of contemporary Standard Slovene, but will not necessarily use it in everyday life. In all likelihood, a colloquial standard language will be used in everyday conversations, which is mostly true for all languages with written form. The colloquial standard language strongly resembles the Standard Slovene language; however, some differences are notable, specifically with more 'archaic' grammatical forms such as the use of duality. Again, this colloquial standard language will differ from region to region and must not be mistaken for dialects, due the fact that dialects will have their own lexis and syntax that will differ from the colloquial use in that region (Greenberg, 2006).

The written standard Slovene and spoken colloquial standard Slovene differ significantly from one another due to the long and complex history. Only in recent decades has there been a major attempt at standardizing and unifying the Slovene language. The first major dictionary, Slovar Slovenskega knjižnega jezika, was published in 1971 (in five volumes) and later in 2001, Slovenski pravopis (Slovene spelling rules). The underlying reasons for such a late publishing could be found in socio and political reasons; Slovenia finally gained its independence in 1991. According to Herrity (2015), these publications serve as a prime vehicle of national identity and are considered the most significant work published in Slovene language. However, in recent years Slovene linguists (particularly in the area of morphology) have been particularly concerned by the 'incursion' of English language words into the Slovene language, consequently suggesting various alternatives (native coinages and calques) (Herrity, 2015).

Sabeč (2005) also pointed out that English has a significant intercultural impact on Slovene in everyday life. In particular, English, instead of Slovene, is used in TV commercials, brand and shop names etc. However, most English names/words are pronounced with Slovene qualities; rarely utilizing English pronunciation. She attributes this to the fact that English is employed as a language of prestige: something that is currently popular and is associated with the global values worth striving for (Sabeč, 2005). Consequently, many Slovenes are unaware of the fact they are losing their identity (particularly younger generations), becoming distinctly less Slovene and more a "globalized entity" (Sabeč, 2005: 479). However, it may be also possible that these Slovenes, may not be 'losing their identity', but may be adapting English for their own purposes.

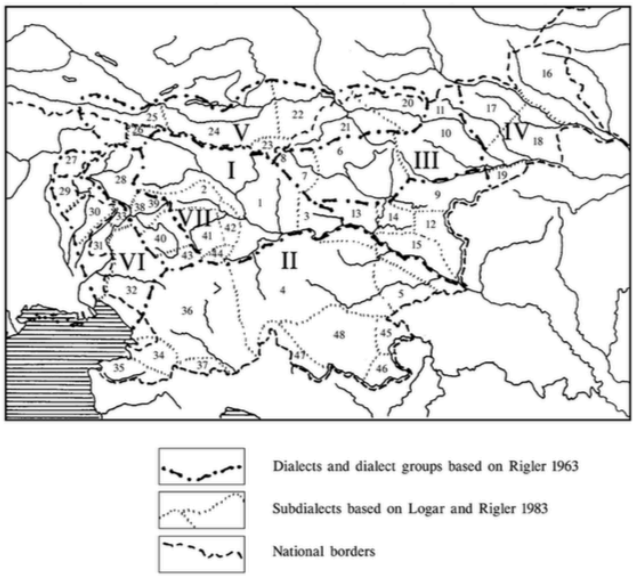

Figure 23: Map of Slovene dialects (Greenberg, 2006:13)

Due to the above-mentioned absence of unifying factors, the presence of dis-unifying geographical and political forces and the strikingly multifaceted dialect systems (Figure 23) of Slovene language, Slovene phonology is considered to be one of the more complex and varied ones in Europe (i.e. stress/tone of various dialects) (Greenberg, 2006). It spans a particularly interesting linguistic territory, encompassing more than 40 different dialects across a relatively small geographical area that represent a wide variety of patterns, tones, quality and stress distinctions.

2.3.3.1.2 Cross-linguistic differences

Slovene phonology is under-represented in theoretical linguistics as only a few publications are available in English (e.g. Lehiste, 1961; Srebot Rejec, 1988; Šuštaršič *et al*., 1996; Jurgec 2010). Most of this literature focuses on fundamental issues and quite often uses outdated methodologies. The most concerning issue is the lack of consensus. This lack of consensus makes it difficult to examine other aspects of language, particularly first language phonological change.

In general, the contemporary Standard Slovene language (SS) has twenty-one consonants (Figure 24) that are all represented in the orthography by a different letter[20] (Herrity, 2015).

	Labial	*Labio-dental*	*Dental*	*Alveo-palatal*	*Palatal*	*Velar*
Voiceless stops	p		t			k
Voiced stops	b		d			g
Voiceless fricatives		f	s	š		h
Voiced fricatives		v	z	ž		[ɣ]
Voiceless affricates			c	č		
Voiced affricates			[dz]	dž		
Nasals	m		n			[ŋ]
Lateral			l			
Roll			r			
Glide					j	
Approximants	[w] [ʍ] [u̯]					

Figure 24: Slovene consonants (Herrity, 2015: 30)

In regards to vowel sounds, Standard Slovene has been described as having eight vowels (Toporišič 1976/2000, Rejec 1998, Šuštaršič et al. 1996), however, Jurgec (2011) claims that Slovene actually has an additional vowel. In his study, Jurgec (2011) suggested an additional low central tense vowel sound / ʌ / exist in Slovene phonology. He claims that no previous phonetic study has provided adequate evidence contradicting his claims. Additionally, he provides evidence that the two low vowels (/ ʌ / and / ɔ/) differ in formant frequencies and duration, which according to Jurgec (2011) is sufficient evidence for the existence of an additional vowel sound. However, for the purposes of this thesis and because of the lack of further evidence to support Jurgec's claims, the traditional and more widely accepted view proposed by Toporišič (1976, 2000), of Slovene having eight vowel sounds, will be used.

[20] The only exception to this is the sound /dz/, which is represented by two letters (this is due to the influences of other Slavic languages)

	Stressed				Unstressed short	
	Long		Short			
High	í	ú	ì	ù	i	u
High mid	é	ó				
Mid				ə̀	ə	
Low mid	ê	ô	è	ò	e	o
Low	á		à		a	

Figure 25: Slovene vowel system

The traditional view of Slovene phonology claims that contemporary Standard Slovene had two phonological systems, which differ on the basis of the prosodic phenomena: the *tonemic*[21] *vowel system* that consists of eight phonemes (/a/, /e/, / ɛ/, /ə/, /i/, /o/, /ɔ/, /u/), which fall prosodically into three groups: long stressed, short stressed and unstressed; and the *non-tonemic vowel system* that is based on stress and vowel length (see Figure 25). Specifically, the general consensus in regard to tones is that contemporary Standard Slovene has two lexical tones[22] (pitch-accents): acute and circumflex tone. Jurgec (2007) claims that tones are obligatory in certain Slovene dialects, but are optional in the standard language. Most commonly, speakers from Ljubljana, the Upper and Lower Carniolan dialects, or the Carinthian dialect may have a pitch-accent or so called tonemic system, whereas the speakers from other dialect areas generally have a dynamic stress, non-tonemic system (Greenberg, 2006).

Additionally, tone must be learned along with the segmental sequence and the meaning. Prominence is marked in at least two broadly different ways depending on which dialectal area a Slovene speaker comes from (Greenberg, 2006). In most languages, tones appear unrestricted on all vowels. However, Slovene language falls in a small group of languages in which the tone on some vowels is predictable (other cases include Tupuri, Cantonese, Shua, and Japanese) (Jurgec, 2007). The word-prosodic

[21] Overall, Hyman (2006:229) defines a tonemic language as a language "in which an indication of pitch enters into the lexical realization of at least some morphemes".

[22] The lexical tone could be described as being a phonological property that refers to the distribution of pitch at the lexical level, meaning some vowels have higher pitch than others (Jurgec, 2007). More explicitly, words that are not considered to be clitics have at least one prominent (stressed) syllable.

features are not normally marked in Slovene orthography (one example being 'vas' (village) and 'vas' (second person plural), except in rare instances where a stress distinction resolves an ambiguity. However, most of the native speakers will easily differentiate these words by considering the context.

In Slovene, most words have a stressed syllable that is (mostly) fixed on the last syllable. However, according to recently published work, the tonemic system has mostly been lost in Slovene language/dialects and is now considered to be archaic. Additionally, it is not obligatory to use it in the standard form (Herrity, 2015: 14). Herrity (2015) even claims that Slovene is a non-tonal language based on stress and vowel length and suggests this system is now generally accepted and used in most up-to-date Slovene grammars and in the Slovene Academy dictionary. Overall, this view is becoming increasingly more accepted in the academic community, as further studies emerge with similar claims.

In comparison, the English language is non-tonemic and the inventory of monophthongs is larger and consists of twelve vowel sounds in Southern British English (/æ/, /ɑ:/, /e/, /ɜ:/, /ə/, /i:/, /ɪ/, /ɒ, /ɔ:/, /u:/, /ʌ/, /ʊ/) (Figure 26) and twenty-four consonants.

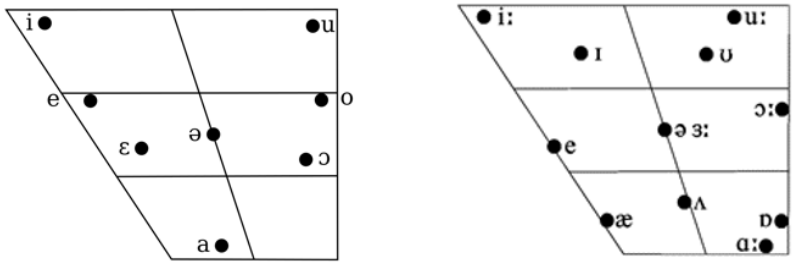

Figure 26: Slovene vowel system (left) (šustaršič, Komar & Peter, 1999) and Southern British English vowel system (right)[23]

The contemporary Standard Slovene is known to be most accurately spoken in the capital of Slovenia (Ljubljana), however, in general the colloquial standard Slovene (knjižnopogovorni jezik) will also be used in everyday life, especially by the educated people living in the urban areas such as Ljubljana. Evidently, the colloquial language could also be impacted by the regional speech habits. Nevertheless, the monolingual participants selected in this study will be recruited from this area (Ljubljana), as they

[23] http://www.phon.ucl.ac.uk/courses/spsci/iss/week5.php (last accessed on 06/11/2016)

are likely to represent the most accurate picture of Contemporary Standard Slovene. Even though the dialectal area of Ljubljana is considered to be tonemic (Slovene tonemic areas stretching from Upper and Lower Carniola with the center in the capital city of Ljubljana) most educated people nowadays do not use the tonemic variety and are even likely not to be able to perceive it (see Herrity, 2015).

In general, the results of studies addressing Slovene tones have been inconclusive, often contradictory and generally not representative, due to extremely small sample sizes. Toporišič (1968) conducted one of the first proper acoustic studies that included a more in-depth view of Slovene tones. However, he based all of his results on the analysis of one speaker. Similarly, Rejec (1988) conducted a more systematic analysis; yet again the sample size was relatively small, as she based her results on three speakers. One of the best and most accurate recent studies was conducted by Jurgec (2006) as he employed acoustic analysis of tone in contemporary Slovene language.

In contrast to previous studies, Jurgec (2006) employed an analysis of measuring the vowel frequencies (F1–F4) of a total of 5,960 vowels using Praat LPC-analysis software. His results were based on a corpus of 241 one-, two- and three-syllable words of ten native speakers of Slovene. This aspect of the study has its limitations, as he was unable to consider any sociolinguistic background that may influence speakers used in the corpus (e.g. age, gender, education etc.). Since then, no other studies have been published to address Slovene tones or the likely progressive loss of tone in Slovene. Therefore, a decade after Jurgec's study and addressing the gap, this study will aim to provide updated evidence, employing the most recent methodology. However, to clarify: the primary aim of this study is to analyze the L1 phonological changes and not tones.

According to Becker & Jurgec (2007), the tonemic system (tones) could influence vowel quality, especially vowel duration, however, tones do not impact the consonant quality, phonation type, or syllable structure. An earlier study conducted by Jurgec (2007) suggested that interaction between tone and vowel frequency may occur, however, it will only be evident in F_o (the fundamental frequency). However, Jurgec (2007) found no statistical differences between vowel frequency, duration and intensity. In the literature, this interaction of tone with vowel quality is rarely reported. In fact, Hombert (1977) and de Lacy (2007) deny that such interactions are possible, as Slovene phonology restricts the combination of high tones with lax mid vowels by adjusting the

tone in the native phonology and adjusting the vowel quality in the loanword phonology.

2.3.3.1.3. Procedure

In general, several different theoretical approaches to measure acoustic similarity have been proposed in the literature. At a glance, the most useful tool for determining L1-L2 acoustic similarity is a 'phonetic symbol test', where L1 and L2 similarity is determined comparing the phonetic symbols in the International Phonetic Alphabet (IPA) to the phonetic symbols in the language under examination, which are based on phonemic considerations. This is considered to be the 'simplest' tool for cross-linguistic phonemic analysis. However, Flege (1999) noted that this test is not completely reliable and should be accompanied with acoustic and perceptual data.

Sooful and Botha (2001) also reported several distance-based algorithms that measure distances between sounds in the phonological space. These are some of the algorithms that have been used in the previous studies:

The Kullback-Leibler measure (Boite & Couvreur, 1999):

$$D_{Bha} = \frac{1}{8}(\mu_2 - \mu_1)^T \left[\frac{\Sigma_1 + \Sigma_2}{2}\right]^1 (\mu_2 - \mu_1) + \frac{1}{2}\log\frac{\left|\frac{\Sigma_1 + \Sigma_2}{2}\right|}{\sqrt{|\Sigma_1||\Sigma_2|}}$$

Figure 27: The Kullback-Leibler measure

The Bhattacharyya distance metric (Mak & Barnard, 1996) used to measure distances between phonemes of different languages:

$$D_{Mah} = \frac{1}{n}(\mu_2 - \mu_1)^T (\Sigma_1 \Sigma_2)^{-1} (\mu_2 - \mu_1)$$

Figure 28: The Bhattacharyya distance metric

The Mahalanobus distance metric (Boite & Couvreur, 1999):

$$D_{KL} = \frac{1}{2}(\mu_2 - \mu_1)^T \left[\Sigma_1^{-1} + \Sigma_2^{-1}\right](\mu_2 - \mu_1) + \frac{1}{2} tr\left(\Sigma_1^{-1}\Sigma_2 + \Sigma_2^{-1}\Sigma_1 - 2I\right)$$

Figure 29: The Mahalanobus distance metric

All the above algorithms employed different approaches to measuring the distances between sounds in the phonetic space. However, one of the limitations of the above metrics and algorithms (Figure 27 - 29) is the fact that they do not consider third vowel formant (F3) (visible in the above formulae as only two variables are considered: μ_1 and μ_2 – these represent the formant values in the equation), which may significantly influence the measured similarity of vowel sounds. Therefore, another useful tool for measuring acoustic similarity is using a calculating metric distance (using Euclidean distance algorithm) between corresponding sounds (Shepard, 1962) that considers all vowel formants (F1, F2, F3). Applying this model to the bilingual phonological system, it predicts that the further apart the sounds in the representational space are, the more likely it is that these sounds will be considered to be dissimilar, whereas the closer together they are, the more likely it is that they will be considered by the bilingual to be similar (Flege, 1987). This model has also been used in monolingual phonetic systems; for example, Padgett and Tabain (2005) used Euclidean distance measures F1-F_0 and F2-F1 to provide a basic picture of a Russian vowel space, as well as vowel distribution.

Chang (2013) acknowledges the limitations of this method as he points out that those vowel frequencies are not the only determiners of vowel quality. He proposed the inclusion of fundamental vowel frequency as well as temporal trajectories of frequency components. Nevertheless, this particular method (Euclidean distance algorithm) was chosen for this experiment to measure the acoustic similarity in Slovene-English late consecutive bilinguals' common vowel space, as it will be additionally and practically (not only theoretically based on calculations) supported by the data of a tested perceptual similarity of naïve monolingual listeners (Slovene).

Before using the acoustic metric, the previously described method of 'phonetic symbol test' was employed to guide and aid the analysis. For example, according to the

'phonetic symbol test' the Slovene vowel sound /e/ should be considered acoustically similar to the English vowel sound /e/. Similarly, this can be applied to the Slovene vowel sound /i/ and English vowel sound /i/. However, the English vowel sound /ʊ/ does not have a counterpart in the Slovene vowel system, therefore, according to the 'phonetic symbol test' it may be considered to be dissimilar.

First, the measured acoustic similarity between the Slovene L1 and English L2 vowel sounds was measured by plotting vowel frequencies (F1, F2, F3) in a three-dimensional vowel space (F1xF2xF3) using Euclidean distance algorithm (Figure 30) to measure the acoustic distance between the sounds.

$$d_{x,y} = \sqrt{(x_1 - y_1)^2 + (x_2 - y_2)^2 + (x_3 - y_3)^2}$$

Figure 30: Euclidean distance algorithm

The data used for calculating vowel frequencies (F1, F2, F3) was extracted from the previous studies that calculated vowel frequencies (Jurgec, 2007: Slovene vowel frequencies and Deterding, 1997: Southern British English vowel frequencies).

The results of the measured acoustic phonological similarity were based on the calculated distances between the vowel frequencies in a combined three-dimensional vowel space based on Pythagoras' theorem extended into three-dimensional space (Figure 31). The bigger the distance between the vowel frequencies (F1, F2 and F3) in a three-dimensional vowel space (in this theorem presented as x_1, x_2 and x_3), the more likely it is that these vowel sounds are further apart and will therefore be considered to be dissimilar; consequently, these vowel sounds may follow the process of dissimilation as the bilinguals gain more L2 experience. In contrast, the smaller the distance between the vowel frequencies in the three-dimensional vowel space, the more likely it is that these vowel sounds will be closer together and will be considered by the bilingual to be similar and follow the process of assimilation.[24] The measured acoustic distances were rounded to a whole number to make it easier to describe and understand the distances between the vowel sounds, as well as to identify any possible mistakes that may occur.

[24] During the assimilation process, according to Flege *et al*. (2003), a new phonetic category fails to be established, even though distinct differences between the L1 speech sound and L2 speech sound are apparent. For further discussion please see Chapter 2.

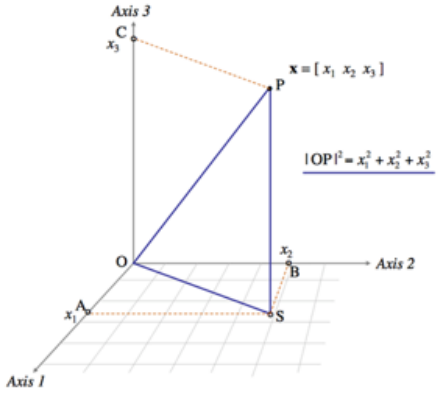

Figure 31: Pythagoras' theorem extended into three-dimensional space

2.3.3.1.4 Results

The results of the measured acoustic phonological similarity suggest that due to the relatively small distances between the sounds, Slovene-English late consecutive bilinguals may follow the process of assimilation and consider the following sounds as being similar: /i/ - /i:/ =156 Hz; /o/ - /ɔ:/ = 43 Hz; /ə/ - /ɜ:/ = 80 Hz (Figure 32). This is graphically evident from Figure 32: vowel sounds are overlapping or closer in the vowel space. Additionally, regardless of a rather large distance in comparison to other calculated ones, it could be anticipated that /ɛ/ - /æ/ = 374 Hz will also be assimilated (Figure 32).

According to this measured acoustic similarity, Slovene /ə/ and English /ɜ: / are considered similar (/ə/ - /ɜ: / = 80 Hz), due to the relatively small distance between the vowels in the vowel space. However, it will not be possible to confirm the measured result for /ə/ in the perceptual similarity test as the initial selection of the words used in the production part of the experiment excluded the vowel sound /ə/ from the analysis. This is because the phonological environment of words that contain /ə/ in Standard Slovene are most commonly and frequently followed by a consonant /r/ (see above commentary).

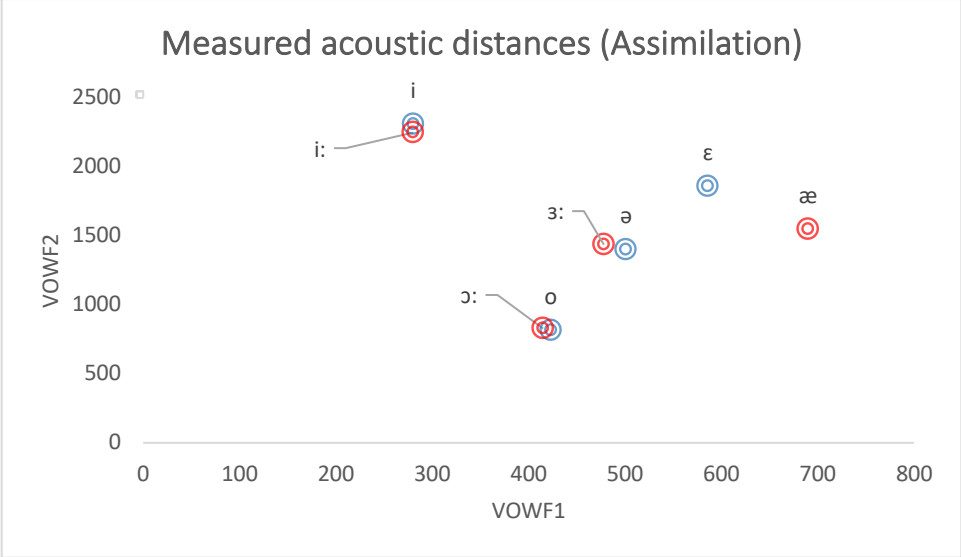

Figure 32: Measured distances that may predict assimilation process (in red English vowel sounds; in blue Slovene vowel sounds)

An interesting result was measured in relation to Slovene-English vowel sounds /e/ - /e/. The phonetic symbol test, which uses phonetic symbols from the International Phonetic Alphabet (IPA) to determine similarity (Best & Bohn, 2002), suggests that the Slovene vowel /e/ and the English vowel /e/ are similar if not identical, as they are presented in the Slovene and English orthography and IPA as the same vowel sound. However, when calculating acoustic distance between the Slovene /e/ and the English vowel sound /e/, a large distance in the vowels space between sounds was measured (=666 Hz). Therefore, this result will need to be confirmed in the perceptual similarity test to determine whether these sounds will be assimilated in the initial stages of second language acquisition (Figure 33).

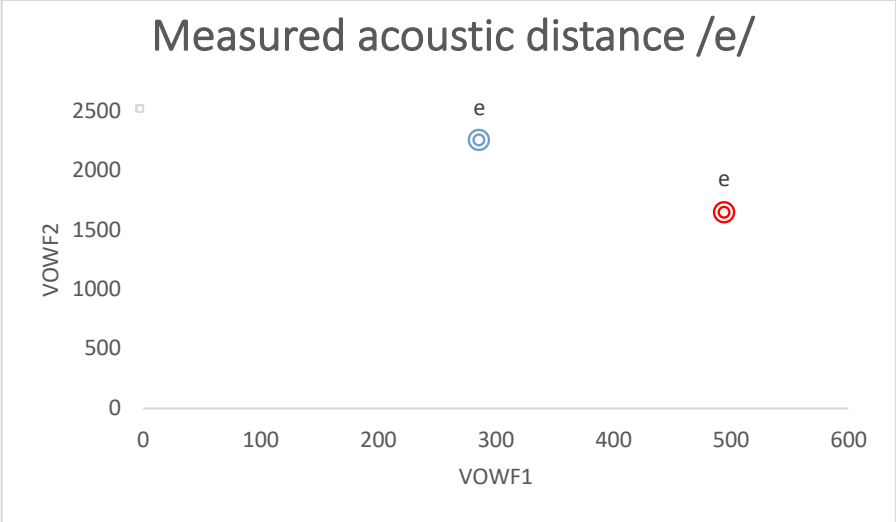

Figure 33: Measured acoustic distance /e/ (in red English vowel sounds; in blue Slovene vowel sounds)

The English vowel sound /ɪ/, will be, in all likelihood, considered dissimilar or new, as the calculated distance (/ɪ/- /i/ = 661 Hz) is relatively high and the nearest vowel sound will be assimilated to English /i:/(/i/ - /i:/ =156 Hz) (Figure 34).

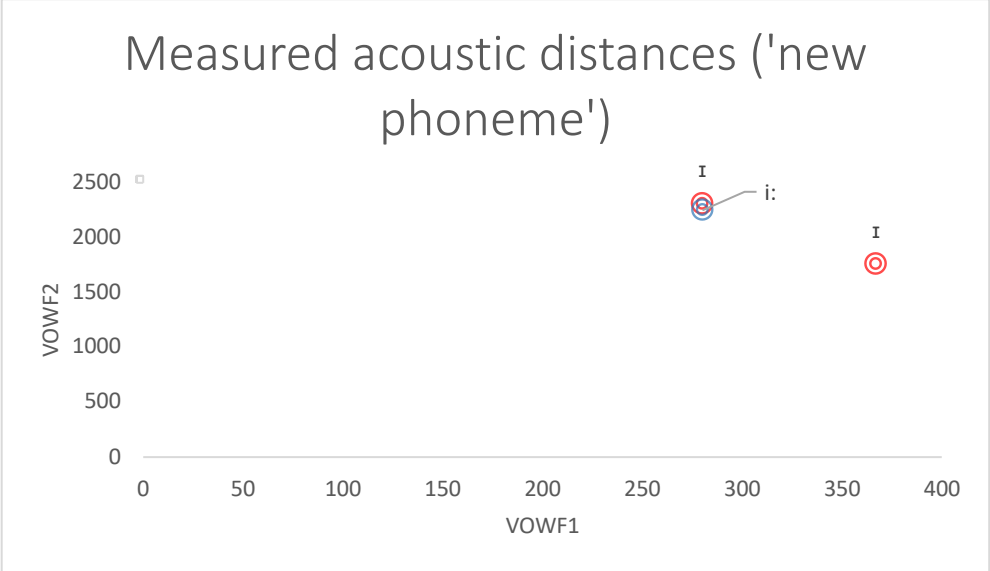

Figure 34: Measured acoustic distances (new phoneme /ɪ/) (in red English vowel sounds; in blue Slovene vowel sounds)

The measured distances between the Slovene vowel sound /a/ and the English vowel sound /ʌ/ and the Slovene /a/ and the English /ɑ:/ are relatively small (/a/-/ʌ/=75 Hz; /a/-/ɑ:/=109 Hz), therefore without a perceptual similarity test, it is difficult to predict to which vowel sound the Slovene vowel /a/ will assimilate. The same may

apply to the Slovene /u/ and the English /u:/ and the Slovene /u/ and the English /ʊ/ (/u/-/u:/=372 Hz; /u/-/ʊ/=346 Hz). In this particular case, depending on to which vowel sound the Slovene /a/ and /u/ assimilate to, the other vowel sounds (either /ʌ/, /ɑ:/, /u:/ or /ʊ/) will in all likelihood be considered by the bilingual as dissimilar or new (Figure 35).

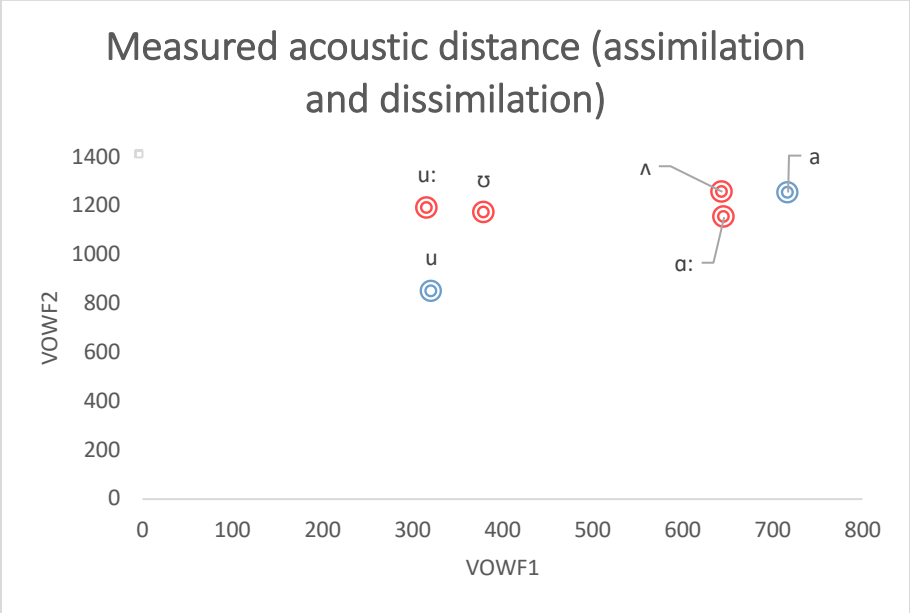

Figure 35: Measured acoustic distances (assimilation and dissimilation process) (in red English vowel sounds; in blue Slovene vowel sounds)

2.3.3.1.5 Summary

Botha and Sooful (2001) noted that the tested measures of acoustic distances for automatic cross-language phoneme mapping of English and Afrikaans segments can influence the results, as four out of six measures used in their study compared favourably with the manually undertaken phoneme mapping. Therefore, as previously discussed, many linguists advocate for perceptual methods of assessment of similarity as an alternative to acoustic measurements (e.g. Bohn, 2002). Consequently, the table below summarizes the results of measured distances between Slovene and English vowel pairs and predicted outcomes based on SLM and PAM-L2, which are tested through a perceptual similarity experiment presented in the next section.

Table 2: Summary of measured acoustic similarity

Slo-Eng vowel pair	Measured distance (in Hz)	Possible outcome
/i/-/iː/	156	Assimilation
/ə/-/ɜː/	80	Assimilation
/o/-/ɔː/	43	Assimilation
/e/-/e/	666	Dissimilation
/i/-/ɪ/	661	Dissimilation
/a/-/ʌ/	75	Assimilation or Dissimilation
/a/-/ɑː/	109	Assimilation or Dissimilation
/u/-/uː/	372	Assimilation or Dissimilation
/u/-/ʊ/	349	Assimilation or Dissimilation

2.3.3.2 Tested perceptual similarity

As previously mentioned, many linguists suggest that perceptual methods, which assess the similarity among sounds, provide an alternative to acoustic comparisons (e.g., Bohn, 2002). These perceptual methods may include direct or indirect tasks. The direct tasks may ask the participants to provide a similarity rating or distance estimation of two or more stimuli presented. In contrast, the indirect tasks may not specifically instruct the participants to compare stimuli or only one of the stimuli in the comparison is presented to the participant (Bohn 2002). Consequently, a tested perceptual similarity experiment was conducted in order to validate and compare the measured acoustic similarity to the tested perceptual similarity.

The tested perceptual similarity experiment used in this study could be compared to a perceptual assimilation task (PAT) that requires subjects to identify a single stimulus in terms of an L1 category and subsequently provide a goodness of fit rating. Therefore, this method may be considered as an indirect task.

Additionally, the methodology used in the perceptual similarity test closely resembles the one previously used in the study of Strange *et al*. (2001), where twenty-four naïve native speaker listeners of Japanese were asked to listen and then categorize English vowels to Japanese vowel categories. Similarly, to Strange *et al*. (2001), this study's tested perceptual similarity required participants to identify a single stimulus in terms of an L1 category and subsequently provide a goodness of fit rating (see Appendix 8). In addition, similar to Strange *et al*.'s (2001) study where the phonological environment of the words was controlled for (CVC context: b-b, b-p, d-

d, d-t, g-g, g-k), this study also controlled for the phonological environment of target phoneme as it placed the vowel sound between voiceless plosives (/p/, /t/, /k/).[25]

However, Mora's (2007) findings suggested difficulty in using this type of task. Mora (2007) used two different types of speech stimuli (task 1: non-words, task 2: words elicited in isolation) to assess perceptual phonological competence. The results of Mora's study of Spanish late learners of English suggest that the use of non-words in the first task made vowel and consonant contrasts easier to perceive. He suggests the use of non-words 'enhanced' their perception, as the learners were not focused on the acoustic level, but rather on the phonemic level of perception (Mora, 2007). Nevertheless, the Strange *et al*. (2001) method described above was used, as it is more robust and had been tested in several other studies (e.g. Strange *et al*. 2001; Bohn, 2002): naïve listeners identify and categorize the sound they hear.

Prior to conducting the testing, the tested perceptual similarity task was piloted on a small number of participants (6 participants took part: 3 female and 3 male) and smaller adjustments were made to the experiment (i.e. allowing the listeners to listen to the recording twice). All ethical procedures were followed as the potential participants were sent the participant information sheet and asked to sign a consent form.

2.3.3.2.1 Procedure

Twenty naïve Slovene listeners were asked to listen to the recording twice and make a number of judgments based on which sound they had perceived. The listeners were asked to categorize each vowel they have perceived into six Slovene vowel categories that were presented in most common Slovene words. The categorization was elicited in the table. (see table in Appendix 8: Tested perceptual similarity – Slovene naïve listeners).

After the experiment, the categorization responses were tallied in an Excel spreadsheet for each naïve listener; frequencies were summed over all listeners and median ratings were calculated. Furthermore, the data analysis consisted of contrasting between measured acoustic data results with the results of the tested perceptual data.

[25] See Chapter 3 for further rationale of the use of voiceless plosives

2.3.3.2.2 Materials

The speech samples used to test perceptual similarity were previously recorded and used in the production part of the experiment (see Chapter 3). The speech samples elicited from the monolingual speakers of Slovene and English were edited and compiled into one speech file using Audacity software, which enables the researchers to clear the recordings of any background noises and insert (if required) appropriate silences (for word lists see Appendix 1: English word list and Appendix 2: Slovene word list).

The Slovene and English words were then randomly distributed across the recording and six-second pauses were inserted between the words, so the listeners had enough time to make their judgments. The results of the pilot study suggested the listeners may have needed to listen to the recording twice as they weren't able to make their judgments by listening to the recording once; therefore, this recording was played twice to all the participants.

In the pilot study the Slovene vowel sounds were presented phonetically (using the IPA phonetic transcription). However, since the participants were not familiar with the IPA, in the experiment they choose between words that represented particular vowel sounds (see Appendix 8).

2.3.3.2.3 Participants

The perceptual similarity experiment involved one group of participants: 20 Slovene naïve monolingual listeners. For the purposes of this study, functional monolinguals were defined in terms of individuals who are not actively learning or using a second language and are consequently linguistically naïve to the target language (Best & Tyler, 2007).

The listeners were recruited through a similar process mentioned in Chapter 3: the Slovene listeners were recruited through direct advertising through the University of Ljubljana. Initially, the recruitment relied on direct advertising through this organization. This way the initial subjects were identified; this allowed the possibilities of expanding the web of contacts (Faugier & Sargeant, 1997).

2.3.3.2.4 Results

The Slovene sounds were not identified in 100% of instances as predicted. However, the twenty Slovene naïve listeners identified their native (Slovene) sounds with a high accuracy level of 97.14%, indicating the participants understood the task and could reliably perform it. Table 3 presents the identification of the native sounds and some misidentifications. The first value presents the number of identifications, whereas the parenthesis values (in bold) represent the mean percent identification.

Table 3: A Slovene rating of native sounds and means per cent identification (in parenthesis)

Vowel Stimuli	a	e	ɛ	ə	i	ɔ	o	u
o							20 **(100%)**	
e		19 **(95%)**			1 **(5%)**			
a	20 **(100%)**							
ɔ				1 **(5%)**		19 **(95%)**		
u								20 **(100%)**
i				1 **(5%)**	19 **(95%)**			
ɛ			19 **(95%)**	1 **(5%)**				

Unlike the Slovene vowel sounds, there was no 'correct' classification of the English vowel sounds (Table 4), as the aim was to test perceptual similarity of non-native (English) sounds.

Table 4: Slovene ratings of non-native sounds (English) and mean per cent identification (in parenthesis)

Vowel Stimuli	a	e	ɛ	ə	i	ɔ	o	u
æ	14 **(70%)**	1 **(5%)**		5 **(25%)**				
a:	20 **(100%)**							
e		15 **(75%)**	4 **(20%)**	1 **(5%)**				
ɜ:		2 **(10%)**	7 **(35%)**	10 **(50%)**	1 **(5%)**			
i:			1 **(5%)**	1 **(5%)**	18 **(90%)**			
ɪ			1 **(5%)**		19 **(95%)**			

ɒ						20 **(100%)**		
ɔ:						17 **(85%)**	3 **(15%)**	
u:			1 **(5%)**		6 **(30%)**		1 **(5%)**	12 **(60%)**
ʌ	3 **(15%)**					4 **(20%)**	13 **(65%)**	
ʊ			4 **(20%)**			3 **(15%)**		13 **(65%)**

The percentages (Table 4) indicate the frequency with which the English vowel sounds were classified to the Slovene vowels. For example, both English open vowel sounds /æ/ and /a:/ were perceived by the Slovene naïve listeners as the same Slovene open central vowel sound /a/ (70% and 100 % frequency level). Similarly, English close front vowel sounds /i:/ and /ɪ/ were perceived as the same Slovene close front vowel sound /i/ (90% to 95% consistency level). Both English open and mid back vowel sounds /ɒ/ and /ɔ:/ were perceived as Slovene open-mid back vowel sound /ɔ/ (85% to 100% consistency level).

Furthermore, the English back closed vowel sounds /u:/ and /ʊ/ followed a similar pattern, as naïve Slovene listeners perceived these vowel sounds as equivalent to Slovene close back vowel sound /u/. However, these vowels were identified less consistently (60% to 65% consistency level). As predicted by the phonetic symbol test and measured acoustic similarity, the English mid front vowel sound /e/ was identified as the Slovene mid front vowel sound /e/ (75% consistency level).

In contrast, the English open central vowel sound /ʌ/ was perceived as a Slovene back closed vowel sound /o/ (65% consistency level), which contrasts with the results from the measured acoustic similarity test. In addition, the English sound /ɜ:/ was more frequently identified as the Slovene vowel sound /ə/ (50%), however, it was also often perceived as /ɛ/ (35% consistency level).

Moreover, the categorization of English vowel sounds was organized in the table below (Table 5) according to the predictions of the category assimilation process. Specifically, Table 5 presents English and Slovene vowel sounds, the frequency of identified sound (in percentages) and the median rating of participants involved in this experiment.

Table 5: Perceptual assimilation of English vowels to Slovene vowels

	English vowel	Slovene vowel	% chosen	Median rating
Open front	æ	a	70	5
Open central	ɑ:	a	100	20
Mid front	e	e	75	4
Central mid	ɜ:	ə and ɛ	85	4.5
Close front	i:	i	90	1
Close front	ɪ	i	95	10
Open back	ɒ	ɔ	100	20
Mid back	ɔ:	ɔ	85	10
Close back	u:	u	60	4.5
Open central	ʌ	o	65	4
Back close	ʊ	u	65	4

To summarize, the English vowel sounds [ɑ:, i:, ɪ, ɔ:, ɒ,] were very consistently assimilated as excellent instances of the predicted Slovene vowel sounds (consistency>85%), while other English vowel sounds [æ, ɜ:, e, u:, ʌ, ʊ], were consistently assimilated as somewhat less good exemplars of particular Slovene vowel sounds (consistency 65%-85%).

2.3.3.3 Combined discussion

When comparing the results of the perceptual similarity test with the results obtained from the measured acoustic similarity test, it could be said that the perceptual similarity results well predicted Slovene-English cross-language patterns and linkage, with varying degree of measured consistency. The only discrepancy between measured acoustic and tested perceptual similarity can be seen in the assimilation pattern of the English vowel sound /ʌ/. The measured acoustic similarity predicted that the English close front vowel sound /ʌ/ would be perceptually assimilated to the closest Slovene open central vowel sound /a/ (/a/-/ʌ/=75 Hz). However, the results of the perceptual similarity suggest that the naïve listeners would assimilate this vowel sound, in the initial stages of L2 acquisition, to the Slovene vowel sound /o/, regardless of the measured acoustic distance between these two sounds being rather large /ʌ/ -/o/ =508 Hz.

There may be several interpretations of these results. Firstly, these results may support Chang's (2012) suggestion that perceptual similarity does not necessarily

follow the acoustic similarity of the vowels. For instance, it is more likely that the 'unfamiliar' vowel sound will be perceptually assimilated to the phonemically similar vowel, than a vowel that is acoustically closer. The evidence to support his claim can be found in Polka and Bohn's (1996) work, when L1 Canadian English speakers perceived the German vowel sound /u/ as a better exemplar of the English vowel sound /u/ than acoustically closer German vowel sound /y/; clearly perceptually assimilating a phonemically closer vowel. Strange *et al.* (2004) also found similar evidence in L1 American English speakers, as they perceived the French vowel sounds /y/ and /œ/, as well as the German vowels sounds /y/, /ʏ/, /œ/, /ø/, more closely to English back rounded vowels then English front unrounded vowels (Chang, 2012).

Secondly, an alternative interpretation for these results could be explained in terms of the perceptual distinctiveness between the vowels (this notion may be compatible with Chang's (2012) discussion: perceptual similarity does not depend on acoustics but also on distinctiveness or use of vowel space). Guion (2003) suggested that in the combined first- and second-language system, there is a need for the two phonological systems to organize themselves in response to the need for greater perceptual distinctiveness. He attributed his conclusions and evidence in support of the concepts provided by the Adaptive Dispersion Theory (ADT) originally proposed by Lindblom (1986). The theory suggests that the vowel space should be maximized in regards to the perceptual distances, regardless of the number of the vowel sounds. The updated version additionally suggested that the increase in the vowel sounds should cause the overall vowel space to expand (Lindblom, 1986).

Lastly, Livjn (2000) examined twenty-eight differently sized vowel inventories and concluded smaller phonological systems (up to eight vowels) do not show significant differences when compared to vowel distances, however, larger vowel systems may. Additionally, Livjn (2000) suggested that other articulatory dimensions such as nasality, diphthongization or voice quality might guide the re-construction of a larger vowel system. Furthermore, evidence against this theory can be found in the work of Recasens and Espinosa (2009) as predictions of the ADT were not supported by the data. Their study compared the first two vowel formants of the five and six peripheral vowel systems of four minor dialects of Catalan and found that the evidence was contradictory to the ADT theory, as the vowel space dispersion actually increased with the decrease of the vowel sounds.

Applying this theory and evidence to the current results of the measured and perceptual similarity, one may firstly consider the Slovene vowel system to have a

smaller vowel inventory, consisting of eight vowel sounds. Therefore, there may be a need for perceptual distinctiveness and vowel dispersion, as suggested by Recasens and Espinosa (2009), vowel space dispersion increases with the decrease of the vowel sounds in the vowel space. This explains the results of the tested perceptual similarity, in particular, the vowel sound /ʌ/ being perceptually assimilated to the vowel sound /o/, which is acoustically further away. However, the participants in this study were naïve listeners, therefore it may be difficult to predict whether the results were indeed guided by the principles of the ADT. Further testing may be needed that includes more experienced L2 learners as well as experienced bilinguals in order to provide a more comprehensive picture.

In addition, based on these results, it could be suggested that Slovene learners of English will, in all likelihood at the start of the acquisition, assimilate the L2 English vowel sounds to the eight Slovene vowel sounds; at the start of acquisition the perception and production would work in parallel. The differentiation between the vowel sounds will in all likelihood happen as the learners gain more experience in their L2 (English).

As previously discussed, Best (1995) makes three predictions (PAM model) in regards to the discriminability of the speech sounds. Firstly, she suggests the assimilation to a native sound, where it would be expected for the naïve listeners to clearly assimilate one sound to another sound or a cluster of sounds. Secondly, Best (1995) suggest the assimilation as an uncategorized sound, where the sound is assimilated, but does not represent a clear category, however, it is still considered in the phonological space. A third possibility is that the sound will not be assimilated (a possibility of a dissimilation process). In this case, the sound would be heard, but would not be considered as part of the phonological space. Considering the results of tested similarity of vowel sounds in the context of Best's PAM model, it could be suggested that PAM adequately predicts the assimilation process of naïve listeners, as all English vowel sounds were assimilated to a native category (first assimilation pattern). However, it could be argued that the five English vowels (æ, ɜ:, u:, ʌ, ʊ) might be considered poorer exemplars of those categories and could be difficult for the Slovene speakers to perceptually differentiate.

Further, if considering Best's (1995) various category assimilation types, the most commonly observed pattern would be the Single Category assimilations (Figure 36), as numerous English vowels were assimilated to the same category (both phonemes assimilated equally well or equally poorly).

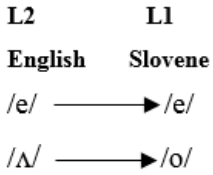

Figure 36: Single category assimilation in Slovene-English naïve listeners

However, cases of Two-category assimilation were also evident, which suggests naïve listeners contrasted between the sounds, therefore, assimilating the sounds to different categories (Figure 37).

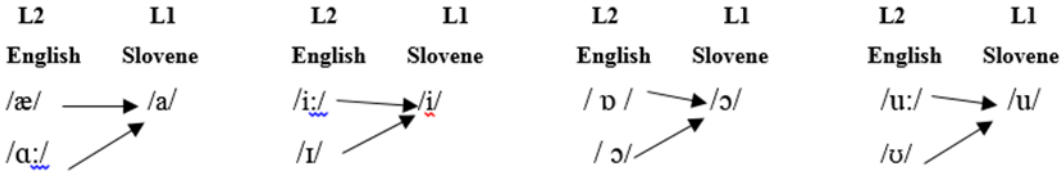

Figure 37: Two-category assimilation in Slovene-English naïve listeners

These results could also be explained in terms of the L2LP (Second Language Perception) model proposed by Escudero (2005). In contrast to both Flege's SLM and PAM, PAM-L2 models (Best, 1995; Best& Tyler, 2007) she advocates separate L1 and L2 phonological systems. Due to differing views, Escudero (2005) also predicts different outcomes in regards to L2 perception (Figure 38).

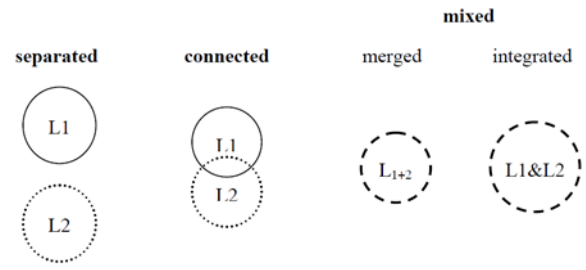

Figure 38: A possible cognitive status of sounds categories and perception processes in L2 learners proposed by Escudero (cited in Boersma & Hamman, 2009:178)

Due to this autonomous system hypothesis, Escudero *et al*. (2009) suggests sounds in both the L1 and L2 phonological systems are either considered separate or connected (they may share some common features). In contrast, to the merged phonological system hypothesis, where L1 and L2 sound may merge or integrate. Considering this hypothesis in terms of the acoustic and perceptual similarity results of this study, one might suggest Escudero *et al*.'s (2009) hypothesis may hold true at the initial stages of language acquisition. However, if this hypothesis is proven inaccurate, as the advanced late L2 learners/bilinguals, who are predicted to have an optimal perception similar to the monolingual speakers, would rarely be able to produce sounds to native-like standards.

Overall, these perceptual test results suggest that Best's (1995) Perceptual assimilation model adequately predicts the assimilation process of English sounds to Slovene sounds. However, it ought to be reiterated again that neither PAM nor PAM-L2 can adequately predict the possible effect the L2 will have on the L1 phonological space. Therefore, in terms of first language phonological change these two models and the application of them is rather limited (de Leeuw, 2007).

One of the limitations of the procedure used to test perceptual similarity could be addressed by comparing the current experiment to the study conducted by Strange *et al*. (2001). Similar to the perceptual similarity experiment at hand, the study conducted by Strange *et al*. (2001) used a perceptual test that asked the listeners to categorize the vowels. However, in their procedure they additionally asked the participants to rate the vowels based on the 'category goodness'. Specifically, after the first testing, the participants were asked to rate on a seven-point scale (poor to excellent) how well a particular sound 'fits' another sound. This particular limitation could be addressed in future research into Slovene-English late consecutive bilinguals; however, it is outside the scope of the current study.

Overall, it may be suggested that these tests had successfully answered the question of how L1-L2 similarity could be initially determined in L2 learning. However, what these tests failed to answer is how this perceived L1-L2 similarity changes over the course of L2 learning, particularly in late consecutive bilinguals. According to Flege's (1995) concept of *equivalence classification* at the earlier stages of L2 acquisition, learners will link L1 and L2 sounds based on 'low-level information' or in other words on the information that is available to them from their first language.

However, at later stages learners may link sounds because of 'higher-level information' or based on the experience they have in their L2 (Chang, 2012).

This idea of language experience was also presented in the work of Best and Tyler (2007) as the theoretical model PAM-L2 suggests naïve listeners may perceive sounds differently to more experienced L2 learners. However, these ideas may suggest that other (extralinguistic) factors, besides internal ones, may contribute to the overall cross-linguistic linkage and the overall influence on production and perception. Best and Tyler (2007) also support this notion, as they suggested future research should consider the relationship between intralingusitic factors (similarity between sounds) and extralinguistic factors, such as language input.

However, recent research (Holliday, 2016) suggests that having additional second language experience can hinder the discrimination of nonnative phonological contrasts rather than aid it. Holliday (2016) compared perceptual assimilation and discrimination of Korean fricatives /s^{h}/ and /s*/ in three groups of Mandarin listeners: naïve, novice L2 learners (four to six weeks experience) and advanced L2 learners (over two years of experience). The results were surprising as the naïve listeners were found to be better at discriminating between the two consonants. Holliday (2016) stated that these results can seem to be counterintuitive, but it could be argued that even the models of PAM and PAM-L2 (Best, 1995; Best & Tyler, 2007) suggest the theoretical possibility of this scenario. In this respect the Slovene-English bilinguals would be disadvantaged by the additional L2 phonetic input they have received through the length of residence in the L2 country. Holiday (2016), therefore, similarly suggested the need to refine our understanding of internal and external factors that may either promote or hinder L2 learning.

Furthermore, Baker and Trofimovich's (2005) study on early and late Korean-English bilinguals, to some extent, agreed with Holliday's (2016) proposal, as they first suggested that the amount of similarity between L1 and L2 sounds would determine the degree and direction of L1 and L2 influence and that secondly, the extent of the bidirectional interaction would have a greater impact at the beginning, rather than in the later stages of L2 acquisition. They supported their claims and hypothesis by presenting evidence that late bilinguals with one-year of US residence did not differ from those with seven years of US residence and consequently suggested no reorganization in the L1-L2 phonetic system.

Most recent research suggests not all non-native contrasts will be equally difficult to perceptually discriminate. Best and Tyler (2007) suggest that this may also

largely depend on the bilinguals' native language. This idea was also explored by Best *et al*. (2003) as they suggested that nonnative speech perception is not only influenced by the bilinguals' L1, but also by the experience of phonetic properties of the L1 phonemes. The close vowel analysis of four languages with distinctly different large vowel inventories (Norwegian, French, Danish and English) suggested that "both phonological and phonetic properties of native language effect strong, systematic differences in nonnative vowel perception by listeners of varying L1s" (Best *et al*., 2003: 4).

Future research into the development of Slovene-English late consecutive bilinguals' phonological system could address these further changes by incorporating in their methodology both naïve and experienced learners. Similarly, to Best and Tyler's (2007) suggestion that future work should focus on the relationship between nonnative speech perception in monolingual speaker and that of L2 learners.

To sum up, at the start of L2 acquisition phonological changes may be predicted in the Slovene-English late consecutive bilinguals, as bilinguals may assimilate most of the L2 vowel sounds (English) to their L1 vowel sounds (Slovene), following the predictions of PAM (Best, 1995).

Overall, this section addressed the intralinguistic factors of phonological similarity – similarity between two sound structure - that may affect the direction of the L1 phonological change for any given vowel in Slovene-English late consecutive bilinguals, however, primarily at the start of the L2 acquisition. The next chapter presents the methods and procedures used in the production part of the experiment as well as global foreign accent rating tasks that aim to answer the primary research question: *'Is there evidence of phonological change in the L1 Slovene vowel system of late consecutive Slovene-English bilinguals?'* and *'Are the changes in production, perceivable to monolingual listeners?'*

Chapter 3: Methodology

The aim of this chapter is to present the methods and procedures used to gather the data required to address the main research questions. The table below presents a general overview of the various methodological steps and tests undertaken in this research, with intended consequences mapped against research questions.

Table 6: Overview of methods and procedures used

	Production experiment	**Global Foreign Accent Rating task**	**Phonological similarity experiments**	**Impact of extralinguistic factors**
Research question	*'Is there evidence of phonological change in the L1 Slovene vowel system of late consecutive Slovene-English bilinguals?'*	*'Are the changes in production, perceivable to monolingual listeners?'*	*'If there is a variation between vowels, what phonetic or phonological factors may determine the change for any given vowel?' and 'Does this change occur in some vowels more than others?'*	*'What extralinguistic factor(s) may determine the extent of the change in a particular speaker?'*
Methods and Procedures	**Acoustic analysis in Praat** Slovene-English late consecutive bilinguals' vowel system compared to the control monolingual groups (Slovene and English).	**Global foreign accent rating task (GAR)** Measured perception of foreign accented speech in Slovene-English late consecutive bilinguals	**a) Measured acoustic similarity** **b) Tested perceptual similarity** Impact of acoustic and perceptual similarity (intralinguistic factors)	**Sociolinguistic and background questionnaire** Impact of extralinguistic factors

In order to address the above-mentioned research questions, experiments were designed and divided into two experimental procedures: a production part and a Global foreign accent-rating task (GAR). The production part of the experiment examined the vowel system of both Slovene and English monolingual speakers and then compared them to the vowel system of Slovene-English late consecutive bilinguals, specifically their production of the vowel sounds on a whole-vowel-system level. Additional analyses examined the changes in individual vowel sounds, where both Slovene and English monolinguals' vowel sounds were compared to Slovene-English late consecutive bilinguals' individual vowel sounds, with the aim of exploring whether L1 phonological change happens in certain vowels more than others. In the Global foreign accent-rating task (GAR), the perception of foreign accented speech was examined (in both their L1- Slovene and their L2-English), which determined whether or not potential changes found in the production part of the experiment are perceivable to the monolingual speakers of either language.

In both parts of the experiment, the independent variables were carefully controlled and measured. The independent variables were target phonemes (all vowel sounds were tested);[26] phonological environment of target phoneme (between voiceless plosives /p/, /t/, /k/); recording equipment and environment (as consistent as possible); variation in the voice quality of individual speakers (use of standardized measures in speech software Praat); all sociolinguistic variables, including e.g. age, gender, level of education, variety of Slovene spoken (dialects), exposure to English (for Slovene monolinguals), degree and type of English usage (for bilinguals) were recorded on a sociolinguistic questionnaire.

Prior to conducting these experiments, a pilot study tested the methods and procedures on a smaller scale (with six participants), and small adjustments were made to the experiment design. Firstly, the use of additional equipment - a pop shield was added to control for the 'popping' of the plosive sounds. Secondly, recordings of the speech materials directly into the speech processing software were added. Lastly, there was an adjustment to the words used in Slovene, due to the ambiguity of certain words.

[26] Information in the brackets indicates how these variables were controlled for. Further detailed explanation is given in the following sections.

The lack of a common framework (e.g. varying use of established methodology) in previously discussed studies that examined L1 phonological changes has often been addressed as a methodological issue. Schmid (2004a), therefore, suggested that a means to address these challenges was to employ a combination of tasks, such as a formal task, free speech, and self-assessment. These tasks provide the researcher with multimodal data that further provide a more comprehensive picture of the overall state (e.g. competence of participants). Consequently, the methods and procedures used in these experiments should provide ample evidence to answer the research questions set at the start of this thesis, and either support or reject the hypotheses. The methodology used in this thesis is based on the preceding literature review and directly derived from the above-mentioned research questions:

1. **Hypothesis:** The *Slovene-English late consecutive bilinguals will show signs of first language phonological change.*

This hypothesis derived from the existing literature as previous studies found significant amount of evidence: bilinguals' L1 differed from monolinguals' L1 and changes were observed in the L1 vowel formants (e.g. Flege, 1987, 1991; Major, 1992 Flege at al., 2003, Mennen *et al.,* 2012; Chang, 2010, 2011; 2012; Mayr *et al.,* 2012).

2. **Hypothesis:** *Slovene-English late consecutive bilinguals will be identified as native speakers of Slovene, even if showing signs of L1 phonological change.*

This hypothesis was also derived from the existing literature: most late consecutive bilinguals were perceived as native (e.g. Sancier & Fowler, 1997; De Leeuw, 2009, Hopp and Schmid, 2013). Additionally, often the changes in the production did not manifest in bilinguals' global foreign accent. In other words, the changes measured in the production were not apparent in how the accents were perceived.

The next few sections present the overall procedure, materials used and the recruitment of participants in both the production experiment and GAR with the aim to test the hypotheses discussed in the text above.

3.1 Production experiment

The aim of this section is to present the methods and procedures used in the production part of the experiment, which examined the vowel system of Slovene-English late consecutive bilinguals and compared it to the control monolingual groups (Slovene and English). More specifically, this section describes the materials used, the profile of all participants included in this experiment and procedures that were undertaken to collect the speech samples. Lastly, it describes the procedure of how acoustic analysis was used to extract the vowel frequencies of target vowel sounds.

3.1.1 Procedure

The production part of the experiment was run in a quiet room to ensure high quality recordings and to avoid interferences. Two laptops and an external blue snowball microphone with USB digital output were used to achieve clear audio recordings (Figure 39). The stimuli were presented on the first laptop and responses were recorded on the second laptop directly into Praat software (Boersma & Weenink, 2005). The audio was recorded at a sampling frequency of 44.1 kHz and 16 bps. In all recordings, the microphone was placed 5 inches from the speaker's mouth, in order to ensure consistency across the recordings and avoid proximity effect, which is a low frequency response when a speaker is too close to the microphone (Figure 40). A pop shield was placed 2 inches in front of the microphone, to avoid the popping of the plosive sounds (especially the /p/ consonant). In order to ensure this study adds to existing knowledge in the field of second language acquisition and first language attrition, and also has potential implications for the replication of the methods, procedure and results, the procedure and a range of measures used strongly resembles those applied by Chang (2010:79) in his study on Korean-English learners. In this study, Chang ensured the use of a quiet dormitory; stimuli were presented, and responses recorded in DMDX on a Sony Vaio PCG-TR5L laptop computer (Chang, 2010: 79). These procedures and measures are particularly useful as they ensure high reliability and accuracy of the obtained data.

Figure 39: Set up of production part of the experiment

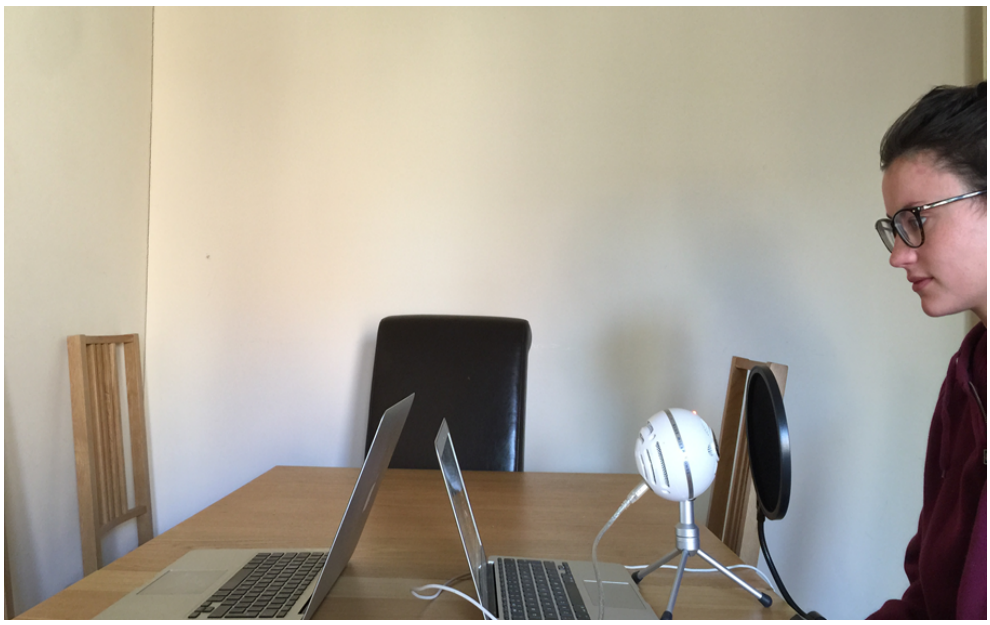

Figure 40: Set up of the production part of the experiment (pop-shield, snowball microphone and stimuli on the first laptop)

The experimental procedure for the monolingual speakers consisted of a single session of approximately fifteen minutes, in which the monolingual speakers were asked to read the words (see Appendix 1: English word list and Appendix 2: Slovene word list) presented in a PowerPoint presentation. As soon as the word appeared on the screen the participants had to read it, focusing on what they were saying rather than on how they were saying it (representative picture of the experimental environment presented in Figure 39 and Figure 40) in order to avoid any inferences of stress and tone of the words, which may impact vowel frequencies and their measures.

The experimental procedure for the bilingual speakers consisted of a single session of approximately 30 minutes and was divided into two parts: the Slovene part and the English part. The languages spoken during the recordings were strictly separated. Specifically, to activate their L1, a short conversation took place in the Slovene language; whereas to activate their L2, a short conversation took place in the English language prior to the recordings. This procedure was undertaken to ensure no language mixing occurred, which could have caused interference that impacted the results. For example, previous literature suggests that bilinguals will operate differently in the monolingual mode (Schmid, 2007a), as compared to the bilingual mode. Schmid (2007a) explains that in the monolingual mode, one of the bilingual's languages will be highly activated, whereas the other one will, in all likelihood, be deactivated. In contrast, if the bilingual speaker is operating in the bilingual mode, both of the languages will be highly activated and will, in all likelihood, result in some sort of language mixing or cause interference (Schmid, 2007a).

To avoid this interference the bilinguals were encouraged to operate in monolingual modes, by all instructions provided in either English or Slovene. In addition, these instructions and a short friendly conversation put the bilinguals at ease and created a more relaxed atmosphere in which the participants were more engaged and willing to partake. The experimental procedure for bilingual speaker was identical to the monolingual procedure: participants were asked to read the words presented in a PowerPoint presentation. The participants were asked to read the words (see Appendix 1: English word list and Appendix 2: Slovene word list) as soon as they appeared on the screen, again, focusing on what they were saying rather than on how they were saying it.

3.1.2 Materials

This section presents the materials used in the production part of the experiment, as well as materials that were consequently used to measure and test phonological similarity between Slovene and English. Additionally, it presents the underlying methodological issues and how these were resolved to achieve high standards throughout the experiments.

Best et al. (2003) suggested that vowels, in particular, may be useful when investigating and analyzing bilinguals' speech. In contrast to consonants, vowel sounds are higher in intensity, longer in duration and involve different articulatory gestures, such as different tongue muscles. Additionally, vowel sounds are voiced throughout, whereas consonants have some aperiodic noise. Often, the phonological system consists of a smaller number of vowels, in comparison to consonants and are, therefore, easier to examine as a whole (Best et al., 2003:1). Previous research has also indicated that changes in the phonological system will first manifest themselves in the vowel system. However, it should be pointed out that articulatory and acoustic characteristics of vowels vary significantly between languages, and also dialects, which may make vowels more difficult to investigate, especially in comparative studies (Best et al., 2003).

Ladefoged (2001) suggested a means to describe vowel sounds by their acoustic properties. In particular, he suggested that the most important acoustic properties of the vowel sound are the vowel formants, which could easily be identified on a spectrogram as a dark band. Woods (2005)[27] defined a vowel formant as an "acoustic energy around a particular frequency in the speech wave" that is measured in Hertz (Hz). There are several formants, each at a different frequency: most commonly investigated are the first (F1), second (F2) and third (F3) vowel formants.[28] The formants that characterize different vowel sounds are the result of the different shapes of the vocal tract; this shape determines the location of the formant frequencies. Reetz and Jongman (2009:184) reported that the vowel height is inversely correlated with the vowel frequency: the higher the vowel (tongue position) the lower the F1. Similarly, the F2 frequency reflects the 'backness' of the vowel sound: a front vowel results in a higher F2. Consequently, the first two formants are the most significant measures in any acoustic study. Even

[27] http://person2.sol.lu.se/SidneyWood/praate/whatform.html (accessed on 08/01/2017)

[28] "Formant frequencies higher than F3 are not considered important cues to the identity of the vowel as they hardly vary as a function of vowel quality" (Reetz & Jongman, 2009: 184).

though the F3, which determines the roundness of the lips, does not change nearly as much as the F1 and F2, the F3 may still represent an important cue, particularly in bilingual studies where vowel quality may be determined through this formant frequency (e.g. in German, Swedish, Dutch, French) (Reetz and Jongman, 2009:184).

Furthermore, there may be two possible issues relating to the investigation of the vowel sound production and perception. The first issue has been widely noted in the literature, as speaker normalization. Johnson (2008:1) defined speaker normalization as an occurrence where phonologically identical utterances show a great deal of acoustic variation. For example, the same word spoken by a man in comparison to a woman may display quite different vowel formants. The scatter plot (**Figure 41**) presented in the study conducted by Peterson and Barney (1952), demonstrates the speaker normalization occurrence, as the first two vowel frequencies (F1, F2) significantly differ in male and children participants measured in their experiment (Figure 41).

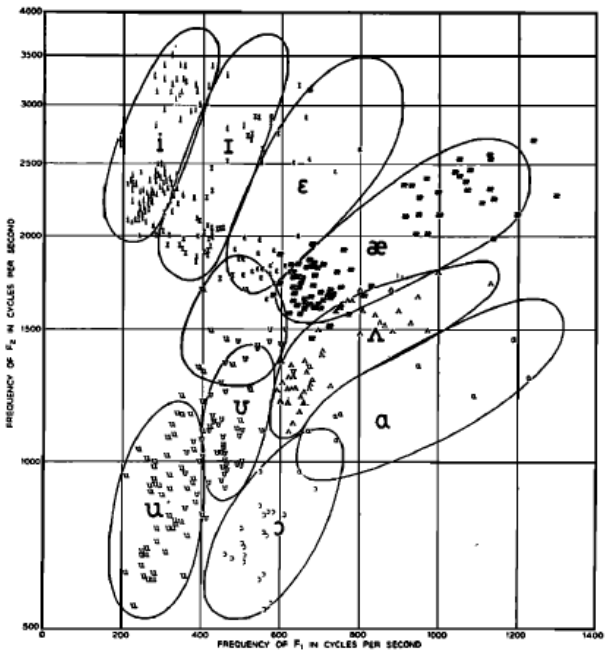

Figure 41: Scatter plot (F1xF2) demonstrating speaker normalization in men and children (Peterson & Barney, 1952:183)

Consequently, many researchers controlled for this issue. Due to technological advances, cross-linguistic gender differences could be easily controlled for in Praat (a speech processing software; Boersma & Weenink, 2005) by adjusting parameters to

account for individual speaker variation. Therefore, during the acoustic analysis the occurrence of speaker normalization was carefully controlled for (e.g. for a female speaker maximum frequency set to 5500 Hz for a male speaker 5000 Hz).

The second issue relating to vowel production is the target undershoot problem. Generally, all vowels are characterized by a vowel spectrum at a single point in the realization (van Son & Pols, 1990:1693). However, due to various factors (e.g. the co-articulation of vowels with consonants) this vowel spectrum may shift away from the ideal one, consequently missing their position by undershooting.[29] Nevertheless, it is unclear what effect this issue will have on vowel formant frequencies: some studies reported differences in shorter vowel duration (e.g. Nord, 1987), some reported a significant dependency on the individual speaker, and others were unable to detect such an issue. For example, a study conducted by van Son and Pols (1990) on the impact of normal and fast rate of speech on Dutch vowel frequencies, indicated that there may be a possibility of a higher F1 in a fast speaking mode, whereas there were no significant differences in vowel frequencies at the normal speaking rate. However, the question may be raised as to how reliable these results are as the 'population' consisted of a single newscaster that read 850 words first at normal speaking rate and once as fast as possible.

Even though previous studies indicate inconsistencies, the variable of a target undershoot problem was considered and controlled for in the experiments conducted for this thesis. Firstly, the speakers in this study were asked to read a passage at their normal reading speed. Secondly, words were presented in a PowerPoint presentation. These were timed to have 3 second pauses/delays to allow the speaker to have a steady and normal rate of speaking. As seen in Son and Pols's (1993) study, a normal rate of speaking should prevent the undershoot problem.

Ladefoged (2001) also suggested that researchers should avoid using nonsensical words when compiling the word lists (stimuli), especially if the participant is a naïve speaker/listener. He argued that the speakers may find it difficult to pronounce unfamiliar words in a natural way and the aim of the experiment is not to test their phonetic decoding skills, but to record/analyze their speech. Consequently, in this research the word lists used in the production part were carefully compiled using words that occur in everyday speech.

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[29] This term implies that due to temporal constraints the articulators do not reach the vowel-specific target resulting in formant undershoot (Mooshammer & Geng, 2008:119).

Considering above concerns, the words that were used as stimuli, were controlled for with regards to their phonological environment: the phonological environment of a target phoneme (vowel) was between voiceless plosives (/p/, /t/, /k/). The first reason for selecting voiceless plosives is that they do not 'interfere' with the vowel quality and most importantly the vowel frequencies. Secondly, they appear on a spectrogram as a white blank: a complete silence. This makes the identification and measurement of the target vowel sound during acoustic analysis straightforward.

Secondly, tonemic aspects of Standard Slovene were taken into consideration. The contemporary Standard Slovene (SS) is tonemic and the vowel system consists of eight phonemes (/a/, /e/, /ə/,/ ɛ/, /ə/,/i/, /o/, /ɔ/), which fall into three prosodic groups: long stressed, short stressed and unstressed. In contrast, English is non-tonemic and the monophthongal vowel system consists of twelve vowels (/æ/, /ɑ:/, /e/,/ɜ:/, /ə/,/i:/, /ɪ/,/ɒ/,/ɔ:/, /u:/, /ʌ/,/ʊ/) (Figure 42). However, as previously mentioned the tonemic system of the Slovene language should not impact the vowel quality, especially in CVC words.

Therefore, both word lists included a number of expected minimal pairs as given in both the Slovene dictionary (the SSKJ – Slovar Slovenskega Knjižnega Jezika) and the Oxford Advanced Learners Dictionary, to ensure a difference in only one phonological element – the phoneme. The selected words were high frequency items and had a CVC (Consonant-Vowel-Consonant) and/or CVCV[30] (Consonant-Vowel-Consonant-Vowel) format.

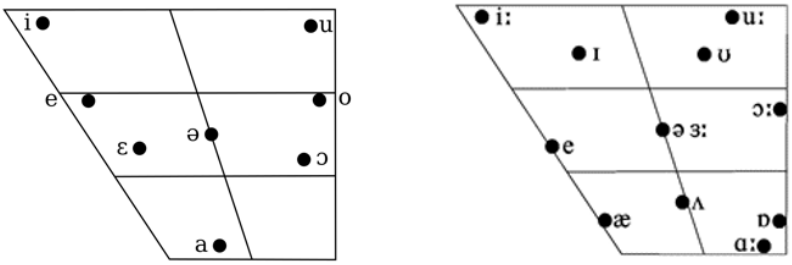

Figure 42: Slovene vowel system (left) (Šuštaršič, Komar & Peter, 1999) and English vowel system (right)[31]

[30] The CVCV format of the words was only used in one case: a Slovene vowel sound /ɜ:/, as the words encompassing this Slovene vowel sound do not exist in CVC words.

[31] http://www.phon.ucl.ac.uk/courses/spsci/iss/week5.php (last accessed on 06/11/2016)

The word lists were then transferred into three separate PowerPoint presentations, designed for monolingual and bilingual speakers (Slovene, English and Slovene-English). The stimulus set used in the PowerPoint presentation consisted of multiple repetitions of each vowel sound by each speaker of each CVC and CVCV syllable i.e. for Slovene vowel sound /a/, a randomized order (the repetitions were not consecutive) 3 (repetitions) x 14 (speakers) (=42). As stated in the above text, three-second pauses were inserted between each word, and words were put on separate slides on white background.

It should also be noted that the vowel /ə/ was excluded from the analysis, as the phonological environment of words that contain /ə/ in Standard Slovene are most commonly and frequently followed by the consonant /r/, which itself is an alveolar trill (when /r/ appears in syllabic position i.e. between consonants, it is realized as /ə + r /).[32] Consequently, inclusion of the schwa sound /ə/ would have greatly impacted the /ə/ vowel frequency.

In the initial PowerPoint presentation (in the pilot study), the words were accompanied with visual support, however, not all words could be presented with an image (e.g. abstract nouns). Therefore, the images were omitted from the actual experiment. Regardless, images appeared not to have any effect on the outcome of the experiment.

[32] Note that regardless of the fact that /ə + r / consistently appear together between consonants, the /r/ trill is considered to be non-epenthetic.

3.1.3 Participants

Three groups of participants were involved in the production part of the experiment: the control group of 14 Slovene monolingual speakers (8 male and 6 female), the control group of 13 English monolingual speakers (6 male and 7 female) and the target group of 17 Slovene-English late-consecutive bilingual speakers (6 male and 11 female). Each group consisted of male and female speakers, in order to determine whether or not there were any perceivable differences based on gender, which could potentially contribute to L1 phonological change (Table 7). Table 7 presents the medium (M) age of each control (Slovene M=23.5; English M=31) and target group (Slovene-English M=29), the average number of languages spoken and the average level of education. This allowed for better comparison between the control and target groups.

Table 7: Groups characteristics

	TARGETSloEng			**CONTROLSlo**			**CONTROLEng**		
	n = 17			n = 14			n = 13		
	M	***SD***	***Range***	***M***	***SD***	***Range***	***M***	***SD***	***Range***
Age	29	7.49	22-46	23.5	4.19	18-31	31	11.59	24-56
NumLang	4	1.27	2-7	3	1.14	2-6	3	1.38	1-6
Education	6	0.78	5-7	5	0.86	4-7	7	0.39	7-8

The bilingual speakers (Table 8) were recruited through the organization 'Slovenci v Londonu' (Slovenes in London), that have members located across many other subsequent Slovene organizations. The Slovene and English monolinguals were recruited through the University of Ljubljana (Slovenia) and Anglia Ruskin University in Cambridge (UK). This approach helped to generalize the study's sample to a larger population. Initially, the recruitment relied on direct advertising through these organizations. This identified the initial subjects and this procedure provided further opportunity for expanding the web of contacts and investigation (Faugier & Sargeant, 1997). This was especially important as it was initially expected that a low number of potential participants would be identified, due to a small population of Slovenia (under

two million), and even smaller population of Slovene migrants in the UK (as mentioned in Chapter 2). As previously mentioned, due to the possible impact of word tones in the Slovene language, all Slovene monolingual speakers and Slovene-English late consecutive bilinguals came from the Ljubljana area. This central area is considered to be tonemic and therefore has a predictable and established word tone. In contrast, in the non-tonemic areas and dialects of Slovene, the stress is contrastive and can occur on any syllable.

Table 8: Slovene-English late consecutive bilinguals' demographic data (Gender, Age, Number of languages spoken, Education, Length of residence, Age of Arrival, Language Contact)

UniqueID	Subject	Gender	Age	NumLang	Education (ISCED level)	LOR (yr)	AOA (yr)	Language Contact (L1 use)
1	SEM251	Male	25	4	5	0.5	10.5	3
2	SEM261	Male	26	2	5	0.1	8.1	3
3	SEM282	Male	28	3	6	1	11	3
4	SEM283	Male	28	3	5	1	13	3
5	SEM322	Male	32	4	6	0.5	10.5	3
6	SEM331	Male	33	4	6	9	19	3
7	SEF222	Female	22	5	6	2	12	3
8	SEF221	Female	22	4	5	2	12	3
9	SEF273	Female	27	5	7	3	13	3
10	SEF272	Female	27	3	6	1	11	3
11	SEF291	Female	29	3	6	2	12	3
12	SEF341	Female	34	4	6	2	12	3
13	SEF361	Female	36	5	7	2	12	3
14	SEF412	Female	41	5	7	2	12	3
15	SEF441	Female	44	6	7	12	22	2
16	SEF461	Female	46	7	7	11	21	2
17	SEF411	Female	41	3	7	16	26	2

This ‘snowball method’ enabled the researcher to identify relevant social networks during the recruitment process. Consequently, the participant pool was homogenous and represented the population sample well (Rasinger, 2013). The aim was to locate a specific, to some extent, ‘hidden’ population of Slovene-English late consecutive bilinguals. However, this method may create a bias in the population, as the first participants will have the strongest impact on the sample, as they recruit

members of their social network, consequently expanding the sample. This would have been highly problematic if the sample was heterogeneous (e.g. research into different social classes), however, the aim of this was to recruit members of the same homogenous sample population (Rasinger, 2013:51). Additionally, bias in this collection procedure was avoided by generating a larger sample than initially anticipated. Furthermore, according to Atkinson and Flint (2001:1) "Snowball sampling contradicts many of the assumptions underpinning conventional notions", such as random sampling. Nevertheless, it "provides a means of accessing vulnerable and more impenetrable social groupings" (Atkinson & Flint, 2001:1), as in this thesis where there are a very small population of Slovene-English late consecutive bilinguals.

Prior to the experiment, the potential participants were sent the participant information sheet (see Appendix 9) and consent form (see Appendix 10). They were then asked to complete an online sociolinguistic and background questionnaire, either through the online survey tool, Survey Monkey, or if preferred, the questionnaire was sent as a document via email correspondence (see Appendix 6). This included a statement that the participant had to read the information sheet, had the opportunity to ask questions and that by completing and submitting the online survey, they agreed to participate in the study. The sociolinguistic and background questionnaire significantly differed from the one used to elicit the information from bilingual participants to the basic background questionnaire used for monolingual participants (see Appendix 7). The aim of the monolingual questionnaire was to elicit necessary basic information, mostly with the aim to control for the previously mentioned variable of a dialect. In contrast, the bilinguals' sociolinguistic questionnaire aimed to gather extensive information regarding various extralinguistic variables. The aim of the questionnaires was not to elicit information that is comparable, but rather to gather background information that would aid to the understanding of the obtained data. Additional sociolinguistic data was added to these questionnaires later in the process, prior to experiments, during spontaneous conversations.[33]

The data obtained from the sociolinguistic and background questionnaire was coded and transferred into a separate Excel spreadsheet. For example, the coding of the

[33] One of the limitations of this study may be lack of the recordings from the initial conversations with the participants. However, these spontaneous conversations were invaluable to the study and may not happen under 'experiment conditions'. Further, these conversations made participants feel at ease and further engaged them to fully participate in the experiment.

level of education consisted of using ISCED (International Standard Classification of Education) 2011 descriptors of level of education, which are used and applied in statistics worldwide with the purpose of assembling, compiling and analysing cross-nationally comparable data. Additionally, ISCED was designed to serve as a framework to classify educational activities as defined in programmes and the resulting qualifications into internationally agreed categories (ISCED, 2011:6). Thus, this appeared to be the most appropriate tool to be used to code the data provided by the bilinguals (Figure 43).

ISCED-Attainment (ISCED-A)	
0	Less than primary education
1	Primary education
2	Lower secondary education
3	Upper secondary education
4	Post-secondary non-tertiary education
5	Short-cycle tertiary education
6	Bachelor's or equivalent level
7	Master's or equivalent level
8	Doctoral or equivalent level
9	Not elsewhere classified

Figure 43: The ISCED coding scheme / level descriptors (cited in ISCED, 2011: 21)

Additionally, the age of arrival (AOA) was measured from the start of L2 acquisition or exposure to the L2 (numerically in years). In this study, in regards to Slovene-English bilinguals, the AOA was measured from the age the bilinguals started learning English in school, as previously mentioned, the onset of early L2 learning may have significantly impacted their L1. Consequently, it should be noted that most bilinguals, due to the Slovene education system, were exposed to their L2 (English language) prior to being immersed in the L2 environment. Therefore, the age of acquisition does not coincide with length of residence, as it would in similar studies that examined late consecutive bilinguals. Similarly, the length of residence (LOR) was measured and coded as a number, which indicates the amount of time spent in a second language country (in years).

As previously mentioned, the variable of a language contact had been reported to be rather difficult to measure as it is somewhat difficult to establish what kind of

language contact is the most significant; would reading a newspaper article be sufficient for maintaining language proficiency or do bilinguals require the a more 'active' use of language? Therefore, when designing the questionnaire both active and passive language contact were considered (see Appendix 7). The coding consisted of combining the passive and active use/contact and categorizing them into daily (3), weekly (2) and yearly (1) exposure. It was evident that the majority of late consecutive bilinguals were either using or being exposed to their L1 (Slovene) on daily basis. This part of data was no surprise as previous literature has noted that late consecutive bilinguals have the tendency to use L1 more frequently than simultaneous bilinguals, who acquired the L2 in childhood (Schmid, 2004a).

The profile of the participants was rather specific, as the initial selection for the production part of the experiment was based on the type of dialect spoken. The criteria for the English monolingual speakers used in this study was a Standard Southern British English dialect, whereas the Slovene monolingual speakers included participants from Ljubljana, the Upper and Lower Carniolan dialects and the Carinthian dialect (this criteria was equally applied to Slovene-English bilinguals) The speakers of these Slovene language dialects are considered use the contemporary standard variety of the Slovene language (SS). Additionally, these dialects are pitch-accented or have a tonemic system, whereas the speakers from other dialect areas generally have a non-tonemic system (Greenberg, 2006). The bilingual speakers were included in the study if they spoke both of these varieties and initially started living in an English-speaking environment after the age of 18.[34] The selection based on the dialects was of a high importance as it ensured that the dialectal background did not interfere with first language phonological change - it eliminated the potential interference in the data set from dialectal variation. As the selection process of the participants involved in the study was rigid, this allowed for a better comparison among monolingual and bilingual speakers.

The participants were, to some extent, aware that the phonetic aspects of their speech were being analyzed during the recordings. However, it was emphasized that they should not focus on how they are saying words, but rather on what they were saying. The participants were also assured that the recordings were not a test of their abilities.

[34] This study focused on adult learners, rather than children acquiring or attiring language.

Consequently, any information, data and the speech samples of this study were kept confidential. The names of the participants were not used in the study and the study did not include any information that would make it possible to identify the participants, as participants were given a unique ID number (Table 8). The digital data was also anonymously stored and analysed on a password-protected computer. The paper research records, including consent forms, were kept in a locked file, and only the researcher had access to the records. Any recorded material was destroyed, after the recording had been transcribed; all procedures were in accordance with the principles of the Data Protection Act 1998 and the EU Directive 95/46 on Data Protection. Taking part in this study was completely voluntary and participants could refuse to take part. If they decided to take part, they were free to withdraw at any time by filling out the withdraw section on the Consent Form. Participants were also able to withdraw any data/information, which they had already provided up until the completion of the analysis.

3.1.4 Acoustic Analysis

After the recording sessions in the production part of the experiment, the acoustic analyses on the production data were conducted. The recorded material from the presentation of the isolated words was analyzed using the speech processing software Praat (Boersma & Weenink, 2005) that has been specifically designed to analyze speech in phonetics. It is currently considered to be the most reliable tool in the area of speech analysis.

First, the words were manually annotated, segmented and labelled for the specific vowels in order to extract values of the first three formant frequencies (F1, F2 and F3), on a wide-band Fourier spectrogram with a Gaussian window shape (window length of 2.5 ms, dynamic range of 30 dB, pre-emphasis of 6.0 dB/oct) or the corresponding waveform (Figure 44). The visual representations of the samples were displayed as waveforms and spectrograms were generated. The frequency of the pure vowel sounds is plotted in on the vertical axis, the duration of the vowel sound on the horizontal axis. The darker areas present the intensity of the vowel; the darker the area the greater the intensity (Figure 44).

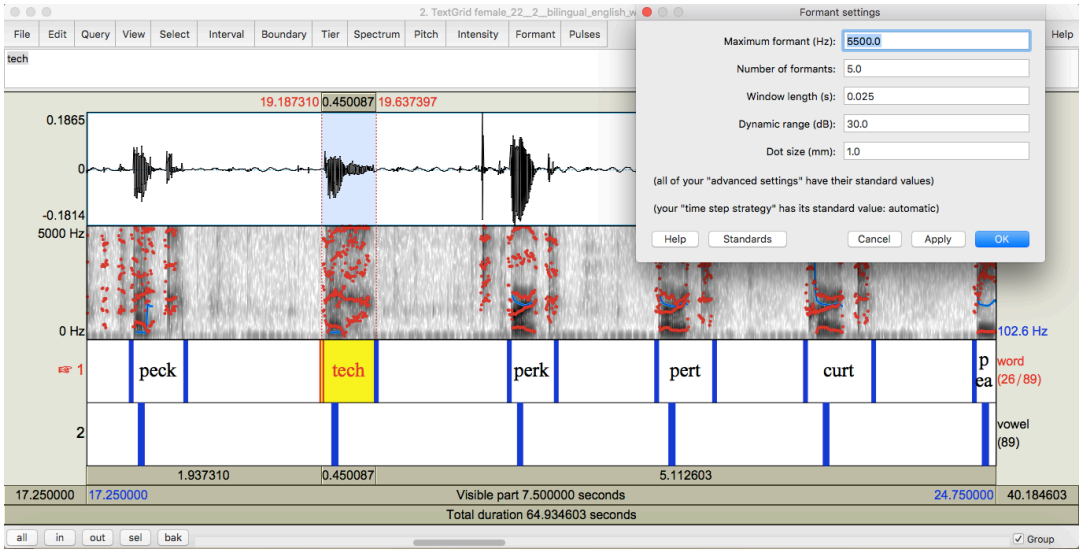

Figure 44: Praat window with used formant settings used in this study

As the phonological environment of the target vowels was controlled for and the initial consonant was a voiceless plosive (/p/, /t/, /k/), the voiceless plosives appeared on a spectrogram as white blanks, whereas the vowel onset time was

determined based on the periodic variation in the waveform that indicated the vocal folds vibration, therefore presenting the formant structure in the broadband spectrogram (vowel-like resonance).

The vowel-offset time was also dependent on the final voiceless plosive, mostly determined by the obvious offset of the voiced formant structure in the vowel (Munson & Solomon, 2004). This way the initial and final point of the vowel was manually marked in the spectrogram (Figure 45).

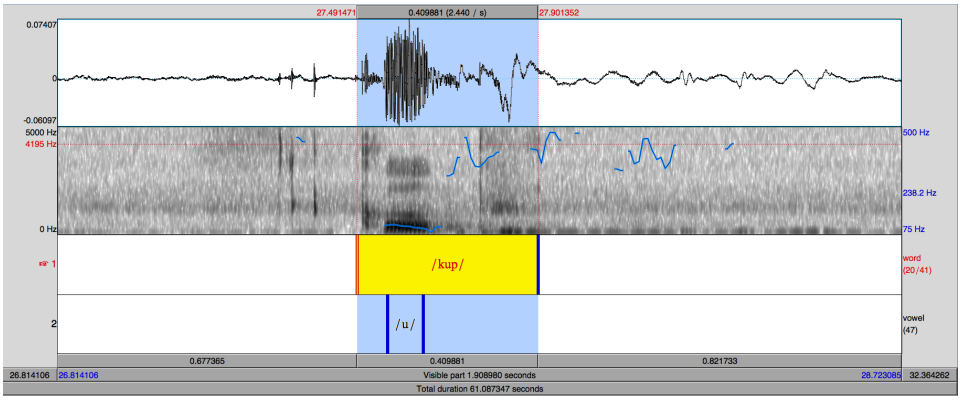

Figure 45: Spectrogram showing the marking of the word /kup/ pronounced by a Slovene male monolingual speaker

Once the measuring point had been determined, the actual extraction of F1, F2 and F3 took place. A semi-automatic extraction process made it possible to visually examine and analyze each vowel. In Praat, linear predictive coding (LPC) was used, as it compares and analyses average vowel frequencies and tracks their contours (Hayward, 2000). Further formant analysis parameters were set with the Formant menu: for a female speaker, it was set to the maximum frequency to 5500 Hz and for a male voice, it was set to 5000 Hz.

Based on the formant analysis parameters, the first three-formant frequencies (F1, F2 and F3) were determined using the command Formant Listing. In other words, for each target vowel, the first three formant frequencies were measured individually using a semi-automated procedure. This created a list of formant frequencies for all of the vowel sounds, which were produced for each speaker (Figure 46).

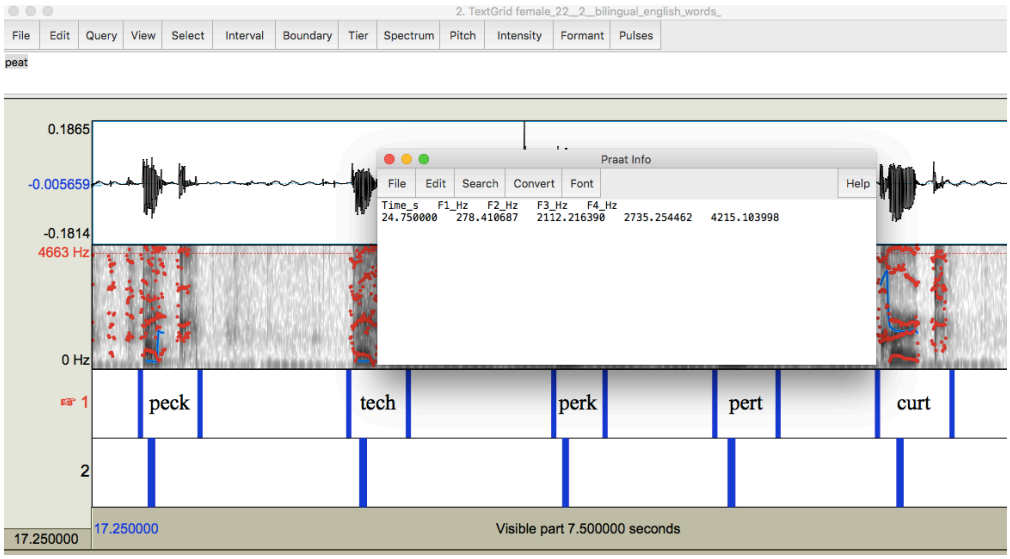

Figure 46: Extracted vowel formant frequencies

The list of extracted vowel frequencies was then transferred to the Excel spreadsheet. The Excel spreadsheet was organized and coded based on the following categories: Unique ID, Subject (code), Number of syllables (1 or 2), Onset (/p/, /t/, /k/), Coda (/p/, /t/, /k/, /a/), Vowel, Word, first three vowel formants (F1, F2 and F3). This coding of the data allowed for accurate and rigorous analysis of the data, in particular when comparing monolingual to bilingual data. The results will be presented in chapter 4.

After conducting the production part of the experiment, the GAR part of the experiment was conducted. The next section provides a detailed overview of methodology and steps taken in this part of experiment.

3.2 Global foreign accent rating task

The aim of this section is to present the methods and procedures used in the Global foreign accent-rating task (GAR), which examined the perception of foreign accented speech in Slovene-English late consecutive bilinguals. The aim of this experiment was to determine whether or not potential changes found in the production part of the experiment are perceivable to monolingual speakers of either language (Slovene and English). Specifically, this section describes the materials used, participants included in the study and procedures that were undertaken to collect the data.

3.2.1 Procedure

Similar to the production part of the experiment, the Global foreign accent-rating task was conducted in a quiet room in order to avoid any interference. Previously recorded passages read by the Slovene-English bilinguals were played to two groups of naïve monolingual listeners of the respective languages (English and Slovene).

The listeners were asked to make a substantial number (21 instances) of judgments (listening to the recordings and making decisions on the level of native-likeness), in order to evaluate the occurrence of a foreign accent. The number of judgments was significant in order to ensure the validity of obtained results. The pilot study indicated that listeners may need to listen to the recordings twice to be able to judge, therefore, the listeners were able to hear the recording twice.

Gut (2009) argued that such perceptual judgments could be impressionistic and subjective, however, previous research indicated that the results have so far turned out to be satisfactorily reliable. The monolingual naïve listeners were specifically asked to rate the degree of foreign-accentedness on a Likert 9-point scale (Figure 47) and 'indicate their agreement or disagreement to a particular statement on a scale' (Litosseliti, 2010:62) (see Appendix 5).

In previous studies a number of rating scales had been used: e.g. 5-point scales (e.g. Thompson, 1991; Bongaerts et al, 1997), 3- points scales (e.g. Tahta et al., 1981a) or 4-point scales (e.g., Asher & Garcia, 1969). However, the use of the Likert 9-point scale dominated previous accent-rating studies (Flege & Munro (1994); Munro, Derwing & Flege (1999); Guion, Flege & Loftin (2000); Yeni-Komshian, Flege & Liu (2000); Munro & Derwing (2001); Piske, MacKay & Flege (2001); Flege & MacKay (2010); Southwood & Flege (1999). The positive effect of using a Likert 9-point scale

was mostly confirmed in all of these studies. However, McAllister et al. (2000) suggested that the question of how valid and reliable the results of the measurements could be, if there is no established and standard scale of measuring the degree of foreign accentdeness. The benefits of using the 9-point scale was also discussed in Southwood & Flege's (1999) global accent rating research, which revealed significant differences in accentedness ratings between using seven-, nine-, eleven-, and thirteen-point scales. The data revealed that the seven-point scale may not allow listeners to rate adequately variations in the perceived degree of Italian-accented English, suggesting that the nine-point scale will be more suitable due to the fact that it allows 'to exploit listeners' full range of sensitivity' (Piske, Mackay & Flege; 2001:195).

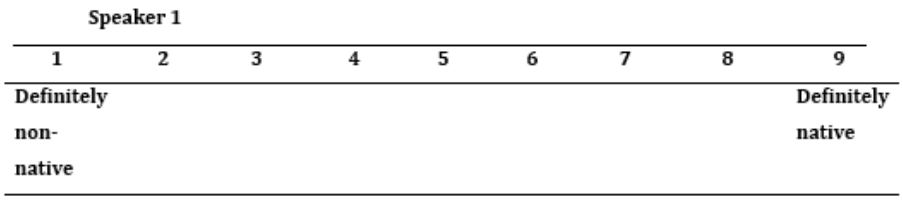

Figure 47: 9-point Likert scale used in Global accent rating task

The Global foreign accent-rating task using the 9-point Likert scale (Figure 47), was also controlled for the non-phonological variables, such as 'scaling effect', that appeared to be influential in the previous research (Johns, 2010). The scaling effect suggests researchers should bear in mind Likert scale's weaknesses: participants may only choose answers that are in extreme categories, participants may want to please the researcher or participants may even want to present themselves in a more favorable way. Considering this, when designing accent-rating tasks using the 9-point Likert scale, particular attention was paid to formulating the questions from a neutral standpoint to avoid leading respondents towards a particular answer or opinion.

3.2.2 Materials

The speech samples used were collected from the control (monolingual) and target bilingual group, who were asked to produce longer stretches of speech. Both groups read two paragraph-length passages, which included sequences and segments

that are considered to be difficult to pronounce by native speakers of both Slovene and English languages (see Appendix 3 and Appendix 4).

Some differences have been suggested between spontaneous and read speech used in accent rating tasks. Oyama (1976), for example, found differences between read and extemporaneous speech of Italian-English bilinguals, however, the two different types of stimuli were reported to be highly correlated. Additionally, Oyama (1976) suggested the bilinguals might be more strongly accented while reading the passage. McAllister et al. (2000) suggested this might be due to the reading ability of the bilinguals' L2, as the bilinguals may have received less education in the L2 as they have in their L1. Nevertheless, Munro & Derwing (2001) supported the use of a read passage, as their study did not provide any perceivable statistically significant differences between read and spontaneous speech. Based on this supporting literature, read passages were selected as stimuli.

Additionally, the length of samples in the literature varies significantly: some studies report using single words while others use paragraphs. It has also been reported native speakers could make judgment relating to accent as quickly as 30ms (Flege et al., 1984). However, the pilot study[35] indicated that some listeners needed considerably longer, in particular Slovene listeners. Therefore, a paragraph length passage was selected as the stimuli.

The English passage (see Appendix 3) used in this study, was previously included in the study conducted by Šuštaršič (2005), the aim of which was to present and identify the most common and more 'challenging' errors of Slovene learners of English. Šuštaršič (2005) tested this passage on 100 randomly selected students and presented the top 20 most common pronunciation errors. The passage read by the bilingual speakers included these twenty words that are most commonly mispronounced by Slovene learners of English.

Similarly, the Slovene passage (see Appendix 4) comprises of words that Slovene speakers may struggle articulating, due to their phonological nature (e.g. rhoticity and the trill 'r'). This passage was extracted from the Slovene Corpus that resulted from the project "Sporazumevanje v slovenskem jeziku" (Communicating in

[35] Due to the already extensive scope of research, data and information that were obtained from main experiments, the decision of presenting only the results of the main experiments has been made.

Slovene language) (2008-2013) under the directive of the Slovene Ministry of Education in collaboration with the European Union.[36]

3.2.3 Participants

The Global accent-rating task (GAR) involved listeners (monolinguals) of each language (Slovene and English), which asked the participants to listen to the recordings of the control (one male and one female L1 monolingual from each target language) and target bilingual group (seventeen bilingual speakers) that previously read two extended passages in both languages (English and Slovene).

The number of raters in previous studies has differed drastically from 1 to 85 (McAllister et al., 2000). To date, there is no general consensus as to how many raters are needed to provide the most accurate picture of bilinguals' levels of accentedness, however, McAllister et al. (2000) suggested that a larger number of raters are needed when trying to examine the degree of foreign accent in a small range of accents. Subsequently, twenty listeners of each language were selected to participate in the experiment.

Previous literature also discusses the use of naïve or inexperienced listeners as opposed to experienced raters such as linguists. Thompson (1991) suggested the use of naïve listeners may be more beneficial, as naïve listeners may detect a higher degree of foreign accentedness, however, he was unable to provide concrete evidence for his claims. Additionally, Bongaerts et al. (1997), in their extensive study, reported no significant differences between naïve and experienced raters. Consequently, naïve listeners were selected to take part in the global accent-rating task and none of the participants received any specific phonetic training.

Similar to the production part of the experiment, participants were selected based on the specific profile of their dialect. The criteria for the English monolingual speakers used was a Standard Southern British English accent, whereas the Slovene monolingual speakers and Slovene – English bilingual speakers included participants were from Ljubljana, the Upper and Lower Carniolan dialects, or the Carinthian dialect, as appropriate. The selection based on the dialects was of high importance as it ensured that the dialectal background does not interfere with first language phonological change.

[36] http://www.slovenscina.eu/korpusi/proste-zbirke (accessed on 03/04/2016)

The participants were recruited through methods previously discussed: Slovene and English monolinguals were recruited through the University of Ljubljana and Anglia Ruskin University. Initially, the recruitment relied on direct advertising through these organizations. This way the initial subjects were identified, and this allowed the possibilities of expanding a web of contacts and investigation (Faugier & Sargeant, 1997).

The next chapter (Chapter 4) reports the results of the production experiment and the Global foreign accent-rating task (GAR). Specifically, it reports the results obtained from the acoustic analysis of the Slovene-English vowel space by considering the first three vowel formants (F1, F2, F3); followed by the report of the analysis of the individual vowel sounds in order to examine whether or not L1 phonological change is evident in specific vowel sounds. As discussed, it also reports the results the Global foreign accent rating (GAR) task in order to establish whether or not potential changes found in the production part of the experiment are perceivable to the native speakers of either language (Slovene and English). Finally, the study reports on the results that aim to establish which, if any, extralinguistic factors most significantly impacted the L1 phonological change of Slovene-English late consecutive bilinguals.

Chapter 4: Results and general discussion

This chapter first reports and discusses the results of the production part of the experiment; specifically, the analysis of the data obtained from the acoustic measurements of the vowel space. This will be followed by analysis of the results of the Global foreign accent task (GAR) to establish whether any potential changes found in the production part of the experiment are perceivable to the monolingual speakers of either language (Slovene and English). Finally, a mixed-effect regression analysis aims to find out which, if any, extralinguistic factors appear most significantly impact the L1 phonological change of Slovene-English late consecutive bilinguals. This data was extracted and coded on the basis of the sociolinguistic and background questionnaire used in the production experiment (see Appendix 7: Sociolinguistic and background questionnaire).

The table below presents a general overview of the various descriptive and inferential statistics undertaken in this analysis, mapped against previously outlined methodology and research questions.

Table 9: Overview of statistical steps and measures

	Production experiment	**Global Foreign accent rating task**	**Phonological similarity experiments**	**Impact of extralinguistic factors**
Research question	*'Is there evidence of phonological change in the L1 Slovene vowel system of late consecutive Slovene-English bilinguals?'*	*'Are the changes in production, perceivable to monolingual listeners?'*	*'If there is a variation between vowels, what phonetic or phonological factors may determine the change for any given vowel?' and 'Does this change occur in some vowels more than others?'*	*'What extralinguistic factor(s) may determine the extent of the change in a particular speaker?'*
Methods and Procedures	**Acoustic analysis in Praat** Slovene-English late consecutive bilinguals' vowel system compared to the control monolingual groups (Slovene and English).	**Global foreign accent rating task (GAR)** Measured perception of foreign accented speech in Slovene-English late consecutive bilinguals	**c) Measured acoustic similarity** **d) Tested perceptual similarity** Impact of acoustic and perceptual similarity (intralinguistic factors)	**Sociolinguistic and background questionnaire** Impact of extralinguistic factors
Analysis	a) Individual measures based on Euclidean distances b) Linear mixed-effects model analysis	Wilcoxon Rank Sum test	a) Individual measures based on Euclidean distances b) A perceptual assimilation task (PAT)	Linear mixed-effects model analysis

4.1 Production

This section presents the results from the production part of the experiment. Specifically, it aims to address the research question: 'Is there evidence of phonological change in the L1 Slovene vowel system of late consecutive Slovene-English bilinguals?'. The null hypothesis proposes that the Slovene-English late consecutive bilinguals will not show signs of L1 phonological change. If monolingual/bilingual status emerges as a statistically significant predictor of vowel quality, or vice versa, then the null hypothesis of showing no difference can be rejected. Therefore, it can then be concluded that there is some evidence of phonological change in the L1 Slovene vowel system of late consecutive Slovene-English bilinguals.

Initially, the data was examined visually, which consisted of normalizing and plotting the vowel sounds. The normalization method consisted of converting the hertz values (Hz) for each speaker into z-scores using the mean and standard deviation of F1 and F2 found for that speaker. This procedure was conducted in R-studio, using the phonR function 'normalizeVowels'. Further, a Lobanov's (1971) formula (Figure 48) was selected, as it allows the normalization procedure to occur speaker-intrinsically. In other words, the vocal track of speakers varies, and in order to compare different speakers and their sociophonetic variation (e.g. female speakers will normally display higher formant frequencies as their vocal track is shorter) researchers should employ normalization procedures to reduce inter-speaker formant value differences.

Lobanov (z-transform, z-score)	Lobanov (1971)	$\frac{F_n - \mu(F_n)}{\sigma(F_n)}$

Figure 48: Lobanov's (1971) algorithm formula (cited in McCloy, 2012:2)

The individual vowel frequencies for each vowel sound were extracted from Praat for both control monolingual groups (Slovene and English), as well as the target bilingual Slovene-English group. The mean values for each individual vowel were calculated by extracting values for each individual vowel sound recorded in Praat.

Additionally, the extracted vowel frequencies were divided based on gender to control for this extralinguistic factor and possible speaker normalization concerns.

Table 10: Standard Slovene vowel frequencies of individual vowel sounds

	Male			Female		
Vowel	**VowF1**	**VowF2**	**VowF3**	**VowF1**	**VowF2**	**VowF3**
i	307	2088	2858	347	2428	3131
e	393	1987	2502	434	2391	2895
ɛ	589	1741	2460	674	1848	2568
a	804	1259	2482	883	1399	2582
ɔ	599	1018	2596	690	1143	2634
o	444	883	2461	455	973	2637
u	340	877	2257	388	923	2563

The values in Table 10 present the extracted and calculated mean Slovene vowel frequencies (of the first three vowel formants: VowF1, VowF2, VowF3) in Hertz (Hz); specifically, values in the table present how and at what frequency an individual vowel sound will likely be produced by Slovene monolingual speakers. These are the first vowel formant frequencies to be recorded in the context of first language phonological change and/or second language acquisition for this particular language combination. They are comparable to the vowel frequencies extracted from previous studies (i.e. Jurgec, 2006) and moreover, the up-to-date methodology and procedures used in this study make these calculations invaluable for future research.[37] These measurements will not only contribute to further research in the area of second language acquisition/first language attrition but will also contribute to future work in the area of Slovene phonology and the development of the Slovene language. Figure 49

[37] Jurgec (2006) conducted an analysis in which he measured vowel frequencies (F1–F4) in contemporary Slovene language of the total of 5,960 vowels using Praat LPC-analysis software. However, his results were entirely based on a corpus of 241 one-, two- and three- syllable words of ten native speakers. This aspect of the study has its limitations, as he was unable to consider any sociolinguistic background that may influence the speakers used in the corpus (e.g. age, gender, education etc.). Additionally, Jurgec did not report on any procedures pertaining to normalization of vowel sounds, which is a crucial procedure that enables researchers to compare the vowel realizations by different speakers. There are no other recent Slovene studies conducted in this area.

graphically presents Standard Slovene vowel space: vowels were plotted on a two-dimensional graph in Excel.

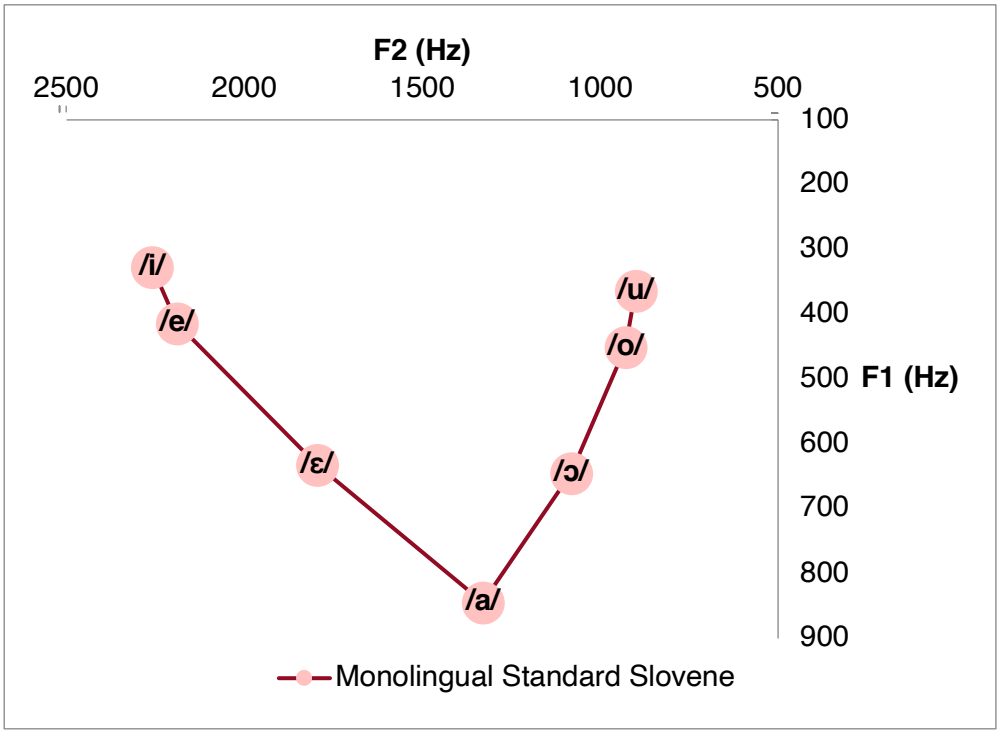

Figure 49: Standard Slovene vowel space

A similar procedure undertaken to measure and calculate Slovene vowel frequencies was used to calculate (mean values of) Standard Southern British English (SSBE) vowel frequencies (F1, F2, F3), which again are mostly in line with the previous studies (i.e. Deterding, 1997) that measured SSBE frequencies (Table 11). Again, the values in the above table specifically present how, and at what frequency, an individual vowel sound will likely to be will be produced by Southern British English monolingual speakers. Figure 50 graphically presents Southern British English (SSBE) vowel space.

Table 11: SSBE vowel frequencies of individual vowel sounds

	Male			Female		
Vowel	**VowF1**	**VowF2**	**VowF3**	**VowF1**	**VowF2**	**VowF3**
i:	302	2345	2768	325	2347	2840
ɪ	474	1948	2530	492	1192	2602
e	704	1661	2321	743	1703	2413
æ	1004	1494	2472	1035	1532	2516
ʌ	780	1168	2670	805	1194	2679
ɑ:	675	1060	2817	700	1089	2814

ɒ	605	947	2761	620	976	2761
ɔ:	421	706	2719	479	935	2860
ʊ	459	1260	2483	477	1358	2507
u:	325	1532	2361	339	1627	2399
ɜ:	581	1340	2573	610	1393	2605

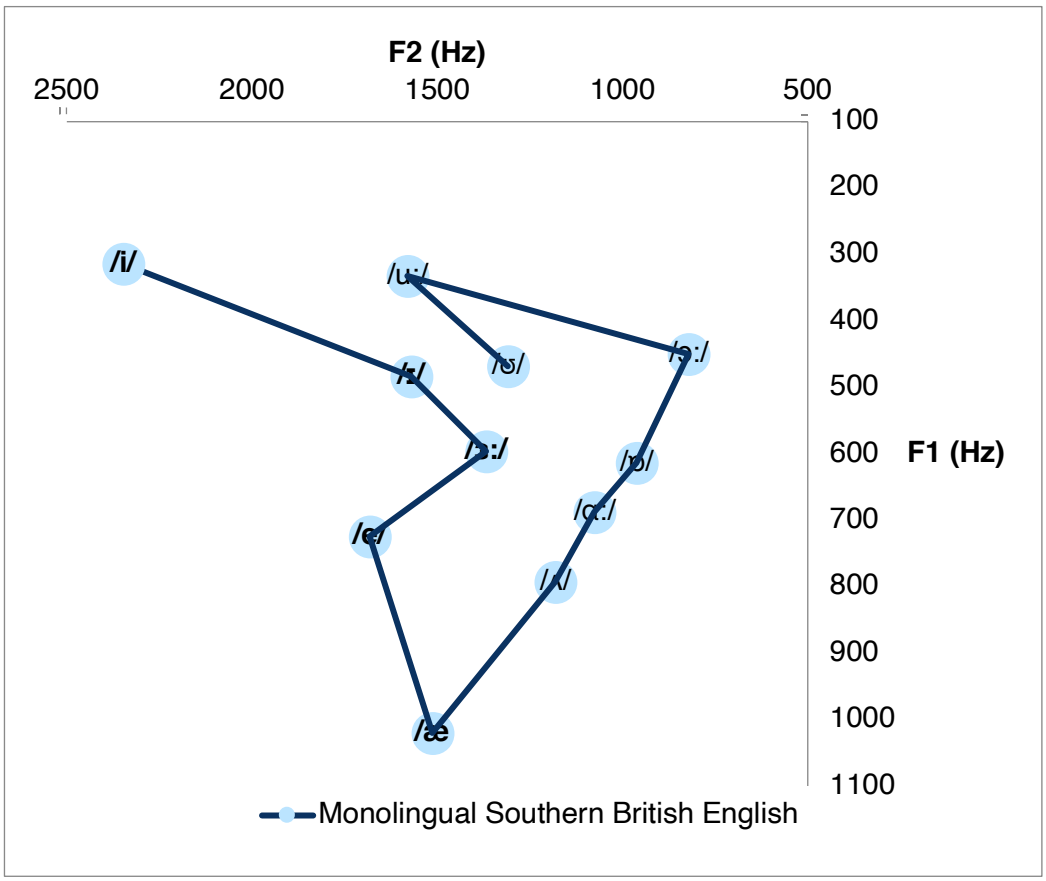

Figure 50: Southern British English vowel space

The Slovene-English late consecutive bilinguals' vowel frequencies were equally extracted, and mean values were calculated for both male and female speakers in both languages. Table 12 presents these Slovene vowel frequencies for male and female Slovene-English bilingual speakers (formant values have been rounded to the first decimal place).

Table 12: Bilingual Slovene vowel frequencies of individual vowel sounds (male and female)

	Bilingual Male			Bilingual Female		
Vowel	**VowF1**	**VowF2**	**VowF3**	**VowF1**	**VowF2**	**VowF3**
i	338	2028	2864	354	2371	3073
e	465	1865	2502	466	2291	2945
ɛ	549	1813	2525	632	2059	2767
a	758	1265	2360	923	1421	2564
ɔ	602	1001	2424	583	999	2522
o	473	823	2197	459	936	2737
u	373	982	2208	375	940	2626

Similarly, Table 13 presents extracted English vowel frequencies for male and female Slovene-English bilinguals. Both tables and their values (Table 12 and 13) present how and at what frequency an individual vowel sound will likely be produced by Slovene-English bilingual speakers.

Table 13: Bilingual English vowel frequencies of individual vowel sounds (male and female)

	Bilingual Male			Bilingual Female		
Vowel	**VowF1**	**VowF2**	**VowF3**	**VowF1**	**VowF2**	**VowF3**
iː	347	2020	2776	381	2282	3120
ɪ	386	1915	2582	421	2188	2860
e	626	1338	2204	754	1913	2657
æ	709	1634	2336	854	1676	2585
ʌ	587	1262	2272	749	1375	2481
ɑː	691	1176	2314	757	1211	2257
ɒ	607	1078	2550	687	1136	2697
ɔː	548	964	2426	532	993	2581
ʊ	398	1253	2204	419	1230	2476
uː	489	1264	1903	561	1425	2101
ɜː	404	1184	2307	405	1272	2565

These measurements are the first to be calculated for Slovene and English late consecutive bilinguals and there are no previous studies where comparisons could be made. This is not only a significant contribution to the field of first language phonological change (L1 attrition), but also to second language acquisition studies, which may be able to use these analyses for future work, especially in regard to Slovene L2 learners, acquiring the English language.

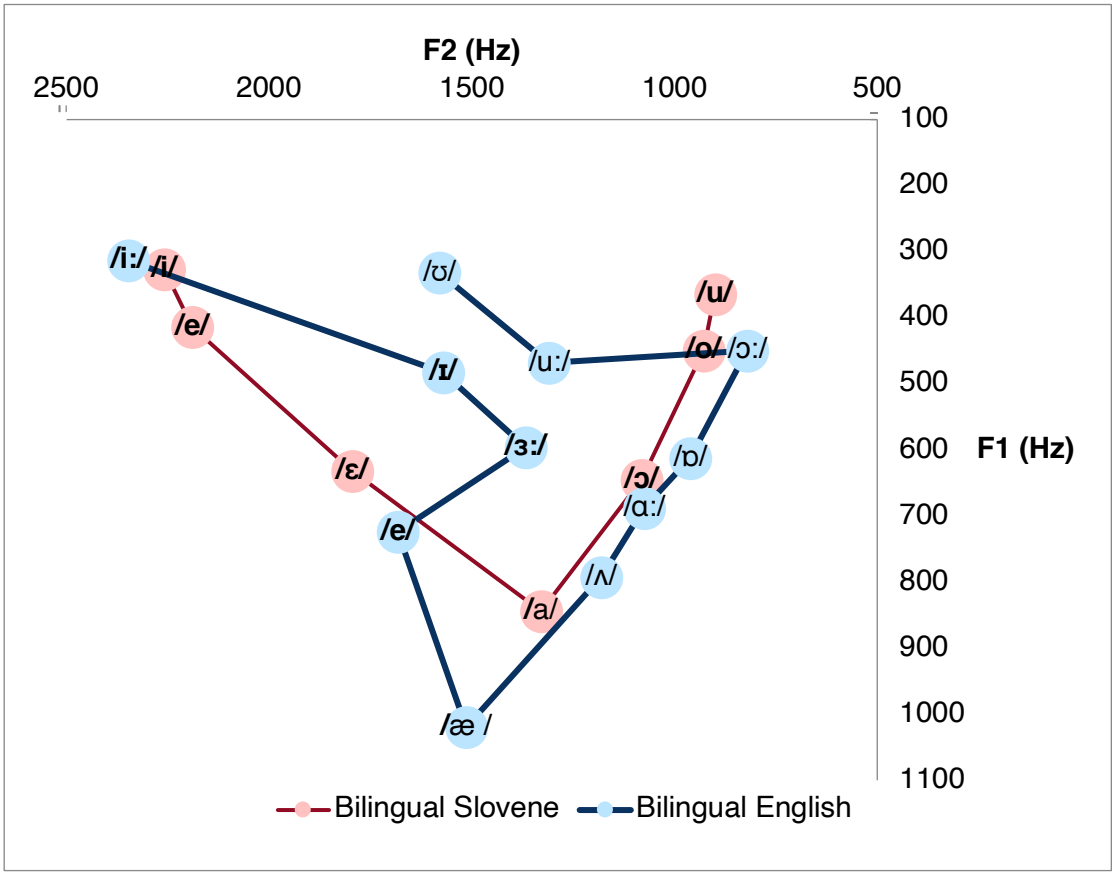

Figure 51: Combined Slovene-English vowel space

Figure 51 presents a combined Slovene-English common vowels space (vowel spaces of both languages within bilinguals). What is evident in particular is that the vowel space of bilingual speakers is far more 'crowded'; and the Slovene monolingual vowel space is far less crowded (consisting of seven vowel sounds) in comparison to the English monolingual vowel space that consists of eleven vowel sounds. It could be inferred, from the descriptive statistics, that the combined Slovene-English vowel space is displaying signs of vowel dispersion or the need for the two phonological systems to organize themselves in response to the need for greater perceptual distinctiveness (Guion, 2003; Lindblom, 1986). However, this needs to be further confirmed through inferential statistics.

Consequently, the above average values for both Slovene and English vowel sounds, served as 'prototype' values which were used to compare each monolingual and each bilingual vowel sound using Euclidean distance measure (previously utilized in the phonological similarity experiments – see Chapter 2).

$$d_{x,y} = \sqrt{(x_1 - y_1)^2 + (x_2 - y_2)^2 + (x_3 - y_3)^2}$$

Figure 52: Euclidean distance measure

Firstly, the distances between the Slovene vowel frequencies in a combined Slovene-English three-dimensional vowel space (F1, F2 and F3) were calculated based on Pythagoras' theorem. The x values in this theorem present the monolingual values (x_1, x_2 and x_3), whereas y values present the bilingual values (y_1, y_2 and y_3).

It is postulated, the longer the distance between the vowel frequencies (F1, F2 and F3) in a three-dimensional vowel space, the more likely it is that these vowel sounds are further apart, and will therefore be considered to be dissimilar. In contrast, the shorter the distance between the vowel frequencies in the three-dimensional vowel space, the more likely it is that these vowel sounds will be closer together and will be considered by the bilingual to be similar. If Slovene vowels are statistically significantly away in the combined vowel space, this would suggest Slovene-English late consecutive bilinguals have undergone the process of L1 phonological change or attrition. Table 14 presents the results of measured Slovene Euclidean distances based on the data obtained from the production part of the experiment.

Table 14: Slovene Euclidean distance measures

Slovene monolingual bilingual vowel pair	Male	Female
/i/ - /i/	68	61
/e/-/e/	142	126
/ɛ/-/ɛ/	105	106
/a/-/a/	131	129
/ɔ/-/ɔ/	173	203
/o/-/o/	272	271
/u/-/u/	120	117

Further, the above Euclidean distances were plotted on two-dimensional graphs (Figure 53 and Figure 54) in Excel. The calculated distances were divided based on gender to control for this extralinguistic factor and possible speaker normalization

concerns.

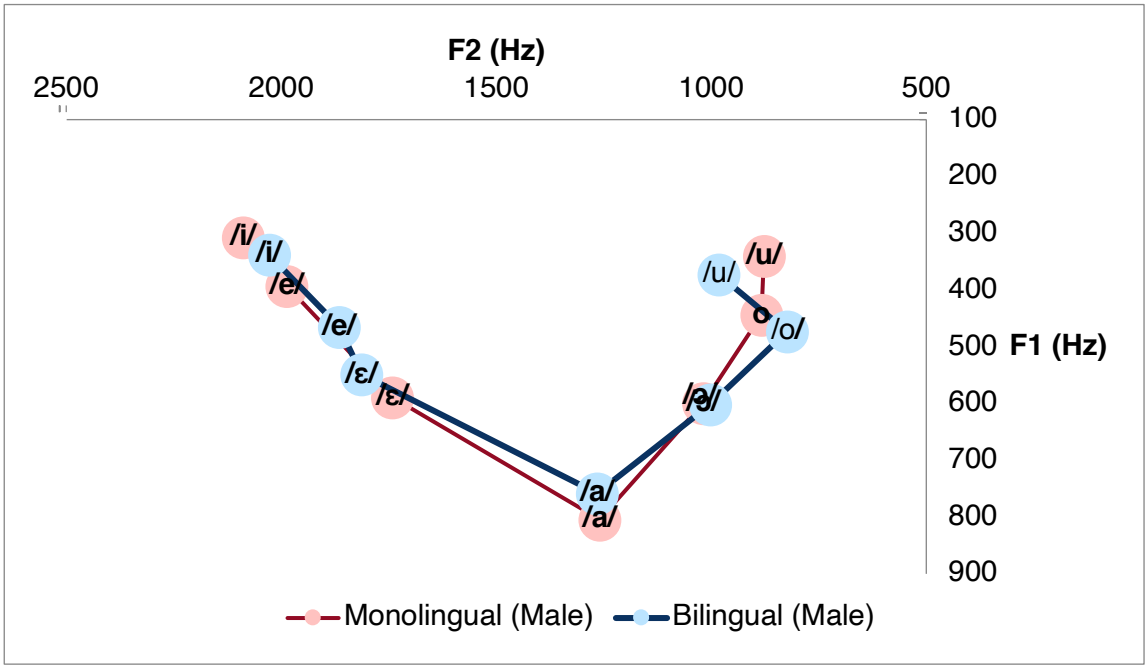

Figure 53: L1 phonological change in male Slovene-English late consecutive bilinguals

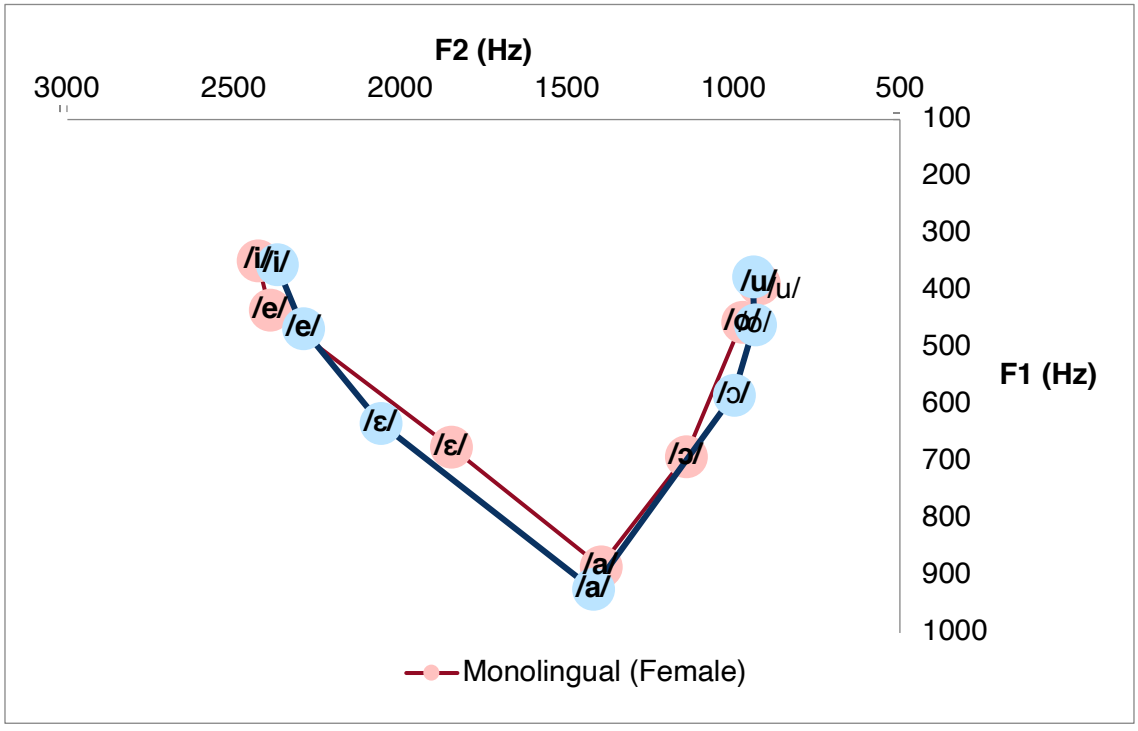

Figure 54: L1 phonological change in female Slovene-English late consecutive bilinguals

From the above measurements it could be hypothesized that the Slovene vowel sounds of /e/, /o/ and /ɔ/ could have undergone the process of L1 phonological change, as they have moved away from the monolingual norms/space. Therefore, in order to address the research question of '*Is there evidence of phonological change in the L1 Slovene vowel system of late consecutive Slovene-English bilinguals?*' and calculate whether the obtained Euclidean distances are statistically significant, linear mixed-effect regression analysis was completed in R-studio.[38] The results of the analysis are shown in table form below (Table 15).

Table 15: Linear mixed-effects model analysis of Slovene-English combined vowel space (acoustic data)

Random effects:

Groups	Name	Variance	Std.Dev.
Word	(Intercept)	0.002292	0.04787
Residual		0.063495	0.25198

Number of obs: 1062, groups: Word, 18

Fixed effects:

Column1	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	1.66E+00	4.54E-02	3.63E+01	36.485	< 2e-16 ***
BIlingualMonolingualM	-3.79E-03	5.30E-02	1.02E+03	-0.072	0.9429
Vowele	-2.09E+00	6.44E-02	3.68E+01	-32.448	< 2e-16 ***
Vowelɛ	-1.11E+00	6.56E-02	3.96E+01	-16.863	< 2e-16 ***
Voweli	-2.60E+00	6.38E-02	3.55E+01	-40.712	< 2e-16 ***
Vowelo	-1.98E+00	9.27E-02	3.94E+01	-21.402	< 2e-16 ***

[38]The analysis described in the following section was carried out with help from my previous supervisor Melanie Bell and will contribute to a joint publication (Bell & Nolimal, in preparation *'Does L2 immersion cause non-native-like L1 pronunciation in Slovene-English late consecutive bilinguals')*

Vowelɔ	-1.23E+00	7.77E-02	4.84E+01	-15.861	< 2e-16 ***
Vowelu	-2.45E+00	6.38E-02	3.55E+01	-38.446	< 2e-16 ***
formantF2	-2.16E+00	5.09E-02	1.02E+03	-42.327	< 2e-16 ***
BIlingualMonolingualM:Vowele	-1.44E-01	7.54E-02	1.02E+03	-1.914	0.0558
BIlingualMonolingualM:Vowelɛ	-2.02E-02	7.62E-02	1.02E+03	-0.265	0.7908
BIlingualMonolingualM:Voweli	-9.09E-02	7.46E-02	1.02E+03	-1.219	0.2233
BIlingualMonolingualM:Vowelo	-6.34E-02	1.08E-01	1.02E+03	-0.589	0.5557
BIlingualMonolingualM:Vowelɔ	1.79E-01	8.89E-02	1.03E+03	2.016	0.0441 *
BIlingualMonolingualM:Vowelu	-4.21E-02	7.46E-02	1.02E+03	-0.565	0.5724
BIlingualMonolingualM:formantF2	4.91E-02	7.49E-02	1.02E+03	0.655	0.5128
Vowele:formantF2	3.53E+00	7.24E-02	1.02E+03	48.819	< 2e-16 ***
Vowelɛ:formantF2	2.10E+00	7.45E-02	1.02E+03	28.21	< 2e-16 ***
Voweli:formantF2	4.21E+00	7.13E-02	1.02E+03	59.112	< 2e-16 ***
Vowelo:formantF2	1.33E+00	1.05E-01	1.02E+03	12.653	< 2e-16 ***
Vowelɔ:formantF2	7.22E-01	9.01E-02	1.02E+03	8.012	3.07e-15 ***
Vowelu:formantF2	1.80E+00	7.13E-02	1.02E+03	25.297	< 2e-16 ***
BIlingualMonolingualM:Vowele:formantF2	2.12E-01	1.07E-01	1.02E+03	1.993	0.0465 *
BIlingualMonolingualM:Vowelɛ:formantF2	-1.29E-01	1.08E-01	1.02E+03	-1.196	0.2319
BIlingualMonolingualM:Voweli:formantF2	1.45E-01	1.06E-01	1.02E+03	1.375	0.1694
BIlingualMonolingualM:Vowelo:formantF2	7.86E-02	1.52E-01	1.02E+03	0.516	0.6056
BIlingualMonolingualM:Vowelɔ:formantF2	-1.16E-01	1.25E-01	1.02E+03	-0.929	0.3529
BIlingualMonolingualM:Vowelu:formantF2	-7.93E-02	1.06E-01	1.02E+03	-0.751	0.4526

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

As evident in the above Table 15, there is a significant random effect for the word spoken, and a significant interaction between fixed effects for speaker group (B/M), vowel and formant.[39] On average, the monolingual and bilingual groups show

[39] **Optimal model formula used in the analysis:**
fNorm ~ BIlingualMonolingual + Vowel + formant + BIlingualMonolingual:Vowel + BIlingualMonolingual:formant + Vowel:formant + BIlingualMonolingual:Vowel:formant + (1|Word)

significant differences (the shaded values show statistical significance) in their pronunciations of /ɔ/ (F1 and F2) and /e/ (F2 only, although there is a marginally significant difference in F1), which would suggest that Slovene-English late consecutive bilinguals have undergone the process of L1 phonological change as evident in individual vowel sounds.

Overall, the analysis of vowel system vowels produced interesting results. Considering the first research question 'Is there evidence of phonological change in the L1 Slovene vowel system of late consecutive Slovene-English bilinguals?', it is clear that evidence was found within the L1 Slovene-English bilinguals vowel system. Moreover, the analysis showed L1 changes only in certain vowel sounds. Below the more in-depth discussion of these results follows.

4.1.1. Discussion

The main question of this thesis concerned the question of whether late consecutive Slovene-English bilinguals can be subject to the process of L1 phonological change. Previous research (see Chapter 2) indicated that changes in the vowel system may indeed be possible—the above results confirm the findings of previous studies, where statistically significant differences were found in individual vowel sounds. To better understand these results in terms of current linguistic theory and to support why these findings may raise problems for some existing theories, Table 16 synthesizes the 'end states' predicted by the L2 models previously reviewed in Chapter 2. These have been formerly used to account for L1 phonological changes in bilingual speakers and outlines, which theoretical models could be applied to the results of this study. The 'end state' of L2 learning may be considered the 'initial state' of L1 change/attrition. The idea that the 'end state', the upper limit of attainment could be perceived as the 'initial state' of L1 change or attrition is linked to the concepts presented by de Bot in the Dynamic Systems Theory (DST),[40] where he suggested "language attrition [is] a normal part of language development" (de Bot, 2004: 233). By considering L1 change as a natural development, one could also postulate that there

[40] DST was first associated with first language change (attrition) by Herdina and Jessner (2002) and later developed by de Bot (2004).

is no 'end state' for L2 acquisition, but only the continuation of the process and the L1 change could be seen a reverse process of L2 acquisition.

Table 16: L2 models 'end state' (adapted from Escudero, 2005: 145)

L2 models	Predictions for L1 Slovene – English bilinguals	Able to account for the L1 changes in Slovene-English bilinguals?
OPM (Ontogeny Phylogeny Model) **(Major, 2001)**	Possibly intermediate	No
PIM (Phonological interference model) **(Brown, 2000)**	Not explicit	No
L2LP (Second Language Linguistic Perception) **(Escudero, 2005)**	L2 can be optimal L1 is not affected = Optimal language modes	No
PAM (Perceptual Assimilation Model) **(Best, 1995)**	Not explicit	Partly
PAM-L2 (Perceptual Assimilation Model for Language Learners) **(Best & Tyler, 2007)**	Late L2 learners = L1 phonology impact L2 perception; L2 vocabulary size correlated with L2 speech learning Early L2 learners = language mode influences perceptual categorization of L1 and L2 contrast (Best, 2014)[41]	Yes
SLM (Speech learning model) **(Flege, 1987, 1995)**	Early = More native-like No perfect / optimal bilingual No monolingual modes	Yes
NLM (Native language magnet) **Kuhl (1993)**	L1 maps & L1 categories	No, however the extension of the model NLM-e can partly address the outcomes
Phonetic drift **(Chang, 2010, 2012)**	Rapid phonetic drift in L1 as a consequence of experience in an L2	Yes

[41] lpp.in2p3.fr/presentations/Conferences.../XLangBilingual_LABEX_2014.pptx.pdf

This line of thinking complies with Keijzer's (2008) concept of language hierarchy that proposed various stages of L1 change. Specifically, she suggested L1 change progresses in a reverse order of L2 acquisition the areas of vocabulary/lexicon are first to be affected, whereas generally phonology, if at all, is affected last. Additionally, she proposed that within the language area, similar hierarchies exist that govern which features are more prone to language change/attrition. In other words, if relating this idea to the study at hand, Slovene-English bilinguals' phonological system has not been fully affected, due to being the highest in the hierarchy and consequently, in the process of L1 phonological change, only certain changes are evident.

Firstly, an explanation for the obtained results may be found in the most frequently reviewed L2 model in the area of second language acquisition, which was only later applied to the studies of L1 phonological change/attrition—the Speech Learning Model (SLM) proposed by Flege (1995). According to this SLM (Table 16) the extralinguistic factor of age will be the one that most likely impacts the bilinguals' 'end state'. In terms of this being the initial state of L1 change, one may assume that Slovene-English late consecutive bilinguals may show signs of L1 change due to a single common L1-L2 phonological space. This 'common phonological space' is further affected by age-related changes that will dictate the interaction of the L1-L2 subsystems. For example, Flege (1995) suggests the L1 phonetic categories will become more powerful 'attractors' of the L2 sounds (they will not allow new category formation), as the person develops through childhood into adulthood (Walley & Flege, 2000; Johnson, 2008). This idea suggests that the Slovene-English late consecutive bilinguals face significant barriers when acquiring new L2 phonetic contrasts, due to established L1 phonetic categories. Therefore, it may be likely that due to these barriers the Slovene L1 changes were only evident in some vowel sounds and not others.

Further, SLM predicts that the L2 end state is underlined and governed by the two mechanisms of assimilation and dissimilation, which are dependent on the bilinguals' age. The so-called 'Interaction Hypothesis' (IH) suggests that L1 and L2 will continue to influence each other to some degree; however, the level of this degree is based on the onset of L2 learning: the earlier the bilingual is exposed to the L2, the higher the likelihood of achieving more native-like competency. However, Flege (1995) specifically claims there is no such state, as a 'perfect or optimal' bilingual (Table 16). This may be particularly significant to Slovene-English bilinguals, as most of the bilinguals were 'passively' exposed to English (L2) in their childhood, which

would consequently suggest that they are more likely to achieve higher-level proficiency in the L2 and may explain the results found when analyzing individual vowel sounds, as the changes in L1 were evident. On the other hand, Slovene-English bilinguals did not 'actively' start using English (as their L2) until later in life, which could explain why these changes were not significant in all vowel sounds.

As mentioned above, one of the key mechanisms, which according to Flege *et al.* (2003) governs the L2 end state, is the process of assimilation. During this process, a new phonetic category fails to be established, even though distinct differences between the L1 speech sound and L2 speech sound are perceived. The category formation would continue to be blocked if the L2 speech sound continues to be identified as an L1 speech sound. To some extent, this is the process that may be active in Slovene-English bilinguals, as the changes were not evident on a system-wide level (effecting all vowel sounds), and it could consequently be assumed that a 'new' category formation failed to be established. However, it ought to be pointed out that Flege (1995) based most of his conclusions on analyzing individual vowel sounds, therefore these conclusions may not be generalizable to the entire vowel system.

Therefore, this L2 model (SLM) seems to best account for changes that occurred on the level of individual vowel sounds. Specifically, based on the changes observed in the Slovene vowel sounds, one may predict that the Slovene-English bilinguals had undergone the process of dissimilation, as during this process, a new category or new phoneme is established for an L2 (English) sound (this triggers a change in the phonetic space, as the L1 vowels and newly established L2 vowels shift away from each other). This tends to occur as the bilinguals strive to maintain phonetic contrast between all speech sounds in the common phonological space (Flege *et al*., 2003).

Figure 55 graphically presents the vowel space and the possible outcomes of L1-L2 interactions of Slovene-English bilinguals' vowel space that may occur due to the previously mentioned pressures in the combined vowel space. What is also evident in Figure 55 is Best's (1995) proposal of various category assimilation types. For example, Slovene vowel sound /e/ and English vowel sound /e/ follow the principles of Single Category assimilation, whereas Slovene vowel sound /i/ and English vowel sounds /i/ and /ɪ/ followed the principles of Two-category assimilation. Additionally, English vowel sound monophthong /ae/ displays clear signs of a dissimilation. What is also evident from Figure 55 is that when the Slovene L1 and English L2 categories failed to be assimilated, new categories were established for the L2 English sounds (e.g. /ʌ/).

This would also explain the changes in the Slovene (L1) sounds, as some vowels did not resemble the Slovene monolingual norms. According to Flege, Schirru & MacKay (2003:471), the category dissimilation could 'only occur if a new L2 category would be relatively close in phonetic space to a pre-existing L1 category'. This may have been the case with Slovene-English bilinguals, whose L1 Slovene vowels were indeed phonetically close to the L2 English vowel in the combined vowel space.

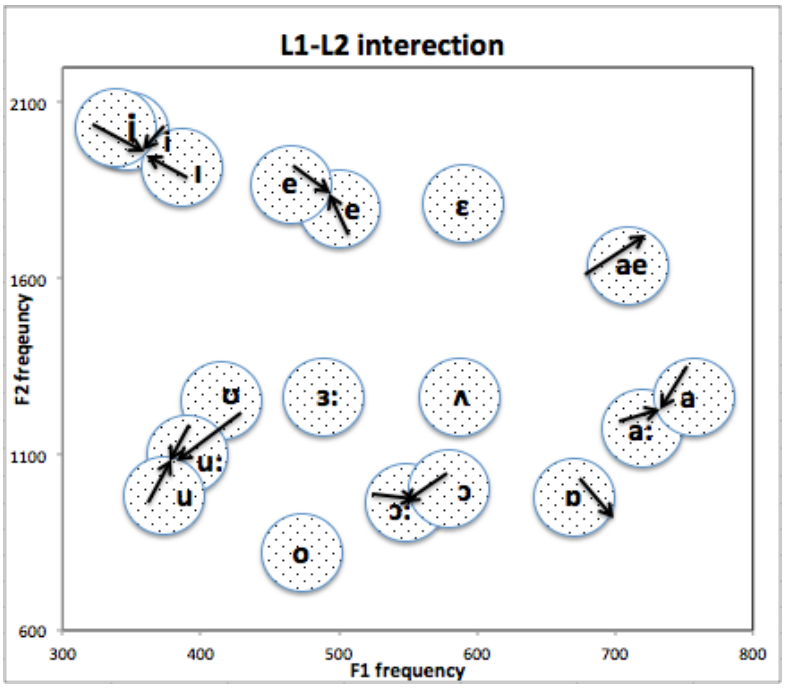

Figure 55: The process of assimilation and dissimilation in Slovene-English bilingual speaker

Further, according to the SLM (Flege, 1995) the greater the perceived phonetic dissimilarity, the higher the likelihood of a new L2 category formation. The dissimilatory effect is most likely to occur in the early simultaneous bilinguals, as they are more likely to have formed separate phonetic categories for the L2 sounds, due to the fact they started to acquire an L2 in childhood before neurological maturation. However, clearly the dissimilatory effect was also evident in Slovene-English bilingual speakers. Similar evidence was presented in the work of Mack (1990) in early French-English bilinguals, where the examination of the VOT showed evidence of dissimilatory effects and consequently the formation of new sound categories. Additionally, similar results were found in Flege and Eefting's (1987) study of Spanish-English bilinguals, who formed new phonetic categories for the English speech sound

/t/. Recurrently, it could be argued that the Slovene-English bilinguals' early exposure to their L2 (reported as early as the age of 10) has significantly impacted their learning in adulthood.

Alternatively, the obtained results could also be explained in terms of the intralinguistic factors first examined in Chapter 2, where perceptual similarity test and measured acoustic similarity test well-predicted cross-language Slovene-English patterns and linkage, with varying degrees of measured consistency, despite previous literature suggesting that vowel acoustic proximity does not necessary follow perceptual assimilation of vowels (Chang, 2010). Specifically, these tests predicted the direction of the L1 phonological change for vowels in Slovene-English late consecutive bilinguals. Initially, the results of the phonological similarly tests predicted that the Slovene-English late consecutive bilinguals would most likely assimilate most of the L2 vowel sounds (English) to their L1 vowel sounds (Slovene), due to the similarity between vowel sounds. However, it ought to be noted that these initial predictions did not take into account the significance of extralinguistic factors, in particular the significance of L2 input and contact.

Both measured and tested phonological similarity predicted that Slovene vowel /i/ will assimilate to English vowel /i/. However, Slovene-English bilinguals did not pronounce Slovene /i/ in accordance to Slovene monolingual norms, but they did pronounce English /i/ in line with the English monolingual norms, suggesting they have created a new category for an English vowel sound. Similar conclusions may be drawn between Slovene vowel sound /a/ and English vowel sound /ɑ:/ and Slovene /u/ and English /u:/. Additionally, the phonetic symbol test suggested that Slovene /e/ and English /e/ should be considered similar if not identical vowels, as they are presented in the IPA alphabet as the same vowel sound. However, the test that measured acoustic similarity calculated a large distance between sounds—consequently suggesting that these two sounds were not assimilated. It seems like Slovene-English bilinguals' vowel system strived to maintain contrast, which consequently resulted in Slovene /e/ shifting away from both L1 and L2 norms. Both measured and tested phonological similarity suggested assimilation, however, Slovene-English bilinguals did not pronounce these specific Slovene vowels in line with the Slovene norms, but did produce English vowels, again providing empirical evidence for the process of dissimilation.

However, one may argue that the process of assimilation could also be observed in Slovene-English bilinguals as the change was not observed in all vowels sounds: a new phonetic category failed to be established, even though distinct differences

between the L1 speech sound and L2 speech sounds were perceived. This leads to the question of whether both processes of assimilation and dissimilation could possibly be observed in a process of Slovene-English bilinguals' language development.

The L2 model that may be able to account and shed further light on these conflicting results was proposed by Best (1995) and Best & Tyler (2007). Firstly, the Perceptual Assimilation Model (PAM) assumes that the naïve listeners categorize sounds according to the phonetic and phonological familiarity. This familiarity is guided by the articulatory gestures that are used to produce L1 sounds and are also used to produce the L2 sounds, whereas the later updated version of the Perceptual Assimilation Model for Language Learners (PAM-L2) suggests that L2 perceptual similarity can predict the degree of difficulty the individual will face while acquiring a second language. It posits that for the L2 sounds to be discriminated accurately, L2 sounds need to be assimilated to a different L1 category; if that does not occur the speech sounds will be discriminated less accurately. This may be the case for the L2 English sounds that had not been produced to monolingual norms by Slovene-English bilingual speakers.

The PAM-L2 also 'allows' for the potential L2 influence on the L1 due to a common phonological space, as the L2 learners and/or late consecutive bilinguals have access to the same language faculty and mechanisms as during L1 acquisition, intimating the possibility of L1 phonological change/attrition. Additionally, Best and Tyler's (2007) ideas concur with SLM's (Flege, 2005: 92-93) hypothesis, which states that the "processes and mechanisms that guide successful L1 speech acquisition remain intact and accessible across the life span". However, Best & Tyler (2007) emphasize that individuals can easily adapt to "changes in the ambient language environment" (Best & Tyler, 2007:19). Furthermore, PAM-L2 predicts that the L2 sound that is acoustically closer in the combined vowel space is likely to be perceptually linked to the L1 sound: Slovene vowel sounds are indeed phonetically close to the L2 English vowel sounds. Consequently, the results of the individual vowel analysis of a combined Slovene-English vowel system follows the predictions made by the L2 model PAM-L2.

In addition, the PAM-L2 model takes into account the individuals' continuing development of the phonetic and phonological knowledge, as it claims that perceptual learning is possible to occur at any stage, regardless of the age of the learner; yet again calling into doubt the notion of the Critical Period (Lenneberg, 1967). It also proposes that the learning mechanisms will be guided by the learner's L2 experience, suggesting

the impact of other factors. In particular, PAM-L2 suggested that the L2 vocabulary size is closely correlated with L2 speech learning, which guides L1-L2 linkage and consequently L1 change. L2 learners with a larger L2 vocabulary size may be more consistent with their vowel assimilation patterns in comparison to the L2 learners with smaller vocabulary output. Specifically, the perception of L2 vowels is guided by the L1 vowel inventory, meaning that the L2 learners with a smaller L1 vowel inventory are more likely to identify a specific L2 sound as 'similar' or 'identical' to the one in the L1 (Iverson & Evans, 2007), consequently 'merging' the sounds (Flege, 1987). The L2 learners with the bigger L2 vocabulary are able to phonologically reorganize the L2 phonological system, meaning they were able to perceive more accurately the L2 sounds. Bundgaard-Nielsen *et al.* (2011) suggest that due to the 'forceful linguistic pressure' exerted by the L2 vocabulary, L2 learners will be broadening their vowel inventory. However, as no proficiency tests were used in this study, it is difficult to establish whether Slovene-English bilinguals L2 vocabulary size effected their L1 production.

Another L2 model that may be able to explain and account for the results of the whole vowel system is Major's (2001) concept of 'Ontogeny Phylogeny Model' (OPM). Similar to Flege's (1995) SLM, OPM attempts to describe the principles under which bilinguals' L1 and L2 phonologies may merge and the changes would be evident in the L1 as a result of the L2 influence. However, Major's (2001) model does not explicitly outline how L1 sounds may be mapped to L2 sounds and argues certain universal principals govern L1-L2 linkage (Table 16). Major (2001) argues that this is a strength rather than a weakness of the model, as this provides the researcher with a framework that allows for individual observations. Consequently, this model poses difficulties when attempting to apply it to the results obtained in this study.

Additionally, OPM makes generic claims that the language develops chronologically; specifically, as the language features in L2 increase, the language features in L1 decrease. To elaborate, Major (2001) proposes a positive linear relationship between acquiring the L2 features and time, which could imply that the extralinguistic factor of length of residence (LOR) may play a significant role in L2 acquisition. Additionally, the LOR plays a significant role in L1 change/attrition as Major (2001) proposes a negative linear relationship between L1 features and time, indicating that over time (the increase in LOR) the L1 may be impacted, due to the interference of L2 (Figure 56). These general ideas may be of significance when

reviewing the factors that influence L1 phonological change and will therefore be revisited in the subsequent sections.

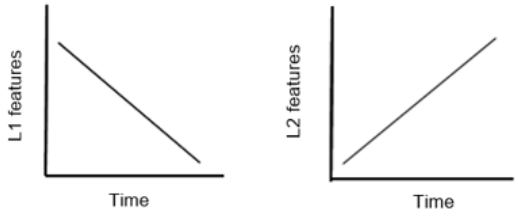

Figure 56: The Ontogeny Phylogeny Model (OPM)

Nevertheless, these ideas are rather generic as most of the OPM assumptions are based around an 'idealized' L2 learner within a macro level framework.[42] Therefore, these ideas may pose difficulties when trying to apply this model in practice, in particular when trying to apply these ideas to the results obtained in this study.

A model that may be able to account for these results is the Native Language Magnet (NLM) model proposed by Kuhl (1995). This suggests that in childhood the L1 native phonemic categories are developed and consequently in adulthood listeners will have difficulties developing new non-native phonemic categories. The model suggests this is because native categories have a magnet-like effect, which makes it difficult for adult bilinguals to discriminate between native and non-native sounds (Kuhl *et al*., 2008). The NLM model was further revisited and extended to NLM-e (Kuhl *et al*., 2017) that incorporates five 'new' principles. One of these principles proposes that language exposure produces a neural commitment that affects future learning, again proposing that the early exposure to the language will shape bilinguals' ability to learn new phonetic categories. Further, their concept of Native Language Neural Commitment (NLNC) proposes that the process of language exposure will result in physical changes, which makes acquiring new categories in adulthood difficult (Kuhl *et al*., 2017: 983).

In contrast to SLM (Flege, 1987), NLM predicts an asymmetry for the discrimination, as the prototypes (or phonemes in this case) will fail to be developed

[42] In this thesis, the micro level term is referring to the areas of microlingusitics, which focusses on changes that occur within the individual's language (in areas of semantics, pragmatics, syntax and phonology). In contrast, the terminology of a macro level directly relates to the area of macrolinguistics, which observes how the language functions in larger social context (Enfield, 2005).

due to lack of relevant acoustic experience. Consequently, at the 'end state', the L2 categories will be mapped onto the L1 categories, which would suggest the impossibility of L1 change (Table 16). Considering the results obtained from the analysis, the NLM model could not be applied as some significant changes were observed in Slovene-English late consecutive bilinguals' vowel sounds, suggesting the L2 English vowel sounds could not have mapped on the L1 Slovene sounds and bilinguals did not retain their L1 properties. These results, however, could be explained by the extended NLM-e model, which proposed a principle of social interaction that influences the early language learning at the phonetic level and the principle of the perception-production link that progresses developmentally (Kuhl *et al*., 2017: 984). Specifically, the early exposure to L2 through social interaction that some Slovene-English bilinguals reported in their sociolinguistic questionnaire (Appendix 7) may have influenced their phonetic categories as well as their perceptual representations that are bound to their speech production.

Additionally, the extension of the NLM-e model proposes that there is no such constraint as maturational limitation and the idea of a critical period, but rather, a language system continues to be developed until stability is reached. However, the question remains: 'When bilinguals are learning and using two or more languages simultaneously, could this stability ever be reached?' It could be assumed that the optimum sensitivity to phonetic learning may be 'ideal' in childhood, however, no 'restrictions' could ever be applied to the continuation of language learning. This suggests that the obtained results observed in Slovene-English bilinguals were not a consequence of age-related or maturational constraints, rejecting previous conclusions of an UG effect. It is rather more likely that these results confirm De Leeuw's (2010) idea of parameter 'resetting' probability, where exposure to the L2 significantly influences the L1.

An alternative L2 model that has been reported in the literature is Second Language Linguistic Perception (L2LP). Interestingly, the L2LP model (Escudero, 2005, 2009) predicts that at the 'end state' of L2 learning, the L1 will not be affected (Table 16). This suggests that L1 phonological change may not possible, which does not coincide with the changes observed in a combined Slovene-English vowel system. The main idea of the L2LP model stems from the *optimal perception hypothesis* (Escudero, 2005, 2009), which suggests that bilinguals will initially perceive and produce L2 sounds as equivalent to L1 sounds, suggesting the results of L1 acquisition will represent the initial state of L2 learning and shape the acoustic similarity, as well

as perceived differences in speech sounds (van Leussen & Escudero, 2015). In contrast to the SLM, which focuses on the individual sounds, L2LP as well as PAM focus on the perceptual development of sounds and the mechanism underlying category formation. Regardless of the significant contributions, both theoretically and methodologically the L2LP model fails to predict the outcome of Slovene-English bilinguals' L1 change. However, in a 2015 revised model the author acknowledged the possibility of a reverse scenario, where the L1 category ceases to exist due to the L2 category formation (van Leussen & Escudero, 2015).

Similar to the L2LP model, Brown's Phonological Interference Model (PIM) fails to account for the changes noted in this study as it proposes that L2 sounds will be acoustically mapped to L1 sounds. Consequently, it could be posited that L1 will not be affected and no L1 phonological change will take place, which contrasts this study's results.

Additional findings that ought to be reviewed when considering the results of a whole vowel system are additional changes that were noted in the analysis of the Slovene-English bilingual vowel system. Overall, the combined vowel system of Slovene-English late consecutive bilinguals evidenced an overall increase in the first vowel formant frequency (F1) meaning the vowel system shifted up and significantly shifted back due to the decrease in the second vowel formant (F2). These results could confirm Mary *et al.*'s (2012) results, where a Dutch-English bilingual displayed a systematic increase in the first vowel formant (F1). However, in their study they reported a shift of L2 sounds, rather than L1 sounds. In their study they termed this phenomenon a 'polarization effect'—where a bilingual has acquired separate representations of the sounds in the two languages and is attempting to differentiate between them. Mayr *et al*. (2012) suggest these results confirm the claims that L1 and L2 vowels are linked on a system-wide level, similar to the results reported by Chang (2010, 2011) and Guion (2003).

Additionally, the direction of the vowel shift is not surprising—Slovene vowels shifted towards SSBE vowels, as they are generally more open than their Slovene counterparts. Mayr *et al*. (2012: 696) proposed this might be due to the human auditory system, which exhibits greater sensitivity towards lower frequencies (Fabio-Smith & Goldstein, 2010) and makes the change in the first vowel formant more likely. However, it remains unclear under which specific mechanisms L1-L2 linkage is possible. Chang (2010) suggested that there might be a possibility that, over time, the bilinguals' L1 vowel frequencies are attuned to the L2 vowel frequencies.

Specifically, in a study of Quichua-Spanish bilinguals, Guion (2003) found that the late consecutive bilinguals produced vowels in both languages with L1-like properties, suggesting no L1 phonological change has taken place. However, the subjects who had started learning Spanish earlier (early and mid-bilinguals) exhibit 'changes' in their L1, to the extent that the bilinguals' vowels were consistently produced with higher formant values in contrast to the monolingual norm, suggesting the L1 phonological change had taken place. This also suggests that the Slovene-English late consecutive bilinguals' early exposure to the second language (some as early as the age of 10) had significantly impacted their language development in their adult life. Regardless that these bilinguals were not actively using the L2 or were being exposed to their second language in their adolescent years, or had not been immersed in the L2 environment—the impact of casual exposure to the L2 could be the explanation for the results obtained.

Further, Guion (2003) reported a shift in the L2 vowels space in the direction of L1 vowels. He offered the explanation in terms of Adaptive Dispersion Theory (ADT) (Lindblom, 1986), where the vowel system organizes itself in response to the need for greater perceptual distinctiveness. This idea may link to the previous observation where the Slovene-English common vowel space may be too crowded (seven Slovene vowel sounds and eleven English vowel sounds) and is consequently displaying signs of vowel dispersion or the need for the two phonological systems to organize themselves in response to the need for greater perceptual distinctiveness (Guion, 2003; Lindblom, 1986). Additionally, ADT could also explain the changes observed in the movement of the vowel system and the clear deviations from the monolingual norms.

Parallels could also be drawn with the study conducted by Mayr *et. al. (*2012), who investigated the VOT values and vowel changes of 62-year-old Dutch-English bilingual monozygotic twins. These two bilinguals displayed a shift of the L2 sounds, rather than the anticipated L1 sounds, similar to the observations made in this study, where the changes in Slovene-English late consecutive bilinguals were mostly observed in the L2 vowel sounds. Mayr *et. al.* (2012) explained these findings in terms of a 'polarization effect', where a bilingual has acquired separate representations of the sounds in the two languages and is attempting to differentiate between them. These findings would also be in line with the findings reported by Flege *et al*. (2003), who found the polarization effect of the vowel sound /e/ in early Italian-English bilinguals. This further contributes to the idea that regardless of the fact that Slovene-English bilinguals first learnt their L1 and later in life immigrated to the L2 country, the effect

of starting to acquire an L2 during puberty has significantly impacted their L2 learning later in life.

In contrast, Chang (2010, 2011) reported the shift in the L1 vowel space in the direction of L2 vowels. The results of this study are similar to the results obtained from Chang (2010, 2011) as the Slovene vowel sounds (L1) shifted in the direction of the English vowel sounds (L2). Chang offered a possible explanation in terms of an assimilatory process that has been previously reported by Flege (1987) and Major (1992). The discrepancy between Chang's and Guion's studies was reported to be due to the onset of L2 learning: Guion made his conclusions based on early simultaneous bilinguals, whereas Chang reviewed changes in late consecutive bilinguals. Due to this additional element, it would be reasonable to conclude the results of this study are more in line with the results reported by Chang (2010, 2011), as Slovene-English bilinguals, due to late emersion into the L2 environment, are considered to be late consecutive learners of L2 (they were immersed and started actively learning and using the L2 post-puberty).

The idea of a shift in the vowel system, rather than a phonological restructuring of the L1 system, was explored further by Chang (2010, 2011) in terms of phonetic drift (Table 16), i.e. changes in the L1 system that do not imply the loss of L1, as the bilinguals' L1 production does not necessarily deteriorate. Specifically, Chang (2010) investigated the L1 phonological change of English-Korean late consecutive bilinguals, with the focus on novice L2 learners, in contrast to the vast majority of previous studies that limited themselves to either advance or native-like proficient learners. The aim of his study was to investigate why and how phonetic drift occurs, also considering the sociolinguistic factors, and specifically the influence of the L2 experience during second language acquisition. Chang (2010) reported that across both genders, female and male participants 'drifted away' from the monolingual norms. These results are in stark contrast to Flege's (2005)[43] proposal that L2 learners will only when given adequate and sufficient input, perceive the phonetic properties of L2 speech sounds accurately.

Additionally, the vowel drift did not only occur on the level of individual sounds but acted as a global shift in formant frequencies across the whole vowel system, bringing vowel categories more closely together. Chang (2010) referred to this

[43] jimflege.com/files/Vancouver_April_2005.pdf (accessed on 11/12/2016)

phenomenon in terms of a *cross-linguistic vowel space*, where both L1 and L2 vowel spaces are interlinked and showing high levels of connectivity, similarly to Flege's (2005:93) terminology of a "common phonological space", where phonetic elements that make up the L1 and L2 phonetic subsystems exist. In his 2011 paper, Chang (2011:430) even suggested that this phenomenon is systematic, as "*instead of [sounds] drifting in disparate directions, the English vowels moved upward in similar fashion, approximating the Korean vowel system in accordance with basic differences between the two languages' vowel inventories. Thus, the movement was systematic, rather than a sum total of assimilatory changes in individual L1 vowels.*". Generally, this shift could be described in terms of a short-term unidirectional drift, where generally L1 properties have the tendency to approximate L2 properties. The results obtained from this thesis' study, therefore coincide with Chang's (2010) proposal of phonetic drift: in the Slovene-English cross-linguistic vowel space, Slovene vowels systematically shifted in the direction of English vowel sounds; the L1 changes are evident in all vowel sounds even if not reported to be significant.

Overall, some of the L2 models struggle to account for all the aspects of L1 phonological change reflected in this study's results. Nevertheless, these results may be explainable when considering a combination of various models, theories and previous empirical evidence. Some L2 models, in particular Kuhl's NLM-e (2008), were able to account for the results obtained from my whole vowel system analysis and Chang's idea (2010) of 'phonetic drift' seems a reasonable explanation of the shift observed in the vowel system. Additionally, it may be concluded that the results obtained from both acoustic and tested phonological similarity did not accurately predict the outcome of the production of Slovene-English bilingual vowel sounds. This may be due to the rigid framework of such analysis that does not take into account the extralinguistic factors that had also clearly impacted such a change; specifically, the early age of exposure to the L2, L2 exposure/contact. Therefore, it may be concluded that intralinguistic factors alone are not sufficient at predicting L1 phonological change. However, Best and Tyler's (2007) PAM-L2 model was able to sufficiently explain the changes observed in individual vowel sounds, therefore making it one of the most pertinent models to L1 phonological change or L1 attrition. Consequently, there is a need for a more flexible, yet effective theory or framework that would take into consideration recent studies and the results obtained in the field of L1 phonological change/attrition. Specifically, it would require a theory that considers both the production and the perception of bilingual speakers, as well as the impact of intralinguistic and extralinguistic factors.

For the moment, the question remains whether these changes are perceivable to the monolingual speakers of both Slovene and English naïve listeners. Therefore, the next section will address the second research question: ‘Are the changes in production, perceivable to the monolingual listeners’.

4.2 Global foreign accent rating task analysis

The aim of this section is to present the results of the global foreign accent rating task (GAR), which examined the foreign accented speech in the Slovene-English late consecutive bilinguals, where naïve listeners of both languages (Slovene and English) were asked to make a substantial number of judgments to validate the occurrence of a foreign accent (see Appendix 5: Global foreign accent) with the aim of answering the second research question 'Are the changes in production, perceivable to the monolingual listeners?'.

The global accent rating (GAR) was calculated from the operative nine-point Likert scale by averaging the ratings of all naïve listeners (Figure 57 and Figure 58), thus assessing bilinguals' L1 or L2 speaker status. Various methods have been reported in the literature as to how to calculate the 'cut off' points on overall items to be able to draw conclusions. However, no census of the 'best' method has been reached. One way of calculating such a 'cut off' point would be to base calculations central tendency summarized by the median score. Using this method, Slovene-English bilingual speakers with a lower global accent rating (GAR) could be assumed to have a stronger foreign accent (<5) and speakers with a higher GAR could be assumed to have a low or non-existent foreign accent (>5); a rating of 1 on a nine-point Likert scale represented the most foreign accented speech, whereas a rating of 9 on a nine-point Likert scale represented a definite L1 accent.[44] In other words, if Slovene naïve listeners had given a higher rating, this may be interpreted as evidence that the phonological change was less obvious in speech perception, regardless of whether it has manifested in production. In contrast, if Slovene naïve listeners gave a lower rating, this was

[44] This procedure is similar to the one reported by De Leeuw (2009) in her study of 34 L1 German-English and 23 L1 German-Dutch bilingual speakers. In her study, she proposed that on the 6-point Likert scare, the value of 6 represent the certainty of non-native speaker status, whereas the value of 1 presents the certainty of a native speaker status. In contrast to De Leeuw (2009) study, in which she has used a 6-point Likert scale, this study used 9-point scale, which has been reported to allow listeners to rate more adequately the variations in the perceived degree of foreign accented speech, thus assuring higher rates of accuracy (Southwood & Flege, 1999).

interpreted as evidence that the phonological change is perceivable to Slovene monolingual listeners. Similarly, if English naïve listeners gave higher GAR, this was interpreted as additional evidence of phonological change.

The second method of calculating 'cut-off' points is by a mean interval scale using a formula: Likert scale = (Maximum – Minimum) / Group. For a 9-point Likert scale used in this study that is 0.88. (=(9-1)/9). The mean interval scale for the study at hand is present in Table 17. This further allows for the scale to be ranked into three categories: *1. Non -native* with a range of 1-3.7; *2. Uncertain* with a range of 3.71-6.3; and *3. Native* with a range of 6.31 – 9. Similar to the first method, if Slovene naïve listeners had given a higher rating above 6.31, this may be interpreted as evidence of L1 phonological change.

Table 17: Mean interval scale and ranked categories for GAR

Mean Interval scale	Ranked categories
1- 1.9	
1.91-2.8	Non-native
2.81-3.7	
3.71-4.6	
4.61-5.4	Uncertain
5.41-6.3	
6.31-7.2	
7.21-8.1	Native
8.11-9	

Since there is no established 'gold' standard for calculating 'cut-off' points in Likert scale, for the purposes of this study the second method of calculation had been used.

Additionally, it is necessary to calculate the internal consistency of all items on the scale by employing Cronbach's alpha coefficient, which has been designed to test whether all items on the scale are working together and that each individual rating is in fact representative of the listeners' ratings as a group. The calculated Cronbach alpha coefficient for English listeners' set of data was 0.88 indicating homogeneity within the ratings and consequently a good inter-rater reliability, whereas for Slovene listeners it was 0.81 again indicating a good inter-rater reliability.

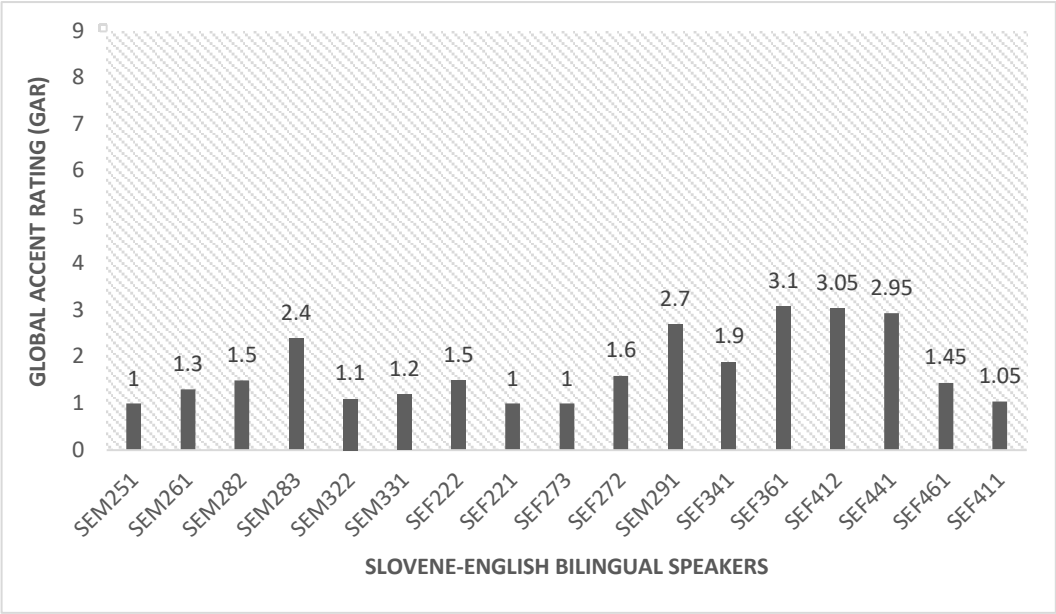

Figure 57: Bar chart of GAR Slovene-English bilinguals with average English (L2) global accent ratings

Figure 57 presents the results of the calculated average English GAR values for each Slovene-English bilingual speaker as rated by English monolingual listeners. It is evident from above figures that the English naïve listeners identified with a high level of consistency, as 100% of all Slovene-English late consecutive bilingual speakers were identified as non-native ($1 \leq GAR \leq 3.1$). This may suggest that the changes observed in the production of bilingual speakers did not affect their overall foreign accent perception in English, as English monolinguals were able to clearly perceive their accents.

Figure 58 presents the results of the calculated average Slovene GAR values for each Slovene-English bilingual speaker speaking Slovene. In contrast to the English naïve listeners, Slovene listeners were significantly more uncertain whether the speakers were native or non-native, as they identified 82% of the bilinguals as uncertain ($3.8 \leq GAR \leq 6.1$). Additionally, 14% of listeners' results could be interpreted as native due to their rating of $7.2 \leq GAR \leq 7.8$. This would suggest that 4% of Slovene-English bilingual speakers were considered as definitely non-native by L1 listeners ($GAR \leq 3.1$). This is an interesting result, as it would suggest that the L1 phonological change in certain speakers is perceivable to the Slovene naïve listeners.

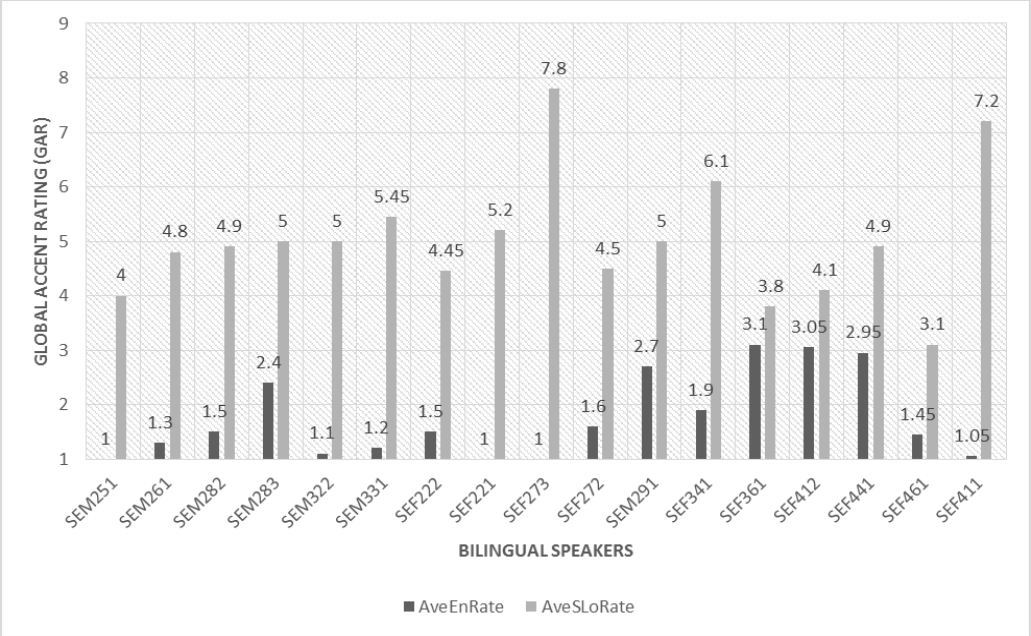

Figure 58: Bar chart of GAR Slovene-English bilinguals with average Slovene (L1) global accent ratings

Figure 59 presents the Slovene and English GAR ratings obtained by each individual Slovene-English bilingual speaker. This clearly presents how each individual speaker was rated in both languages.

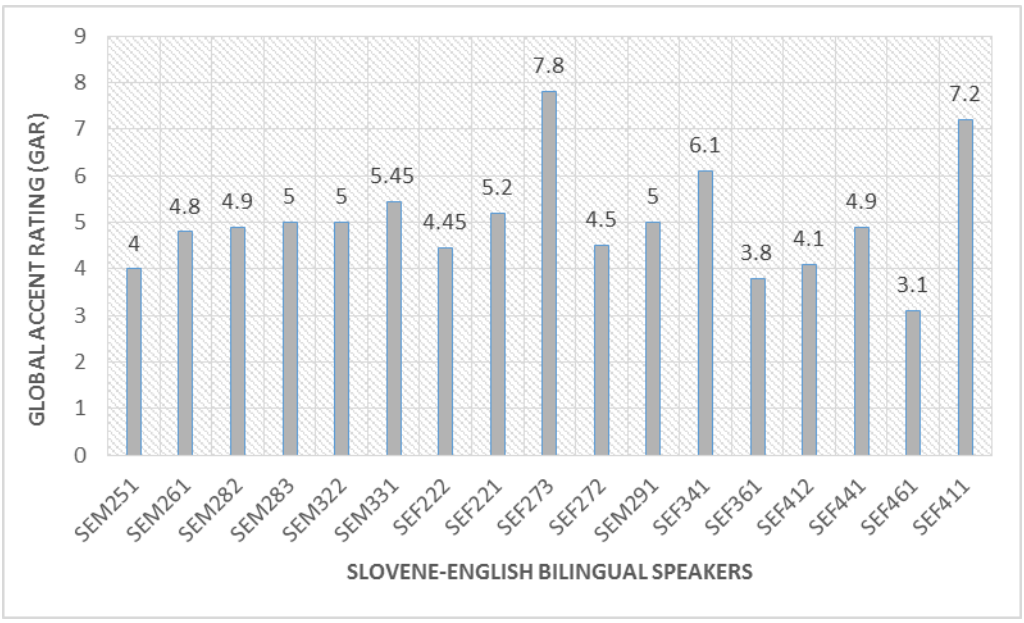

Figure 59: Bar chart contrasting Slovene and English global accent ratings (GAR)

Additionally, the average ratings were calculated for the English control group (EF- English female speakers, EM – English male speakers) and Slovene control group (SM, SF); the calculated mean values were divided based on gender to control for this extralinguistic factor. Figure 60 shows that the calculated mean value of global accent rating for the control groups of English male (EM) speakers (n=20) was 8.7, whereas for English female (EF) speakers (n=20) it was 8.8. Similarly, the calculated mean value of global accent rating for the control group of Slovene male (SM) speakers (n=20) averaged at 8.7 and Slovene female (SF) speakers (n=20) received the average rating of 8.5. The average target group's English GAR value for Slovene-English male (SEM) speakers (n=120) was 1.43, whereas for Slovene-English female (SEF) speakers (n=120) the value was calculated at 1.95. Similarly, the calculated target group's mean value of Slovene GAR value for Slovene-English male (SEM) speakers (n=120) averaged at 4.9 and Slovene-English female (SEF) speaker (n=120) received the average rating of 5.13.

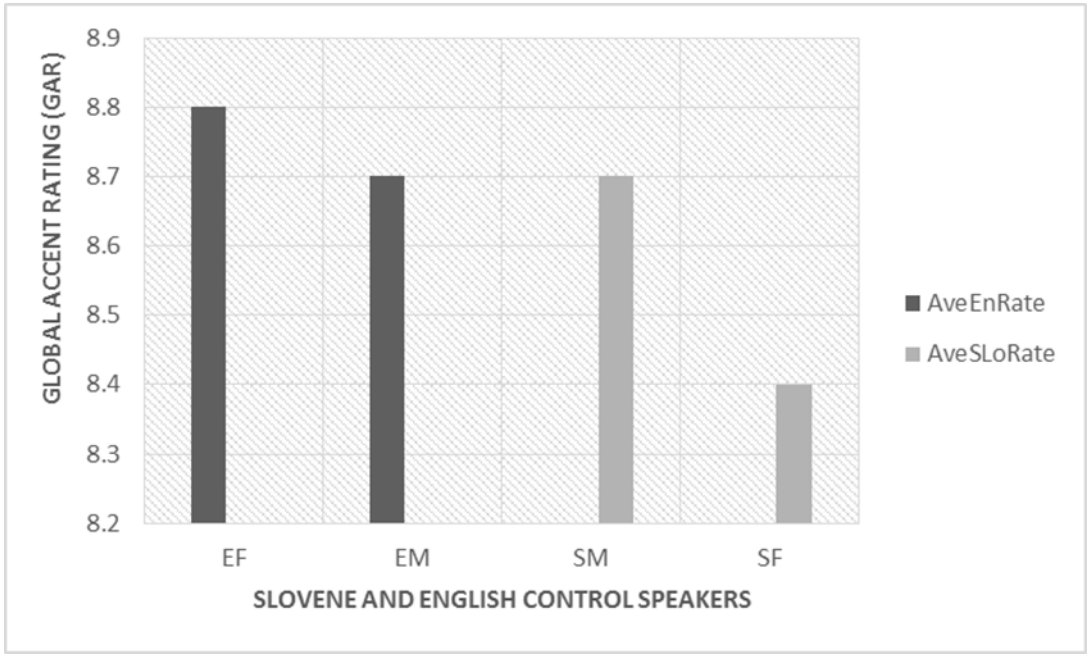

Figure 60: Bar chart of GAR of Slovene and English control group

After the initial analysis, the calculated mean GAR values of Slovene-English (SEM and SEF) bilingual speakers (target group) were compared to the Slovene and English monolingual (control) speakers' (EM, EF, SM, SF) calculated mean GAR values to test the statistical significance between these groups in order to validate the

previously obtained results. Again, the analyses were divided based on gender classification to control for this extralinguistic factor.

To statistically confirm the above histograms, Wilcoxon Rank Sum test was used in Excel (the data was not normally distributed; data is non-parametric and requires a non-parametric test) to compare GAR values of Slovene-English male (SEM) speakers to GAR values of English male (EM) speakers. The results of the test ($W = 4$, $p = 2.2*10^{-16}$) indicate that there are statistically significant differences between these two groups. Furthermore, GAR values of Slovene-English male (SEM) speakers were compared to GAR values of Slovene male (SM) speakers ($W = 349$, $p = 2.44*10^{-7}$), which also indicated towards statistically significant differences. Similarly, the statistical significance was found when comparing GAR values of Slovene-English female (SEF) speakers to mean GAR value of English female (EF) speakers ($W = 45$, $p = 2.2*10^{-16}$) and mean GAR values of Slovene-English female (SEF) speakers to mean GAR values of Slovene female (SF) speakers ($W = 759$, $p = 8.7*10^{-07}$). All p-values are small, and the w-values are not very big, which suggests there is a statistically significant difference between these groups at every comparison.

Figure 61: Slovene-English target group and Slovene and English control groups

These results may not be surprising, as a degree of foreign accent was to be expected in Slovene-English bilinguals' L2. However, what is surprising and important to the study at hand, are the low ratings that the Slovene-English bilinguals received in their L1. Furthermore, these results are presented graphically in Figure 61 where the differences between the target and control groups are evident; control groups were

confidently rated as L1. Additionally, what is evident is that the group controls are more likely to be perceived as L1 speakers than the bilinguals. Secondly, what the box plot also presents are the so-called outliers (dots above whiskers of the upper quartile) in the Slovene data set. To some extent, these outliers are the key part of the data, as they suggest only the outliers – only a few Slovene-English bilinguals – were considered to be L1 speakers of Slovene.

4.2.1 Discussion of perception experiment

The degree of L2 foreign accent has been considered as an identifying factor of non-native speech in second language acquisition studies. However, only a handful of studies have considered measuring the degree of foreign accent in the L2 learner's first language. This study, consequently builds on previous studies (e.g. Sancier & Fowler, 1997; De Leeuw, 2009) that have explored the idea of L1 phonological change as perceived in the speech of late consecutive bilingual speakers. Overall, the most significant finding of this study undoubtedly relates to the results from the Global Accent Rating (GAR) task that assessed the perception of Slovene-English late consecutive bilinguals by both groups of naïve monolingual listeners (Slovene and English).

Unsurprisingly, the results of the analysis show that the English pronunciation of Slovene-English late consecutive bilinguals was indeed identified as non-native by the English monolingual naïve listeners (in 100% of instances), which is in line with the previous research. Interestingly, the Slovene monolingual naïve listeners displayed signs of uncertainty as to whether or not the Slovene pronunciation of Slovene-English bilingual speakers was native in 82% of the instances. Additionally, they have identified Slovene-English bilinguals as non-native in about 4% of cases. In only 14% of cases Slovene-English late consecutive bilinguals were identified as native Slovene speakers. These results challenge the hypothesis proposed at the start of this study, where it was hypothesized that the changes in production will consequently result in changes in the perception of bilinguals. Clearly, even non-significant changes on the whole vowel system level or relatively slight changes on the level of individual vowel sounds in production, impacted the way the Slovene-English bilinguals were perceived and rated by Slovene naïve listeners. Additionally, according to Hopp and Schmid (2013) the proportion of late consecutive bilinguals that may be perceived as non-native in their L1 is significantly lower in comparison to the late consecutive bilinguals who achieve native-like fluency and accuracy. This data alone from the GAR (disregarding results

obtained from the production experiment) would suggest that the L1 phonological change is perceptible in the pronunciation of Slovene-English late consecutive bilinguals.

Nevertheless, these results may not come as a surprise as previous studies (Sancier & Fowler, 1997; Major, 2010; de Leeuw, 2009) demonstrated that L1 phonological change (in their work referred to as L1 attrition) may occur on the perceptive level, more specifically it might be detectable in the global foreign accent. To recapitulate, Sancier and Fowler (1997: 421) addressed these perceptual changes in the L1 in terms of a 'gestural drift': 'perceptually-guided changes in speech-production in a bilingual speaker'. Specifically, they suggested that the gestural drift occurs as a consequence of bilinguals' predisposition to imitate the sounds, the idea originating from a theory that the acoustic signals are mapped onto abstract phonological categories. They draw these conclusions based on the results obtained from a particular participant, a 27-year-old female native speaker of Brazilian Portuguese with an advanced level of proficiency in American English. The speaker started acquiring English at age 15 and was extensively exposed to English for the duration of four years prior to data collection. This bilingual is, therefore, in stark contrast to some of the bilinguals that took part in this current research, as some had as little as six months exposure to English prior to data collection. Therefore, applying the theory of a gestural drift to this study would be rather difficult, as it does not account for the minimal exposure to the L2.

Similar to Sancier and Fowler's (1997) study, de Leeuw (2009) investigated the global foreign accent in 34 L2 German speakers in Anglophone Canada and 23 L2 German speakers in the Netherlands. The German naïve listeners were more consistently identifying both groups of consecutive bilinguals to have a global foreign accent than the control monolingual German group. Overall, twenty bilinguals were clearly rated to be native speakers; twenty-three unclear and fourteen speakers were clearly rated as non-native. Therefore, it may be suggested that the L1 phonological change manifested in these fourteen bilinguals. However, de Leeuw (2009) suggested that due to the fact that 'only' fourteen bilinguals (24% of the overall assessed bilinguals) were identified as non-native, their global accent rating result may not be a "a priori consequence" of the L2 contact (de Leeuw, 2009: 38), suggesting other factors or variables may have influenced these results.

Additionally, de Leeuw (2009) suggests that the perception of bilinguals may be closely linked to Kuhl's (1993) idea of the Native Language Magnet model (NLM).

Specifically, she argues that perhaps early simultaneous bilinguals are more susceptible to language flexibility and can therefore produce words more accurately, whereas late consecutive bilinguals have less flexibility and consequently the changes in their production are audible to naïve monolingual listeners, who are often used as controls in these experiments. Furthermore, de Leeuw (2009:206) questions whether it is possible that the languages with numerous dialects could allow for more flexibility in what is perceived by the naïve listeners as foreign accented. This may be the case in Slovene-English bilinguals, as Slovene language is well known for its range of dialects – it encompasses more than 40 different dialects across a relatively small geographical area that represent a wide variety of patterns, tones, quality, and stress distinctions.

However, on the basis of the results obtained from the study at hand, it could be argued against this notion, as approximately 86% of the Slovene-English late consecutive bilinguals were not identified as native suggesting that the way the bilinguals are perceived may be the first to be affected. Nevertheless, the findings that a percentage (14%) of the Slovene-English bilinguals were still perceived as native would seem to concur with de Leeuw's (2009) conclusions that other factors may be influencing the global foreign accent. In particular, de Leeuw (2009) investigated the impact of AOA, LOR and L1 contact. They concluded that L1 contact might be more powerful at predicting the stability of the L1 than AOA. However, this is again in contrast with the results reported in my study, as most of the bilinguals reported daily use of their L1, which would suggest 'higher stability' of their L1 and consequently lower likelihood of displaying signs of L1 phonological change.

The notion which may be able to account for these sudden changes (LOR < 6 months) in the way Slovene-English bilinguals were perceived by naïve Slovene monolingual listeners, is the idea proposed by Chang (2010, 2011) of 'phonetic drift': quick subtle changes in L1 accent. This idea is similar to that proposed by Sancier and Fowler (1997) (a gestural drift), however, it contrasts in one significant way: Chang (2010, 2011) focused on L2 learners at the initial stages of L2 acquisition. Therefore, when considering the range of Slovene-English bilinguals' LOR (6 months to 16 years), the idea of phonetic drift could account for the changes obtained from the Global Accent Rating (GAR) task.

Additionally, the results and explanation of why English monolingual naïve listeners consistently identified Slovene-English bilingual speakers as non-native could also be explained in terms of paralinguistic phonetic characteristics that are associated with native speech (Scovel, 1995).Specifically, foreign accent may be detected based

on the features that are not typically linguistic (e.g. certain prosodic differences that reveal emotions/attributes/personality traits). Scovel (1995) suggested that these features may be universal and even listeners who are not familiar with the nuances of the language may be able to perceive those differences. However, they may be more apparent: the naïve listeners may perceive changes in pitch, tone, speaking rate etc. However, these suprasegmental features of speech were not investigated in the study at hand.

Additionally, Major's (2010) perception study indicated towards other paralinguistic features, which may influence listeners' judgments. As, for example, among four different groups of raters (Brazilian Portuguese, American English, American English listeners without previous Portuguese experience, Brazilian Portuguese to whom English as a second language listeners) virtually no changes were found in their rating of Brazilian Portuguese native and non-native speakers. Major (2010), therefore, concluded that raters'/listeners' first or second language does not influence foreign accent ratings and other paralinguistic features must be at play. However, there may be limitations to Major's (2010) study in terms of the target language (English), which all the listeners were familiar with; the idea that English language is a Lingua Franca.[45] Consequently, this may have also impacted the overall perception of foreign accent speech in both Slovene and English naïve listeners.

As the English monolingual naïve listeners listened to Slovene-English bilinguals reading a passage that included the twenty words that are most commonly mispronounced by Slovene learners of English, it would be natural to assume English listeners were able to recognise paralinguistic phonetic characteristics in bilingual's speech that would characterize them as non-native.

However, this idea that universal characteristics exist may be of further interest, as it suggests that there may be a Critical period (CP) for the identification of foreign accents in any language. The study at hand might have provided perceptual evidence that CPH exists for late consecutive bilinguals. Several studies provided similar evidence in favor of this idea (Asher & Garcia, 1969; Tahta *et al*., 1981a; Johnson & Newport, 1989). For example, Mackain *et al.* (1981) found evidence for a CP, as adult English learners of Japanese were not able to discriminate between sounds as well as

[45] Lingua Franca: A language that is adopted as a common language between speakers whose native languages are different. (Oxford Advanced Learner's Dictionary, 2000)

their monolingual counterparts. In contrast, Mack (1984) compared French-English early simultaneous bilinguals, who learnt the L2 before puberty, to English monolingual speakers. She found significant differences between the two groups. However, she did not interpret her results in terms of evidence against the CP, but rather as a result of two phonological systems being in contact. Similarly, Flege (1987) argues against the existence of a CP for adult learners, as in his study (1981) adult learners produced sounds as well as if not better than children. Additionally, Flege (1987), in his review of evidence against CPH, argues that the evidence on this matter is inconsistent and the evidence that does exist in favor of a CP is most likely conflated by other sociolinguistic factors such as L2 input, motivation of adult learners, social factor and incomplete learning. Overall, it is not clear whether the obtained results were the consequence of a CP or interaction of two phonological systems or even a consequence of other confounding sociolinguistic factors.

Alternative explanation may be found in Chang's (2010) study of Korean-English novice L2 learners. Chang (2010) determined that across both genders, female and male participants 'drifted away' from the monolingual norms only after a short exposure to the L2. Piske *et al.*'s (2001) findings are in line with Chang's (2010), as they suggested that bilinguals do not benefit from additional years of experience and do not display any significant changes over an extended period of time. Similarly, de Bot and Clyne (1997) suggested that certain features of a migrant's native language are only susceptible to change in the first years after migration. Additionally, de Leeuw (2009) found additional evidence in her study of German migrants, where an extralinguistic variable of LOR of 10 years or more no longer displayed significant effects.

Additionally, as reported, the comparison between production and perception of the bilingual speakers was often mismatched. The bilinguals, who were identified as not displaying signs of L1 change in their production were often identified as showing signs of L1 change in the way they were perceived by naïve listeners: they were showing signs of L1 change in the degree of their foreign accent in their L1. Major (2010) suggests that these results are not surprising, as often this type of L1 change is less dominant in contrast to other types. He agrees with the concept that production and perception are indeed correlated. However, very few previous studies examined both production and perception to this extent; they mostly focused on one particular area of bilinguals' change in L1 production. Therefore, the study at hand is one of the first to

confirm that L1 change in the way bilinguals are perceived is more prevalent than L1 change in production or the way the bilinguals speak.

Overall, in regards to the second research question ‘Are the changes in production, perceivable to the monolingual listeners?’ it could be argued that some changes in the vowel system of Slovene-English late consecutive bilinguals are indeed perceivable to naïve listeners, in particular to Slovene naïve listeners. In regards to the subsequent question of ‘Are the changes prominent in some speakers more than others?’ the results suggest that these changes are noticeable in some speakers, however, they are rarely either exhibited in both production and perception**.**

The question remains as to why changes occurred in these particular speakers and not in others. Taking into consideration the results obtained from production part of the experiment and GAR task, the next section seeks to answer this question and addresses the research question, ‘What extralinguistic factor(s) may determine the extent of the change in a particular speaker?’

4.3 Impact of extralinguistic factors

This section reports the impact of extralinguistic variables on L1 phonological changes to address the research question of 'What extralinguistic factor(s) may determine the extent of the change in a particular speaker?'. Firstly, the data was extracted and coded from the extralinguistic questionnaire (see Appendix 7) and the overall data for each individual Slovene-English late consecutive bilingual is presented below in Table 18 (For the coding for each individual variable please Chapter 3).

Table 18: Extralinguistic variables

UniqueID	Subject	Gender	Age	NumLang	Education	LOR	AOA	Language Contact
1	SEM251	Male	25	4	5	0.5	10.5	3
2	SEM261	Male	26	2	5	0.1	8.1	3
3	SEM282	Male	28	3	6	1	11	3
4	SEM283	Male	28	3	5	1	13	3
5	SEM322	Male	32	4	6	0.5	10.5	3
6	SEM331	Male	33	4	6	9	19	3
7	SEF222	Female	22	5	6	2	12	3
8	SEF221	Female	22	4	5	2	12	3
9	SEF273	Female	27	5	7	3	13	3
10	SEF272	Female	27	3	6	1	11	3
11	SEF291	Female	29	3	6	2	12	3
12	SEF341	Female	34	4	6	2	12	3
13	SEF361	Female	36	5	7	2	12	3
14	SEF412	Female	41	5	7	2	12	3
15	SEF441	Female	44	6	7	12	22	2
16	SEF461	Female	46	7	7	11	21	2
17	SEF411	Female	41	3	7	16	26	2

The forthcoming pages graphically present the relationships between changes in extralinguistic variables of AOA, LOR, L1 language contact, education and number of languages spoken (presented on the x-axis) mapped against vowel formant frequencies (VowF1, VowF2 and VowF3) presented on the y-axis. The graph's line indicates possible increase / decrease the value of vowel formant frequencies. These will be later confirmed using mixed-effects model analysis.

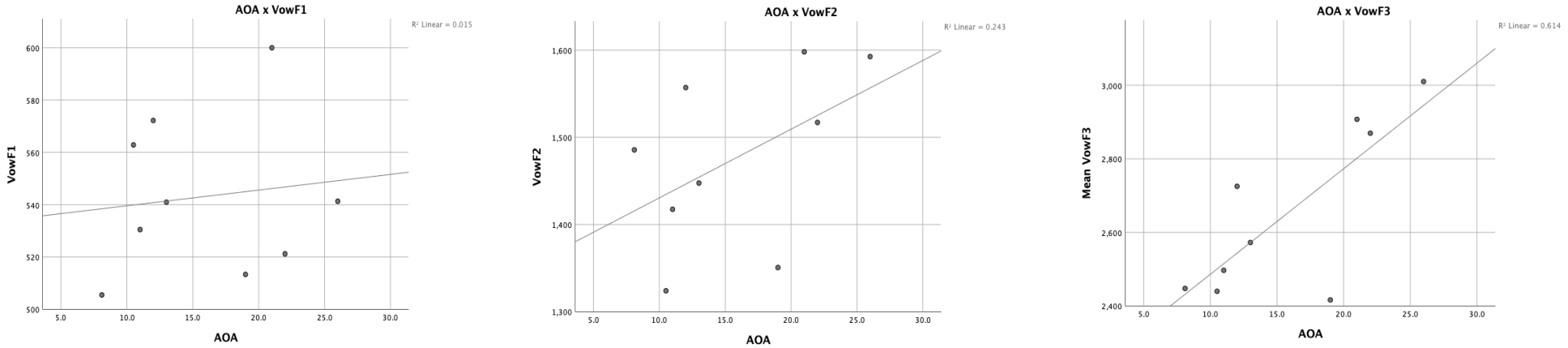

Figure 62: Correlation between L1 change and the extralinguistic factors of age of acquisition (AOA)

Figure 62 illustrates positive correlation between the extralinguistic variable of age of acquisition (AOA) and vowel formants (F1, F2, F3). In other words, as the age of acquisition of Slovene -English bilinguals increases, the amount of L1 changes that can be noted in their production of L1 vowel sounds decreases. These results coincide with the results reported in previous studies (Yeni-Komshian, Flege & Liu's, 2000; De Leeuw, 2010; Baker and Trofimovich, 2005). Specifically, Schmid & Dusseldorp (2010) found that beyond puberty only minimal language loss or L1 change will be experienced bilingual speakers.

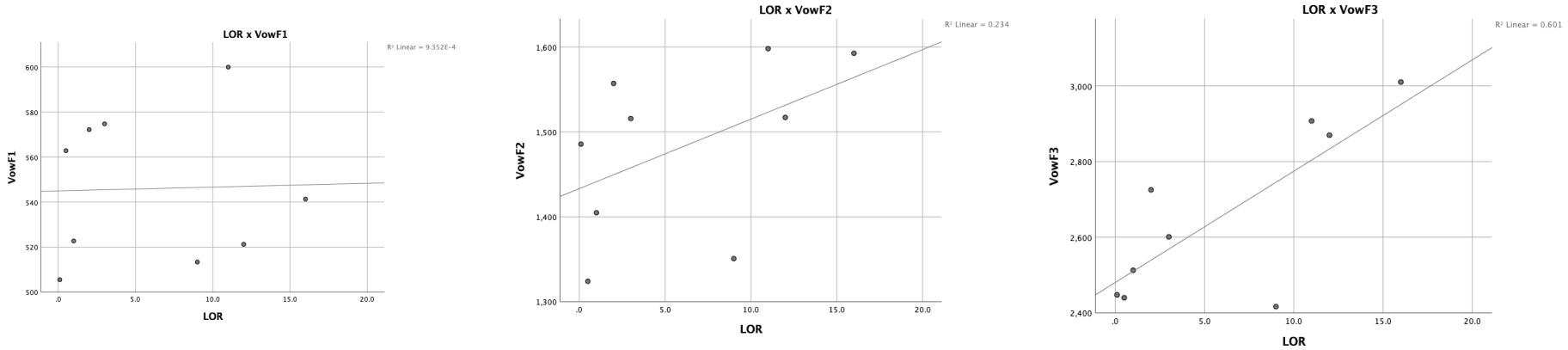

Figure 63: Correlation L1 change and the extralinguistic factor of length of residence (LOR)

Figure 63 illustrates a positive correlation between the extralinguistic variable of length of residence and the second and third vowel formants (VowF2 and VowF3). In other words, as the length of residence of the Slovene-English bilinguals increases the amount of changes that can be noted in their production of vowel sounds increases. This finding may be in line with previous research in the area of second language acquisition, which suggested a non-linear correlation (Piske *et al*., 2001), where near native-like bilinguals do not benefit from additional years of L2 experience and do not display any significant changes. In other words, as the LOR increases, L2 changes decrease, L1 changes increase. Again, these results may not be surprising, as previously mentioned—this is not unusual, since one of the definitions considers L1 phonological change or attrition as a reverse process of L2 acquisition (Schmid & Köpke, 2009).

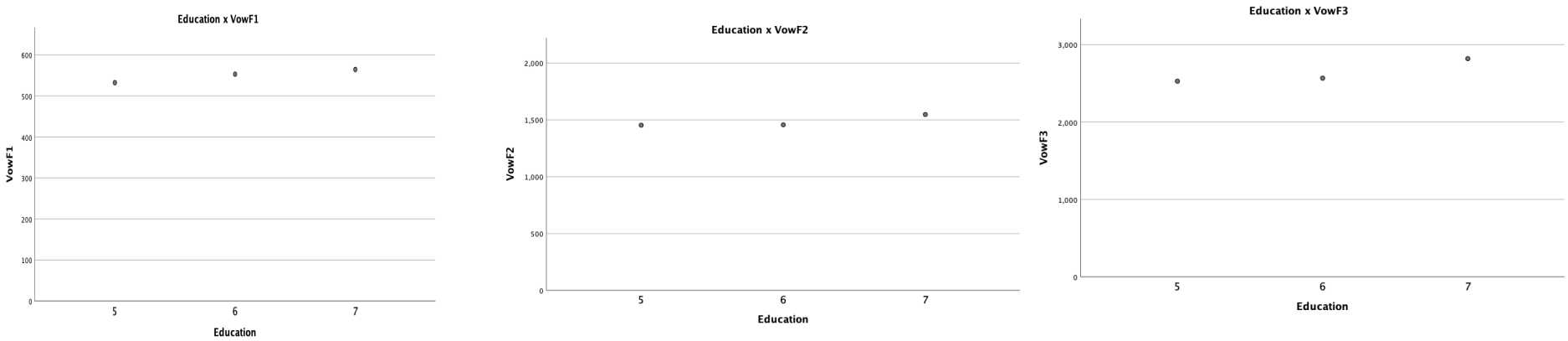

Figure 64: Correlation between L1 change and the extralinguistic factor of education

Figure 64 illustrates a slight positive correlation between the extralinguistic variable of education and vowel formants. In other words, as the level of education of the Slovene-English bilinguals increases, the amount of in their L1 changes that can be noted in their production of vowel sounds increases. This is in contrast with the previous studies (i.e. Jaspaert & Kroon, 1989) that reported the likelihood of bilinguals with a higher level of education to retain their L1 language proficiency (bilinguals display either less or no change at all in vowel formants), in comparison to the bilinguals with a lower level of education. The profile of the participants used in this study in comparison to the previous study (Jaspaert & Kroon, 1989) is similar: the participants were of various age groups and educational backgrounds. Similar to Slovene-English bilinguals, the first-generation Italian migrants in Jaspaert and Kroon's study had little or no contact with other Italians living in the Netherlands. However, the difference in their results might arise from the use of a slightly different methodology: Jaspaert & Kroon (1989) measured the extralinguistic factor of education in the number of years of school attendance. In contrast this study used an ISCED classification (see Chapter 3). Additionally, according to Schmid & Dusseldrop (2010: 129) these results could have been influenced by the choice of task (methodology) used in the procedure: they proposed that the educational level would influence task, particularly a formal one. However, it ought to be noted that very little variation is shown in this variable and further data / research ought to be completed to validate these results.

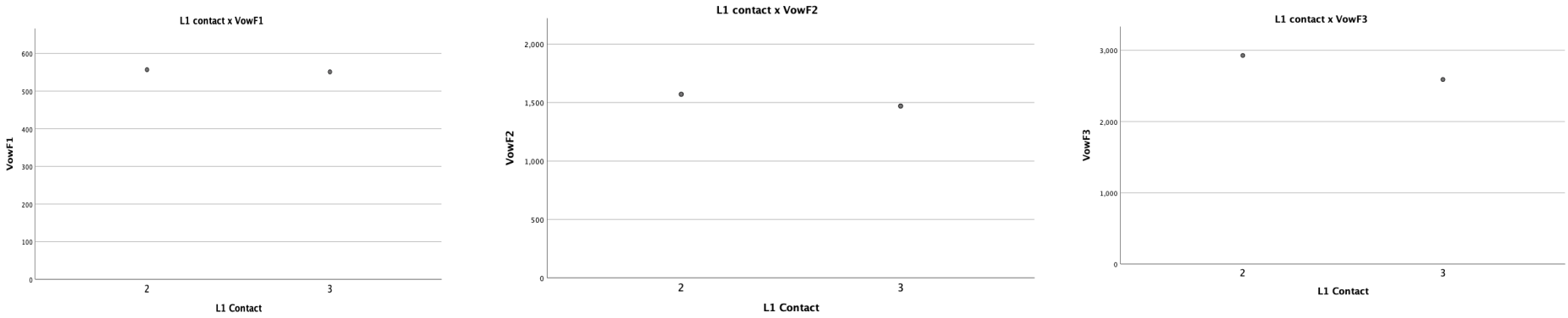

Figure 65: Correlation between L1 change and the extralinguistic factor of number of L1 Language contact (LanguageContact)

Figure 65 illustrates negative correlation between the extralinguistic variable of language contact and L1 change suggesting that the decrease of L1 contact will be reflected in the amount of changes noted in the production of Slovene-English bilinguals' vowel sounds. Even though Figure 65 may illustrate this correlation, what is clear is that in order to be able to make conclusive claims that are substantiated with data, further, more varied results ought to have been obtained. Additionally, it should be noted that the amount of L1 language contact was self-reported in a sociolinguistic questionnaire, which may have resulted in the above data results.

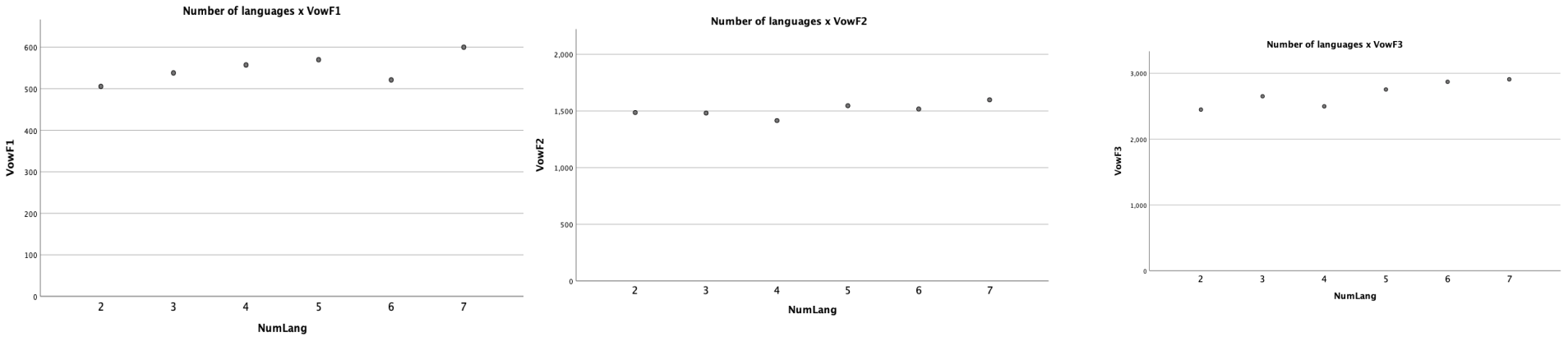

Figure 66:Correlation between L1 change and the extralinguistic factor of number of languages spoken (NumLang)

Figure 66 illustrates a positive correlation between the extralinguistic variable of number of languages spoken and L1 change. In other words, with the increased level of the number of languages spoken by the Slovene-English bilinguals, the amount of L1 changes that can be noted in their production of vowel sounds increases. These results could be explained in terms of the phonological similarity or specifically the degree of a cross-linguistic overlap between native and non-native languages. The Slovene-English bilinguals reported to have spoken languages such as Croatian, Serbian, Bosnian, German, Spanish, Italian, French, Dutch, Russian and Greek. Among these, the Slavic origin languages (Croatian, Serbian, Bosnian, Russian) have very similar, if not identical, vowel systems to Slovene, and would not have influenced the vowel system of Slovene-English bilinguals. In contrast, the Romance languages (Italian, Spanish and French) and the Hellenic language Greek, have vastly different phonologies, which could explain these results. Additional influences could also be attributed to other Germanic languages: German and Dutch. However, their vowel system is more similar to the English one. Overall, it is clear that Slovene-English bilinguals are susceptible to phonological neighbourhood density, which manifested in their L1 language change.

What is also evident from above graphical representation of extralinguistic variables and further exploratory analysis of the data in R-studio, there is a strong correlation between the sociolinguistic variables of AOA and LOR. Consequently, these sociolinguistic variables were combined and further grouped: (1) Bilinguals with longer LOR (2) Bilinguals with shorter LOR, before completing linear mixed-effect regression analysis. Figure 62 graphically presents the correlation and grouping of these variables.

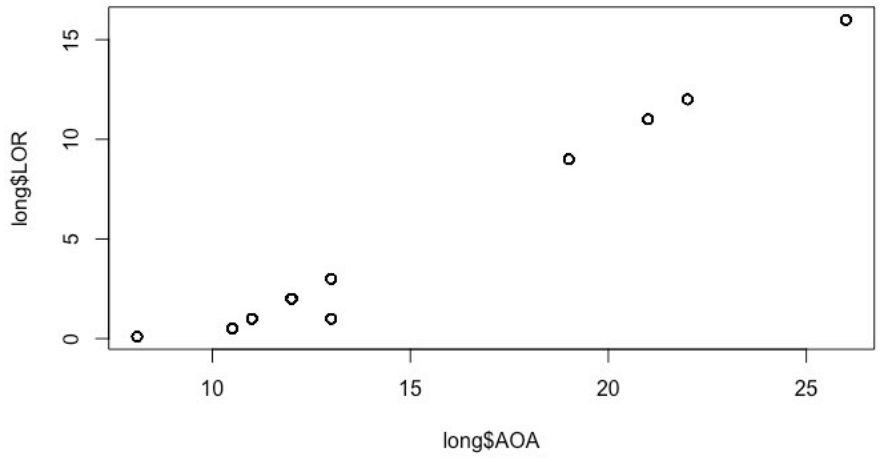

Figure 67: Grouping of LOR (in years) and AOA (in years)

A linear mixed-effect model analysis[46] was used in R-studio to establish whether any extralinguistic variables graphically presented above impact previously reported L1 phonological changes in vowel sounds. Below table reports the results of the analysis.[47]

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[46] The analysis described in the following section was carried out with help from my previous supervisor Melanie Bell and will contribute to a joint publication (Bell & Nolimal, in preparation *'Does L2 immersion cause non-native-like L1 pronunciation in Slovene-English late consecutive bilinguals')*

[47] Optimal model formula used in the analysis: Vowel:formant + BIlingualMonolingual:Vowel:formant lmer2 <- lmer(fNorm ~ LORbin*Vowel*formant + Education + Age + Gender + NumLang + L1Contac t+ (1 | Subject) + (1|Word), data=long, control=lmerControl(optimizer="bobyqa"))

Table 19: Backward reduced fixed-effect table (Degrees of freedom method: Satterthwaite)

	Eliminated	Sum Sq	Mean Sq	NumDF	DenDF	F value	Pr(>F)
Education	1	0.00028	0.000281	1	1005.4	0.0044	0.94699
Gender	2	0.00695	0.006947	1	1006.5	0.1093	0.74104
Age	3	0.01765	0.01765	1	1008.3	0.2779	0.5982
NumLang	4	0.05143	0.051435	1	1008.3	0.8104	0.36822
L1Contact	5	0.00749	0.007494	1	1021.4	0.1179	0.7314
LOR:AQA	0	1.53545	0.127954	12	1008.9	2.0163	0.02016

From the above Table 19, it is evident that only the binary variable of LOR and AOA emerge as statistically significant to L1 phonological change (shaded in dark grey). However, due to its binary nature, the results of the study cannot be attributed to a specific variable. The discussion of these results is presented in the following section.

4.3.1 Discussion

The aim of this study was not only to explore the impact of extralinguistic factors on first language phonological change, but also the impact of intralinguistic factors, in particular the impact of phonological similarity between the L1 and the L2. To recapitulate, the measured acoustic and tested perceptual similarity tests successfully answered the question of how L1-L2 similarity could initially predict the outcome of L2 learning. However, what these tests failed to answer was how this perceived L1-L2 similarity of bilingual speakers changes over the course of L2 learning, particularly in Slovene-English late consecutive bilinguals. Best and Tyler (2007), suggested that extralinguistic factors, in addition to internal/intralinguistic factors, may contribute to the overall cross-linguistic linkage and the overall influence on production and perception. Specifically, they suggested future research should consider the relationship between intralinguistic factors (similarity between sounds) and extralinguistic factors, such as language input. As such, the next section does not

only explore each individual factor, but also the relationship between these various (intralinguistic and extralinguistic) variables.

The results obtained from the analysis that examined the impact of extralinguistic factors on L1 phonological change showed that the variable of AOA and LOR significantly impacted L1 phonological change in Slovene-English late consecutive bilinguals. These results are also mostly in line with the previous literature, especially taking into account the fact that previous studies varied considerably in their design and methodology, often resulting in contradicting results. However, it ought to be noted that the process of first language phonological change is determined by a complex interplay between all extralinguistic variables and therefore only a careful consideration of all the variables may shed light on these results (Schmid & Düsseldorp, 2010).

Some extralinguistic variables have received more attention in the literature than others (Pavlenko, 2000). Especially age of acquisition (AOA), sometimes also referred to as age of arrival (AOA) or age of L2 learning (AOL), has often been considered to be one of the most significant factors to influence both second language acquisition and first language change or attrition. As discussed earlier, this variable indicates the start of L2 acquisition or exposure to the L2. It is usually defined as the age at which the subjects first arrived in a predominately L2 speaking country (Piske *et al.*, 2000). However, it may not be this clear-cut. For example, some Slovene-English participants in this study had been exposed to the L2 prior to being immersed in the L2 environment, which suggests some of these late consecutive bilinguals may exhibit changes that are typically associated with early simultaneous bilinguals. Specifically, previous studies (e.g. Piske *et al*., 2001) suggest AOA may become more significant if it does not correlate with the age of acquisition, specifically if a bilingual had been exposed to the language prior to immigration.

Furthermore, the results obtained from the previous studies suggest that the earlier in life an individual is exposed to the L2, the better their pronunciation will be and the more likely they are to have less L2 foreign accented speech. In terms of L1 phonological change, this could suggest that the L1 pronunciation may also be affected, meaning that these bilinguals may be perceived as non-native in their L1. To some extent, this was evident in this study as Slovene naïve listeners identified Slovene-English bilinguals as non-native. However, English naïve listeners identified the same bilinguals as uncertain or non-native, which would suggest that their early exposure to the L2 had not significantly impacted their L2 pronunciation. Nonetheless, as Schmid

(2010:48) noted, it is rather difficult to predict whether the observed changes in late consecutive bilinguals are the result of language attrition or just a failure to acquire a second language. In particular, this may be due to the prevailing evidence that after a particular age (Clyne (1981) claims that age is twelve) it is next to impossible to acquire a new language to native-like ability.

Therefore, it is no surprise that when examining the results obtained from this study, the variables of age at time of study and AOA appeared to significantly impact bilinguals' L1 production. However, some correlation was found between the variable of the AOA and the amount of L1 change that occurred. Clearly, these results support the studies which suggest that 'earlier is better', often referring and interpreting the evidence as a direct reflection of a critical (sometimes referred to as 'sensitive') period (CP) to L2 learning (e.g. Scovel, 1988; Patkowski, 1980, 1990; Mack, 1990). According to the CP hypothesis an age exists for human speech learning; it suggests that the L2 native-like ability is no longer possible after that age. Researchers such as Seliger (1978), Long (1990) and Hurford (1991) suggested there might be several CPs, each affecting different linguistic abilities. However, the linguistic ability, which is suggested to be affected first is the ability to develop native-like pronunciation in the L2 (Piske *et al*., 2001). This may explain why some English naïve listeners perceived Slovene-English late consecutive bilinguals as non-native. However, it does not explain why Slovene naïve listeners perceived some bilinguals as non-native. De Leeuw (2010:26) offered an explanation for this occurrence by suggesting there might be a possibility of a parameter that is set in L1 acquisition to be neutralised as a result of prolonged L2 acquisition or L2 exposure, allowing the possibility of first language phonological change. Yet again, the variable of a chronological age may be amalgamating with the variable of length of LOR, implying a close, intertwined relationship.

Some evidence coinciding with the results obtained in this study, can be found in Moyer's (1999) study, where she presented the results obtained from the analysis of an English-German late consecutive bilingual (AOA=22 years), who was identified as native-like in his L2. Similarly, the study conducted by Bongaerts *et al*. (1997), who examined five adult L2 learners, presented results, which were comparable to the ones obtained from native speakers. These results may be explained in terms of Hopp and Schmid's (2013:362) suggestion that rather than maturational constraints, "the degree of L1 entrenchment in phonetic categorization" may be playing a significant role. Specifically, Hopp and Schmid's (2013) suggestion coincides with previously proposed

idea of equivalence classification of L1 and L2 (Flege, 1999). The cognitive mechanism of equivalence classification suggests that at the earlier stages of L2 acquisition, learners will link L1 and L2 sounds on the basis of 'low-level information'. In other words, on the basis of the information that is available to them from their first language and only at the later stages the learners may link sounds on the basis of 'higher-level information' or on the basis of the experience they have in their L2.

The extralinguistic factor of length of residence (LOR) that emerged as statistically significant factor in this study had been extensively reported to impact L1 phonological change. Despite this, previous studies produced conflicting evidence as to whether the increased time spent in the L2 country improves L2 accuracy and consequently impacts the changes in L1 pronunciation. For example, Flege and Liu (2001), while analyzing Chinese-English late consecutive bilinguals, suggested that the LOR in the L2 country plays as an important role as the quality and quantity of the L2 native input substantially influenced bilinguals' perception and production. The Chinese-English bilinguals with the correct (possibly sufficient) amount of input showed positive correlation with the LOR, meaning their performance improved as the LOR increased. Therefore, it would be logical to assume a linear relationship between L1 phonological change and the LOR.

However, de Leeuw (2009) reported that in in her study, German migrants with an LOR of 10 years or more no longer displayed significant effects. Nevertheless, based on the studies that have been reported in the recent literature it is rather difficult to establish at which 'stage' LOR becomes a less significant predictor as there is no relevant reported longitudinal study. The results of this study do not concur with the ones obtained from de Leeuw (2009) as with the increase of LOR in Slovene-English bilinguals, the L1 phonological change increased. These findings are also not in line with previous research, which suggested a non-linear correlation (Piske *et al.*, 2001), where near native-like bilinguals do not benefit from additional years of experience and do not display any significant changes. However, these findings do coincide with the previously mentioned Ontogeny Phylogeny Model (OPM) (see Chapter 2), as Major (2001) suggested that language develops chronologically and as the language features in L2 increase, the language features in L1 decrease, which would suggest a possibility of L1 phonological change.

The results of this study could also support the findings in Baker and Trofimovich's (2005) study on early and late Korean-English bilinguals. They suggested that the effect of LOR on late bilinguals with one year of US residence did

not differ from the amount of change that was evident in those bilinguals with seven years of experience; the LOR was different however the change was similar. Specifically, to present the relationship between intralinguistic and extralinguistic factors, Baker and Trofimovich (2005) proposed that the amount of similarity between L1 and L2 sounds would determine the degree and direction of L1 and L2 influence and that, secondly, the extent of the bidirectional interaction between languages would have a greater impact at the beginning, rather than in later stages of L2 acquisition. Consequently, the results of this study and those obtained from Baker and Trofimovich (2005) suggest that length of residence (LOR) does not influence L1-L2 phonological similarity and no reorganization in the L1-L2 phonetic system is evident.

Additionally, de Bot and Clyne (1997) suggested that certain features of a migrant's native language are susceptible to change only in the first years after migration. Previously discussed Figure 68 illustrates the possible outcomes of L1 language attrition/change that is highly depended on L1 use and not on LOR. A reoccurring theme suggested by Schmid and Düsseldorp (2010) of a complex interplay between extralinguistic variables emerges again: LOR linked to L1 contact/use. What is also clear from Figure 68 is the stabilization process after the initial changes in language proficiency. However, the question that may arise from this illustration is why certain bilinguals will experience this 'loss' or change in proficiency and other bilinguals will not.

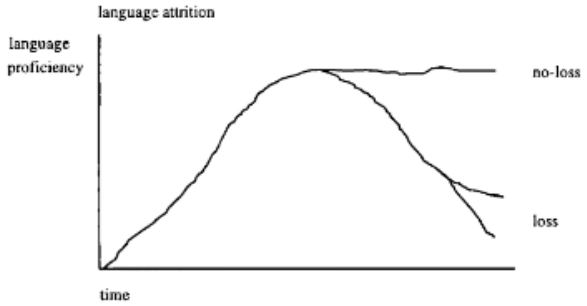

Figure 68: The effect of time on L1 attrition (De Bot, 1999:146)

Building on the assumption that the LOR and L1 use/contact/input are interrelated, the evidence of such relationship should be found in the data obtained in this study. Schmid (2010) suggested that the extralinguistic variable of contact with and use of L1 is particularly important to L1 attrition or change. In this study, the Slovene-

English bilinguals self-reported that they frequently use their L1 (14 bilinguals on a daily basis and 3 bilinguals once a week). This may be the reason why L1 contact was not statistically significant for Slovene-English bilinguals. As previously noted, to make conclusive claims that are substantiated with a wider range of data, further and more varied results ought to be obtained. Additionally, it should be noted that the amount of L1 language contact was self-reported in a sociolinguistic questionnaire, which may have resulted in obtaining data that show very little variation and is very similar.

Bearing in mind these limitations, there may be several reasons for these results. Despite the frequent L1 use, the sociolinguistic factor of identity may be significantly impacting L1 change. The last question on the sociolinguistic questionnaire (see Appendix 7) asked the participants whether they feel bilingual. Mostly, the responses were negative, which is not surprising as late consecutive bilinguals often have the general tendency not to perceive themselves as bilinguals, but rather as L2 learners. Therefore, it would have been useful to rephrase this question in a way that asked as to which culture they identified more with, British or Slovene? From the informal conversations with the bilinguals that were unfortunately not part of the initial methodological framework and consequently not included in this study, most bilinguals reported that they often feel 'closer' to the British culture than to Slovene culture. Would that be due to the successful and complete immersion or is there a question of how Slovene bilinguals perceive Slovene identity? Schmid (2010) claims that the attitudes and ethnic affiliations are among the most important factors for predicting 'success' of L2 language learners and similar comments have been made in regards to L1 attrition or change. Schmid and Dusseldorp (2010:130) even suggested that negative feelings towards the L1 might lead to higher levels of L1 attrition.

Considering these ideas presented by both Schmid and Dusseldorp's (2010) and Major's (2010:178) statement that "identity and attitudes are often closely tied to native and nonnative accents", it could be inferred that due to Slovene-English bilinguals identifying more with the British culture and identity than they do with the Slovene identity and culture. This affiliation to the British culture had led to significant changes in Slovene-English Late consecutive bilinguals' L1 production and has impacted the way they were perceived by Slovene naïve monolingual listeners. These ideas were presented as early as 1985 by Le Page and Tabouret-Keller, in their theory of Act of Identity, which predicted that individuals will conform to patterns of linguistic behavior through which they resemble that group of people to which they wish to belong (Le

Page & Tabouret-Keller, 1985:181). In other words, language becomes a major predictor of cultural identity.

This may be of no surprise as according to Erjavec's (2003) controversial view on this matter, Slovene identity may be considered a media construct that has arisen after independence in 1991 and was mostly based on building the ethnic identity on antagonism or resentment towards the previous regime. Erjavec (2003: 98) claims: "With the independence of Slovenia in the 1990s, the Slovene people are trapped in the dilemma of searching for their own identity while trying to cope with their history and future". Possibly in this 'search for the identity', Slovene-English bilinguals, who migrated to England, actually 'found' their identity and defined themselves as British, consequently or subconsciously this affected their speech. An additional consideration that was also addressed in de Leeuw's (2010) work is the idea of where these bilinguals, who have been identified as non-native by their native speaker, 'fit' in a scale of identity. The traditional two-dimensional view of L1 and L2 culture may not be sufficient to explain this predicament.

Another reason of why the increased use of L1 may not have resulted in L1 phonological change may be due to the type of L1 use or as Schmid (2007a: 150) suggested the 'quality of the contact might be more important than the quantity', consequently implying that language contact plays a less important role than it was first anticipated due to being dependent on the richness of the input. In this thesis' study, the variable of language contact was calculated by averaging participants' responses to questions relating to Slovene use (see Appendix 7) and converted into numbers, disregarding the type of use. Reconsidering this methodology, it may have been more appropriate to measure the formal and informal uses of L1, as Schmid (2012) provided evidence that the use of L1 with friends does not significantly impact L1 change. In contrast, de Leeuw, Schmid and Mennen (2010) provided evidence that L1 change becomes more apparent through an increased use of the L1 in formal situations. Additional reason for these results may coincide with Köpke and Schmid's (2004) view that the first language phonological change of bilinguals that are part of an immigrant community may not follow the same principles as first language change in more isolated immigrants. This may be the case in Slovene-English bilinguals who are not part of the larger community (estimate Slovene population according to 2001 census in the UK is only 1228).

However, it ought to be noted that the L1 contact in this study did not distinguish between different types or contexts of L1 use. The coding consisted of combining the

passive and active L1 use and L1 contact and categorizing them into daily (3), weekly (2) and yearly (1) exposure. Specifically, the coding consisted of establishing the frequency of L1 use/contact. It was evident that the majority of late consecutive bilinguals were either using or being exposed to their L1 (Slovene) on a daily basis. This part of the data was of no surprise, as previous literature noted that late consecutive bilinguals have the tendency to use their L1 more frequently than simultaneous bilinguals, who acquired L2 in childhood[48] (Schmid, 2004). Nevertheless, future research ought to consider different L1 contexts, rather than considering L1 contact as a one-dimensional factor.

Interestingly, neither the extralinguistic factor of education or number of languages spoken by Slovene-English late consecutive bilinguals emerged as statistically significant factors. In regard to the number of languages spoken by bilingual speakers, to date no studies exist that could either support or contradict these findings. One of the few studies that explored the link between language aptitude and L1 language attrition was conducted in the area of morphosyntax (Bylund, Abrahamsson & Hyltenstam, 2010). Based on the results obtained in their study, Bylund, Abrahamsson & Hyltenstam (2010) made two theoretical predictions regarding how language aptitude may affect L1 change: **(**1) language aptitude is related to L1 proficiency and (2) language aptitude promotes high levels of proficiency in the L2. Based on these predictions and the results obtained from the current study, it could be argued that the likelihood of the Slovene-English bilinguals retaining their L1 norms in relation to the L1 vowel changes, while acquiring other languages, is low as Slovene-English bilinguals had shown changes in their L1 vowel production. However, the current results do concur with the second assumption that language aptitude promotes high level of proficiency, as clearly seen in the analysis of individual speakers as Slovene-English bilinguals were able to perform within L2 native-like norms. These results serve as a significant contribution to the theoretical assumptions made by Bylund, Abrahamsson and Hyltenstam (2010) as these results provide the empirical evidence to both the field of first language phonological change or attrition.

Overall, these findings may confirm Schmid *et al*.'s (2013:676) claim that first language change is a complex and non-linear process, as it does not progress linearly over longer periods of time and is mostly based on each individual's language

[48] Note that the simultaneous bilinguals are also more likely to have more than one L1 rather than an L1 and L2.

experience, based on a close interplay between intralinguistic and extralinguistic factors.

4.4. Summary

This discussion will summarize the main findings and conclusions drawn from the discussion part of this study. Firstly, not all areas of Slovene-English bilinguals' phonological system were subject to L1 phonological change. Some evidence of L1 phonological change was found only effecting particular vowel sounds. What was also evident is that only certain L2 models or parts of the existing L2 models or theories could provide a satisfactory account for the results obtained in this study. Nevertheless, evidence was found that coincides with the basic ideas of SLM (Flege, 1995), PAM-L2 (Best & Tyler, 2007), NLM-e (Kuhl *et al*., 2008) and phonetic drift (Chang, 2010, 2011). This suggests that the area of L1 change remains to be a complex issue and calls for further research.

Additionally, it may be claimed that even slight, almost negligible and minimal changes on the phonetic level, affected the way the bilingual speakers were perceived. Specifically, the changes in production may have been audible or perceptible to the naïve monolingual speakers, in particular to the Slovene naïve listeners, who in 82% of the instances showed signs of uncertainty as to whether the speakers were Slovene or not. However, English naïve listeners displayed no difficulties with identifying Slovene-English bilinguals as non-native, which may also be due to suprasegmental language features, such as pitch or tone. However, it may be also be possible that the changes were perceivable in consonants rather than vowel sounds. Consequently, it could be claimed that the process of L1 phonological change is gradual and is slowly penetrating each level of both L1 and L2 production and perception of Slovene-English late consecutive bilinguals.

In regards to the variables that influence L1 phonological change in Slovene-English late consecutive bilinguals, a clear thread was evident: the process of L1 phonological change is determined by a complex interplay between all extralinguistic and intralinguistic variables and therefore only a careful consideration of all the variables can help to interpret the results obtained. Nevertheless, the extralinguistic factors of AOA and LOR appear to have significantly impacted Slovene-English late consecutive bilinguals' L1 phonological change. However, due to the high level of correlation, the results could not be attributed to one particular variable. Additionally, the data collated for these bilinguals showed very little variation, which may have

resulted in not obtaining any statistically significant differences for other extralinguistic factors.

Probably the most interesting realization or unintended consequence of examining L1 phonological change is in all likelihood the discussion of the importance that Slovene identity may have had, as a close link was found between Slovene identity and the impact it has on Slovene-English bilinguals' use of language. Specifically, this finding has ramifications for Slovene migrants worldwide. This study's approach mostly considered individuals and the changes that occurred on the individual level, rather than changes that are a reflection of the speech community. The overall realization that due to geopolitical, social and cultural influences, Slovene-English bilinguals identify more closely with their adopted British culture than they do with Slovene identity and culture, may have led to changes in their L1 production and had significantly impacted their perception.

The next chapter summarizes the main findings of this study, acknowledges the limitations of this study and considers the implications of this study for future theory and practice, considering future directions that L1 phonological or attrition studies may want to take.

Chapter 5: Conclusion

What happens in the mind of an adult bilingual speaker when languages come into contact? Is there a possibility that while acquiring a second language, your first language may change or is significantly affected? What internal and external factors may be influencing this process of change? These were some of questions onto which this thesis attempted to shed light.

Specifically, this thesis examined L1 phonological change in Slovene-English late consecutive bilinguals with the aim of answering the question of whether L1 pronunciation can be affected by the L2 in adult learners. In particular, the research focused on the examination of Slovene-English late consecutive bilinguals' combined vowel system by contrasting it with monolingual speakers of both Slovene and English. Additionally, this study aimed to explore whether any changes in their pronunciation (or speech production) would be perceivable to naïve monolingual listeners of both languages—Slovene and English.

To systematically approach this investigation, research questions were outlined at the start of this study:

Research question 1: Is there evidence of phonological change in the L1 Slovene vowel system of late consecutive Slovene-English bilinguals?

a) Does this happen in certain vowels more than others?
b) If there is a variation between vowels, what phonetic or phonological factors may determine the change for any given vowel?

Research question 2: Are the changes in production perceivable to the monolingual listeners?

a) Are the changes prominent in some speakers more than others?
b) What extralinguistic factor(s) may determine the extent of the change in a particular speaker?

By carefully taking into consideration previous literature in the field of both second language acquisition and first language attrition (Chapter 2) the following hypotheses were made:

1. Hypothesis: *The Slovene-English late consecutive bilinguals will show signs of first language phonological change.*

2. Hypothesis: *Slovene-English late consecutive bilinguals will be identified as native speakers of Slovene, even if showing signs of L1 phonological change.*

To answer the above questions and test the hypotheses, several experiments were designed and divided into two parts: a production experiment (addressing first research question) and a Global accent rating task (addressing second research question). The production part of the experiment examined the vowel system of both Slovene and English monolingual speakers and then compared them to the Slovene-English late consecutive bilinguals, specifically their production of the Slovene and English vowel sounds across the whole vowel system. The analyses examined the changes in the individual vowel sounds, where both Slovene and English monolingual vowel sounds were compared to Slovene-English late consecutive bilinguals' individual vowel sounds, with the aim of exploring whether L1 phonological change happens in certain vowels more than others. Additionally, the possible changes in the L1 phonological system were explored by employing Global accent rating task (GAR), in which monolingual speakers of both languages (Slovene and English) assessed the foreign accented native speech and rated individual speech samples of Slovene-English late consecutive bilinguals (Chapter 3: Methodology).

A further experiment was designed to account for any possible changes that may be found in individual vowel sounds, by measuring acoustic similarity and testing perceptual similarity of Slovene and English vowel sounds (Chapter 2: Intralinguistic factors). The aim of these experiments was to account for any changes to the L1 that may occur and address the subsequent research question 'If there is variation between vowels, what phonetic or phonological factors may determine the change for any given vowel?'. Specifically, these experiments aimed to examine the impact of intralinguistic factors that may contribute to the overall L1 phonological change.

As previously outlined, this study did not only aim to investigate the intralinguistic factors (addressing part of first research question), such as phonological similarity between vowel sounds, but also aimed to investigate the impact of extralinguistic factors (addressing part of second research question) such as length of residence (LOR), age at arrival (AOA), language contact, education, language aptitude (in this study measured as number of languages spoken). The LOR and AOA emerged as statistically significant extralinguistic factors that impacted L1 phonological changes. However, due to strong correlation between these variables, the results could not be specifically attributed to one particular variable.

The results of the production part of the experiment (Chapter 4) evidenced that Slovene-English bilinguals did indeed undergo a process of L1 change, as the analysis of individual vowel sounds revealed that they exhibited changes in particular vowel sounds (see Chapter 4), consequently rejecting the null hypothesis and addressing the first research question: **this study found evidence of phonological change in the L1 Slovene vowel system of late consecutive Slovene-English bilinguals.**

Additionally, the results obtained from the Global accent rating task were the most intriguing part of this study. The Slovene naïve monolingual listeners rated Slovene-English late consecutive bilinguals were in 82% of instances 'uncertain' as to whether or not bilinguals were native speakers of the Slovene language. This would suggest some L1 phonological changes may also influence how the Slovene-English late consecutive bilinguals are perceived by naïve native listeners, thus rejecting the second hypothesis which posited that Slovene naïve listeners would still identify Slovene-English late consecutive bilinguals as native speakers of Slovene and answering the second research question: **this study found that changes in production are (to an extent) perceivable to the monolingual listeners of Slovene language.**

However, it ought to be noted that the English naïve listeners had no difficulties identifying Slovene-English bilinguals as non-native (100% of instances), which is in line with previous research. However, the results obtained from the Slovene naïve listeners are in stark contrast with the results obtained in previous studies. De Leeuw (2010), for example, found very few changes in the perception of bilingual speakers.

These results may hopefully prompt future research to investigate L1 phonological changes from a different perspective, considering their methodology the possible impact of paralinguistic phonetic characteristics, which are associated with native speech (such as tone and pitch, which were not measured in this thesis). Additionally, future research may also consider features that are not typically linguistic (i.e. nuances of language, language speed) (Scovel, 1995). A further avenue of future research could explore whether the changes, which were perceived by the naïve listeners, were actually changes that occurred in consonants rather than in vowel sounds, which were under examination in this thesis. This would require a larger scale study that would incorporate both vowels and consonants of both the L1 and L2.

It has been also outlined (Chapter 4) that current linguistic theories can only sufficiently account for the results reported in this study when considered holistically. It was clear when trying to apply various models or theories to these results, each model displayed significant insufficiencies. As generating a new model to serve future studies

is beyond the scope of this study, this may call for research to closely examine existing models and theories and address insufficiencies. Specifically, future research could focus on generating a model that would consider both production and perception of bilingual speakers, as current models are either focusing on one or the other. Nevertheless, Chapter 4 reviewed the significance of the obtained results within the current linguistic theory. It was concluded that the basic ideas of the Speech Learning Model (Flege, 1995), PAM-L2 (Best and Tyler, 2007) and phonetic drift (Chang, 2010, 2011) were the most able to account for the changes found: from the lack of evidence that was found when analyzing a whole vowel system to finding some significant L1 changes on the level of individual vowel sounds. In other words, a unidirectional drift in Slovene-English cross-linguistic vowel space has occurred as a consequence of Slovene vowels systematically shifting in the direction of English vowel sounds.

Probably the most interesting conclusion drawn from examining the L1 phonological change is the discussion of Slovene identity. Specifically, the outcome of such an influence/factor on Slovene migrants worldwide, as a close link was found between Slovene identity and the impact it has on Slovene-English bilingual's use of language. This study's approach mostly considered individuals and the changes that occurred on the individual level, rather than changes which may be a reflection of community. The overall realization that due to geopolitical, social and cultural influences, Slovene-English bilinguals identify more closely with their adopted (British) culture than they do with Slovene identity and culture, had led to significant changes in their L1 production that has in turn impacted on the way that they are then perceived by other native speakers.

This thesis also challenged the traditional labels that most linguists tend to apply: late consecutive versus early simultaneous bilinguals. Based on the results of this study, the need to reconsider these traditional labels was evident. Slovene-English bilinguals would by traditional norms be considered late-consecutive due to the fact they had entered the L2 environment after adolescence and had a 'late' onset of L2 learning. However, this traditional view does not take into account any minimal early exposure (i.e. English courses) to the L2 that the bilinguals may have had. Such minimal L2 exposure had clearly impacted Slovene-English bilinguals in this study, as they had showed clear signs of a dissimilatory process during L1 sound change, which tends to be only evident in early simultaneous bilinguals, who have used both their L1 and L2 in their childhood.

Overall, this thesis contributes to the current understanding of L2 models and theories. It also provides empirical evidence not only in the field of second language acquisition and first language attrition, but also to the field of Slovene theoretical linguistics, by providing theoretical and empirical evidence that will aid future research. Specifically, it contributes much needed evidence to the field of perception of global accented speech among L1 attriters (only one previous study exists: de Leeuw, 2008). Additionally, it not only offers a much-needed comprehensive review of Slovene phonology, but also, by using up-to-date methodology, provides new and updated formant frequencies (F1, F2 and F3) for all Slovene vowel sounds. This will undoubtedly aid historical linguistics, which is currently examining some drastic changes within the Slovene language, in particular in the area of phonology. Additionally, this thesis tested and examined the language pair of Slovene and English which has never been studied before in this way. This pair of languages has rarely been considered in the area of second language acquisition and has never been reviewed in terms of first language phonological change (attrition). Further, when considering the extralinguistic factors, this study provides a comprehensive review of all variables that may impact L1 attrition or change and most importantly this study is the first to offer empirical evidence as to how language aptitude (in this study measured as the number of languages spoken) may significantly impact first language phonological change.

Therefore, it may be concluded that only a comprehensive observation and examination that considers all aspects of bilingual speech (production and perception), intralinguistic and extralinguistic (or often referred to as sociolinguistic) factors may adequately account for the L1 phonological changes in bilingual speakers. Furthermore, the individual's language experience (i.e. language identity) may govern L1 phonological change.

5.1 Limitations, implications and future directions

Methodological limitations:

Arguably, as this study's methodological approach measured a particular 'moment' in the development of late consecutive Slovene-English bilinguals, these results may not represent a holistic picture of the bilinguals' language state. Possibly, by conducting a longitudinal study—research that examines and repeats the measurements—the results may have looked different. Additionally, further data could shed light on the overall process and observe the possible stages that bilinguals (attriters) may undergo. Therefore, future studies may want to consider a longitudinal approach to the examination of L1 phonological change. However, it ought to be noted that researchers may be faced with the problem of repeatedly testing an element that is undergoing change and consequently influencing the outcome. Specifically, the researcher may face the so-called 'observer effect', where the participants are aware of the repeated measurements and this could impact their findings.

Additionally, this study mostly focuses on the organization of the vowel system of Slovene-English late consecutive bilinguals, consequently disregarding early simultaneous bilinguals. Therefore, future work in this area may want to examine how the phonological system develops in Slovene-English early simultaneous bilinguals, as well as investigating not only the vowel system, but also the impact of L1 change on consonants, as the changes in consonants may be more prominent than in vowel sounds. Note, however, that previous literature suggests that consonants have the tendency to change less over time.

Hopp and Schmid (2013) argued that the methodological choice of using monolingual control groups as a norm or measure of 'native-likeness' is highly debateable as in all likelihood the norms will be out of reach for most bilinguals. They propose that it may be more appropriate to investigate and compare late consecutive bilinguals to early simultaneous bilinguals to establish to what extent the speakers, who learnt a second language in childhood, approximate speakers who learnt a second language later in life. However, finding such a sample of the population may pose further difficulties.

Furthermore, after reviewing the methodological approach to this study, one may note that no proficiency test was employed to measure Slovene-English bilinguals' proficiency in either L1 or L2. This was a conscious decision due to the length of the

procedures used in the experiments as the participants were volunteers and were not financially, or in any other way, compensated. Future research may want to employ an Oxford Quick Placement Test or similar test to test the bilinguals' proficiency and reflect on the impact of such a score on their overall changes in either production or perception. Additionally, by utilising proficiency tests, future research may shed light on the impact of the educational level, which might be linked to English proficiency in this study.

Moreover, this study did not examine suprasegmental features of language such as pitch and tone. However, in retrospect the additional data and the examination of pitch and tone could have shed light on why Slovene-English late consecutive bilinguals were perceived as non-native. Future research could therefore consider these features and explore whether they may be of significance to the perception of bilinguals by native speakers.

Lastly, it was noted in Chapter 4 that the informal conversations held with all participants were rich in information and shed light on the results. However, these conversations were not recorded, as the already robust approach in the experiments was considered sufficient. In retrospect, the 'informal' data would have been an interesting avenue to explore, as it would further explain the extralinguistic predictors of the bilinguals' lives. Additionally, the approach of recording informal conversations would have led to a more sociolinguistic study, which was not the focus of my research. Nevertheless, a more sociolinguistically motivated study or approach could have proved fruitful.

Implications and future directions:

Future research in the area of first language phonological change could also address various aspects that were beyond the scope of this thesis. For example, Best *et al.*'s (2009:64) suggestion that the "L2 vocabulary growth and the L2 phonological acquisition during the first 12 months of the immersion" significantly impacts the perceptual similarity of vowel sounds. Additionally, while examining vocabulary growth one may want to consider the view that the increase of the vowel sounds in a combined L1-L2 phonological space may cause the overall vowel space to expand (Lindblom, 1986) and from a theoretical point of view, the research could focus on measuring the size of this L1-L2 vowel space in both early and late Slovene-English bilinguals.

Furthermore, the results suggest that future work in the area of phonological change adapts the whole vowel system approach, as this methodological approach enables the researcher to gain a comprehensive and non-biased picture of the combined L1-L2 vowel system, incorporating both intralinguistic as well as extralinguistic factors.

This study could also have future implications for foreign language (FL) pronunciation instruction, in particular in regards to Slovene-English L2 learners, as well as early and late consecutive bilinguals. Specifically, the perceptual training could constitute an essential component in the design of the pronunciation tasks that may aid these learners. In particular, the results of the second experimental procedure (measured and tested perceptual similarity) outline vowel sounds Slovene learners of English may find particularly difficult to acquire at the start of second language acquisition.

The main findings of this study may also serve as a 'praise' of the Slovene educational system, where many L2 learners, who leave compulsory education, have the ability to communicate in a foreign language, due to the early starting age of L2 learning (age 10). This was first evident from the informal conversations that took place in an English monolingual mode—participants were able to accurately and fluently express themselves in their L2. Most notably this was evident from the results (specifically production), as all Slovene-English bilinguals were able to produce words that were considered 'difficult'/'tricky' to Slovene learners of English (see Chapter 3). However, this may also be due to self-selection, or where / when participants were recruited. Based on these outcomes, one may suggest that the structure of the Slovene educational system has significantly impacted the ongoing language development of Slovene-English late consecutive bilinguals.

In closing, I would like to emphasize that in this contribution I aimed to promote a reconsideration of the current linguistic theory regarding L1 phonological change and seek further empirical evidence that would systematically account for all phonological aspects of bilingual speakers' production and perception, as well as to closely consider the impact of intralinguistic and extralinguistic factors that are clearly strongly correlated.

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Appendices

1. Appendix: English word list

English word list

(CVC words, 11 vowel sounds, /ə/ not included)

Controlled for the phonological environment of the words (start and end with unvoiced plosives /t/, /k/, /p/)

/æ/

1. pat /pæt/
2. pack /pæk/
3. tap /tæp/
4. tat /tæt/
5. tack /tæk/
6. cat /kæt/

/ɑ:/

1. part /pɑ:t/
2. tart /tɑ:t/
3. cart /cɑ:t/

/e/

1. pet /pet/
2. pep /pep/
3. peck /pek/
4. tech /tek/

/ɜ:/

1. perk /pɜ:k/
2. pert /pɜ:t/
3. curt /kɜ:t/

/i:/

1. peat /pi:t/
2. peak /pi:k/
3. peep /pi:p/
4. teat /ti:t/

/ɪ/

1. pip /pɪp/
2. pit /pɪt/
3. tick /tɪk/
4. tip /tɪp/
5. tit /tɪt/

/ɒ/

1. pop /pɒp/
2. pot /pɒt/
3. top /tɒp/
4. tot /tɒt/

/ɔ:/

1. port /pɔ:t/
2. caught /kɔ:t/
3. taught /tɔ:t/

/u:/

1. poop /pu:p/
2. coot /cu:t/
3. toot /tu:t/

/ʌ/

1. pup /pʌp/
2. puck /pʌk/
3. cut /kʌt/
4. cup /kʌp/
5. tuck /tʌk/
6. tut /tʌt/

/ʊ/

1. put /pʊt/
2. took /tʊk/
3. cook /cʊk/

2. Appendix: Slovene word list

Slovene word list

(CVC and CVCV words, 7 vowel sounds, /ə/ not included)

- Controlled for the phonological environment of the words (start and end with unvoiced plosives /t/, /k/, /p/)

/a/

1. pak /pak/
2. pat /pat/
3. tat /tat/
4. kap /kap/

/e/

1. pet /pet/
2. pek /pek/
3. tek /tek/

/ɛ/

1. peta /pɛta/
2. teta /tɛta/
3. pepe /pɛpɛ/

/i/

1. pik /pik/
2. kip /kip/
3. kit/kit/

/o/

1. pot /pot/
2. pok /pok/
3. tok /tok/
4. kot /kot/

/ɔ/

1. pop/pɔp/
2. pot /pɔt/
3. kot /kɔt/
4. top/tɔt/

/u/

1. put /put/
2. kup /kup/
3. kuk /kuk/

3. Appendix: English extract

Text: Pink Floyd (extract)

It could all have gone wrong at this early stage. I could have ended up a Pink Floyd enthusiast. It happened to a lot of people I knew and they weren't necessarily to blame. I understand because I came damn close. But I got away with it.

I was dimly aware that Pink Floyd had been another kind of group altogether back in the 1960s; that there had been a figure in the band called Syd Barrett who was clearly some kind of off-the-cuff genius and who wrote trippy, psychedelic and yet strangely insightful little pop songs. Unfortunately, drugs or success or the uncontrollable loopings of his own imagination, or some volatile combination of the three, had driven him mad and he'd gone to live with his mum in Cambridge. But I'd missed all that, and since then Pink Floyd had turned into sulky, earnest, self-conscious, pompous rock stars, prone to large-scale, surreal public events, like floating a giant inflatable pig above Battersea Power Station. You could see why they went down well with sixth-formers. Leaving aside the publicity stunts with air-filled animals, you're looking at a fairly accurate personality profile for me and most of my closest friends, circa 1978.

Pink Floyd played progressive rock. (And continue to play it, despite a serious rending of the group's social fabric which has led Roger Waters to stomp off on his own. Waters was, some would argue, the band's lynchpin - though don't get into this with serious Floyd fans unless you've got at least a week to spare.) This is to say, they are not renowned for snappy, chart-busting singles, but are instead spoken of, in reverent tones, as an albums band, a distinction which, during the seventies, one rather generously bestowed on any group that couldn't come up with a decent chorus. Most progressive rock bands contain a classically trained keyboard player who will explain during interviews that the organ figure in 'Asylum Of The Sane' is, in fact, based on a piece by Bach. You don't call them songs, you call them 'tracks', and a track isn't really pulling its weight if it comes in under seven minutes. Progressive rock is pop with big ideas.

4. Appendix: Slovene extract

Morda je vaša nečakinja tak primer, ponudi s tolažljivim glasom oče in opazuje slamnik, črne trakove na vratu, kako mahajo za njenim hrbtom. V drugem delu mesta, v stari hiši ob spodnjem trgu, moški, oblečen v črne žametne hlače in temno volneno jopo, prekine molk: merila sta se izpod čela, oče je dvignil skodelico in spustil po grlu zadnji požirek kave. Tekmeca, ki so jima okoliščine onemogočile, da bi postala zaveznika, kljub temu pa je bilo za ostrimi vprašanji in odgovori prisotno neizgovorjeno razumevanje; zajeto je bilo v samoumevnosti, tisti samoumevnosti, ki edina zbliža ali odbije svetove. Ja, se je nasmehnil Florjan in obmiroval s pogledom na skupinici kaplanov iz okoliških mestec in vasi, ki so se hranili ob obloženi mizi sredi prostora, ampak svet je ne glede na muke zadnjih dni odrešen. Povej Daretu, stoka Iztok, povej mu, da me ni, kurc … Cigareta je zaplavala men njimi, sprejel jo je tudi oče, ponižno, vdano; zmehčala je prostor, misli. Kaja se je kmalu zatem prvič nasmehnila, seveda še vedno zbegana. Po stavku, ki je presenetil tudi njega samega, je nastala tišina; vedel je da Kaja noče govoriti o tem, prav zato, ker njena trdnost popušča. In prav ker njena trdnost popušča, je treba govoriti o tem. Preprost račun. Trenutki zmede in negotovosti so voda na Lutov mlin, vohal je to, kot žival, ki voha utrujenost žrtve. Hoče Kajino javno priznanje, hoče uživati v svojem zmagoslavju in Iztokovem porazu, tudi on hoče h koritu slave. Meso med prsti Lutove roke žalostno odmre, popravi si hlače in pograbi hladno pivo. Naslednja pesem se ovije v molku, vsak na svojem koncu s slušalko v roki, Kaja ponovno v nanizanki, Lut med kitarami pod stropom. Sedi, ud je za trenutek svetilka v puščavi.

5. Appendix: Global accent rating task

On the following scales, please circle the answer that best reflects your opinion.

Speaker 1

1	2	3	4	5	6	7	8	9
Definitely non- native								Definitely native

Speaker 2

1	2	3	4	5	6	7	8	9
Definitely non- native								Definitely native

Speaker 3

1	2	3	4	5	6	7	8	9
Definitely non- native								Definitely native

Speaker 4

1	2	3	4	5	6	7	8	9
Definitely non- native								Definitely native

Speaker 5

1	2	3	4	5	6	7	8	9
Definitely non- native								Definitely native

Speaker 6

1	2	3	4	5	6	7	8	9
Definitely non- native								Definitely native

Speaker 7

1	2	3	4	5	6	7	8	9
Definitely non- native								Definitely native

Speaker 8

1	2	3	4	5	6	7	8	9
Definitely non- native								Definitely native

Speaker 9

1	2	3	4	5	6	7	8	9
Definitely non- native								Definitely native

Speaker 10

1	2	3	4	5	6	7	8	9
Definitely non- native								Definitely native

Speaker 11

1	2	3	4	5	6	7	8	9
Definitely non- native								Definitely native

Speaker 12

1	2	3	4	5	6	7	8	9
Definitely non- native								Definitely native

Speaker 13

1	2	3	4	5	6	7	8	9
Definitely non- native								Definitely native

Speaker 14

1	2	3	4	5	6	7	8	9
Definitely non- native								Definitely native

Speaker 15

1	2	3	4	5	6	7	8	9
Definitely non- native								Definitely native

Speaker 16

1	2	3	4	5	6	7	8	9
Definitely non- native								Definitely native

Speaker 17

1	2	3	4	5	6	7	8	9
Definitely non- native								Definitely native

Speaker 18

1	2	3	4	5	6	7	8	9
Definitely non- native								Definitely native

Speaker 19

1	2	3	4	5	6	7	8	9
Definitely non- native								Definitely native

Speaker 20

1	2	3	4	5	6	7	8	9
Definitely non- native								Definitely native

Speaker 21

1	2	3	4	5	6	7	8	9
Definitely non- native								Definitely native

6. Appendix: Sociolinguistic and background questionnaire: Monolingual

---

*1. Date of birth?

*2. Are you male or female?

- Male
- Female

Other (please specify)

*3. Where were you born?

*4. Nationality:

*5. Would you say that you spoke a standard variety of your first language or a dialect?

- Standard
- a dialect, namely:

Other (please specify)

*6. What is the highest level of education you have completed?

- Did not attend school
- primary school
- secondary school
- high school
- higher education, namely:
- university, degree:
- postgraduate degree, namely:

Other (please specify)

*7. What is your current profession?

*8. Do you speak any other languages or have learnt them in the past?

- only my mother tongue
- (an)other language(s) as well, namely:

Other (please specify)

*9. What language or languages did you learn professionally or at school?

*10. What language or languages did you learn outside of an educational environment (so outside of school or work)?

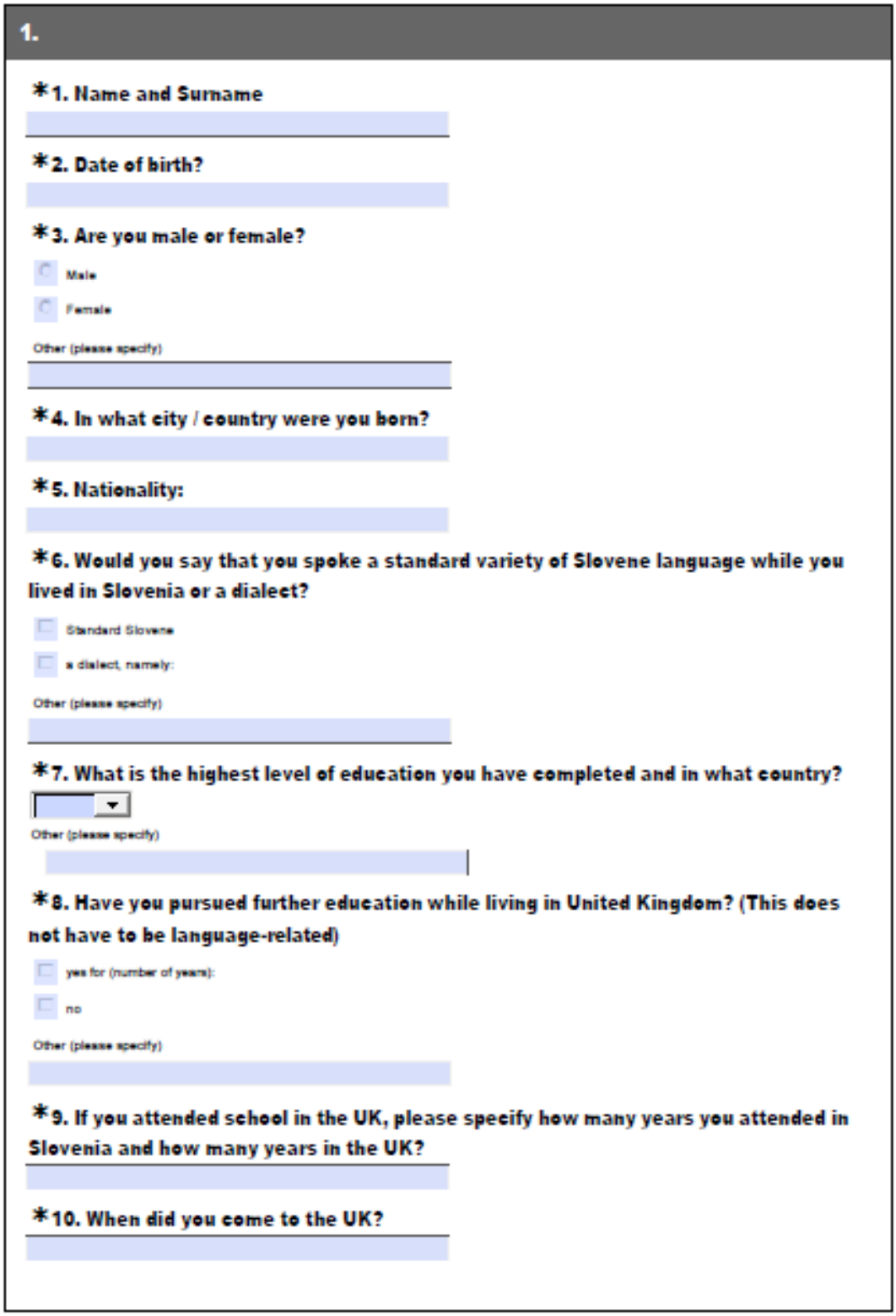
*11. In general, how would you rate your first language proficiency?

- very good
- good
- ok
- fairly poor
- very poor

Other (please specify)

12. You have come to the end of this questionnaire. Is there anything you would like to add? This can be anything from language-related comments to remarks about the questionnaire or research itself.

7. Appendix: Sociolinguistic and background questionnaire: Bilingual



1.

*1. Name and Surname

*2. Date of birth?

*3. Are you male or female?

Male

Female

Other (please specify)

*4. In what city / country were you born?

*5. Nationality:

*6. Would you say that you spoke a standard variety of Slovene language while you lived in Slovenia or a dialect?

Standard Slovene

a dialect, namely:

Other (please specify)

*7. What is the highest level of education you have completed and in what country?

Other (please specify)

*8. Have you pursued further education while living in United Kingdom? (This does not have to be language-related)

yes for (number of years):

no

Other (please specify)

*9. If you attended school in the UK, please specify how many years you attended in Slovenia and how many years in the UK?

*10. When did you come to the UK?

***11. Apart from the UK, have you ever lived in a country other than Slovenia for a longer period of time?**

- ☐ no
- ☐ yes, in:..... for the period of:

Other (please specify)

2.

***12. Did you learn any other languages?**

- [ ] only Slovene language
- [ ] (an)other language(s) as well, namely:

Other (please specify)

***13. Did you attend any English classes before coming to the UK?**

- [ ] no
- [ ] yes, for the duration of (number of years):

Other (please specify)

***14. Did you attend English classes in the UK?**

- [ ] no
- [ ] yes, for the duration of (number of years):

Other (please specify)

***15. What language or languages did you learn professionally or at school?**

***16. What language or languages did you learn outside of an educational environment (so outside of school or work)?**

***17. What is your current profession?**

***18. Have you ever been back to Slovenia since leaving for the UK?**

- [ ] no, never
- [ ] yes, but only occasionally
- [ ] yes, regularly: one in.....years OR about:..... times a year.

Other (please specify)

***19. If you have indicated that you have been back to Slovenia, could you please indicate what the reason or reasons for such a visit were (you may tick more than one box here)?**

- [ ] because of urgent family matters (such as a wedding or a funeral)
- [ ] to visit friends and relatives
- [ ] for another reason, namely:

Other (please specify)

***20. In general, how would you rate your English language proficiency before you moved to the UK?**

- [ ] very good
- [ ] good
- [ ] ok
- [ ] fairly poor
- [ ] very poor

Other (please specify)

***21. In general, how would you rate your English language proficiency at present?**

- [ ] very poor
- [ ] fairly poor
- [ ] ok
- [ ] good
- [ ] very good

Other (please specify)

3.

***22. How often do you speak Slovenian?**

- daily
- weekly
- a few times a year
- less than that, namely

Other (please specify)

***23. Do you consider it important to maintain your Slovene language?**

- very important
- important
- no opinion
- fairly unimportant
- very unimportant

Other (please specify)

***24. What language are you using during mental calculations?**

- Slovene
- English

Other (please specify)

***25. In general, do you have more Slovenian- or English-speaking friends in the UK**

- only Slovenian-speaking friends
- both, but more Slovenian-speaking friends
- as many Slovenian- as English-speaking friends
- both, but more English-speaking friends
- only English-speaking friends

Other (please specify)

***26. Do you feel more at home with Slovenian or with British culture?**

- with British culture
- with both, but more with British culture
- with both cultures, equally
- with both, but more with Slovenian culture
- with Slovenian culture

Other (please specify)

***27. Do you feel more comfortable speaking Slovenian or English?**

- no preference
- Slovenian
- English

Other (please specify)

28. What is your current marital status?

- married
- separated/divorced
- widow/widower
- living together unmarried
- single

Other (please specify)

29. With what language(s) was your (ex)partner brought up?

- English
- Slovenian
- other, namely:

Other (please specify)

4.

30. What language or languages do you mostly use when talking to your (ex)partner?

- only Slovenian
- both Slovenian and English, but mostly Slovenian
- both Slovenian and English, without preference
- both Slovenian and English, but mostly English
- only English

Other (please specify)

31. Do you have children?

- no
- yes, they are ..... years old

Other (please specify)

***32. What language or languages do you mostly use when talking to your children? If you don't have children, what language would you use?**

- only Slovenian
- both Slovenian and English, but mostly Slovenian
- both Slovenian and English, without preference
- both Slovenian and English, but mostly English
- only English

Other (please specify)

***33. Are you in frequent contact with relatives and friends in Slovenia?**

- all the time
- frequently
- sometimes
- rarely
- very rarely

Other (please specify)

***34. How do you keep in touch with those relatives and friends in Slovenia?**

- telephone
- letters
- e-mail
- another way, namely:

Other (please specify)

***35. What language or languages do you mostly use to keep in touch with relatives and friends in Slovenia?**

- only Slovenian
- both Slovenian and English, but mostly Slovenian
- both Slovenian and English, without preference
- both Slovenian and English, but mostly English
- only English

Other (please specify)

***36. 37. Do you think Slovenian plays an important role in the relationship between your direct family members?**

- not at all
- not much
- no opinion
- a bit
- very much

Other (please specify)

***37. Have you ever been a member of a Slovenian club or organisation in UK?**

- no
- yes, namely (name of the organisation and period of membership)

Other (please specify)

***38. What language do you use when you are alone or upset?**

5.

***39. Do you ever get homesick in the sense of missing Slovenia?**

- [ ] no, because.....
- [ ] yes, what I then miss most is/are:
- [ ] sometimes.....

Other (please specify)

***40. Do you ever listen to Slovenian songs and/or radio?**

- [ ] no
- [ ] yes

Other (please specify)

***41. Do you ever read Slovenian newspapers, books or magazines?**

- [ ] no
- [ ] yes

Other (please specify)

***42. Do you ever watch Slovenian television programmes?**

- [ ] no
- [ ] yes

Other (please specify)

***43. Do you think your Slovenian language proficiency has changed since you moved to UK?**

- [ ] no
- [ ] yes, I think it has become better
- [ ] yes, I think it has become worse

Other (please specify)

***44. Do you think you use more or less Slovenian since you moved to UK?**

- [ ] no, I don't think I use more or less Slovenian now
- [ ] yes, I think I use less Slovenian
- [ ] yes, I think I use more Slovenian

Other (please specify)

***45. Do you see yourself as bilingual? In other words, do you think you are as proficient in Slovenian as in English?**

- [ ] no, because
- [ ] yes, because
- [ ] I don't know, because

Other (please specify)

46. You have come to the end of this questionnaire. Is there anything you would like to add? This can be anything from language-related comments to remarks about the questionnaire or research itself.

8. Appendix: Tested perceptual similiarity - Slovene naïve listeners

	Kap	Pek	Peta	Krt	Pik	Pok	Pop	Kup
1								
2								
3								
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9								
10								
11								
12								
13								
14								
15								
16								
17								
18								

9. Appendix: Consent form

Anglia Ruskin University
Cambridge Chelmsford Peterborough

NAME OF PARTICIPANT:

Title of the project: **Phonological change in late consecutive bilinguals**

Main investigator and contact details: **Mihaela A. Nolimal**

Members of the research team: **Melanie Bell, Bettina Beinhoff**

1. I agree to take part in the above research. I have read the Participant Information Sheet, which is attached to this form. I understand what my role will be in this research, and all my questions have been answered to my satisfaction.
2. I understand that I am free to withdraw from the research at any time, for any reason and without prejudice.
3. I have been informed that the confidentiality of the information I provide will be safeguarded.
4. I am free to ask any questions at any time before and during the study.
5. I have been provided with a copy of this form and the Participant Information Sheet.

Data Protection: I agree to the University[1] processing personal data which I have supplied. I agree to the processing of such data for any purposes connected with the Research Project as outlined to me

Name of participant (print)……Signed……Date……

Name of witness (print)……Signed……Date……

YOU WILL BE GIVEN A COPY OF THIS FORM TO KEEP

If you wish to withdraw from the research, please complete the form below and return to the main investigator named above.

Title of Project:

I WISH TO WITHDRAW FROM THIS STUDY

Signed: _____ Date: _____

[1] "The University" includes Anglia Ruskin University and its partner colleges

10. Appendix: Participant information sheet

Anglia Ruskin University
Cambridge Chelmsford Peterborough

Participant Information Sheet

Phonological change in late consecutive bilinguals

This study will increase our understanding of the effects of learning a second language to a high level of proficiency, by comparing the speech of bilingual and monolingual speakers of English and Slovenian.

You have been asked to participate in this postgraduate research project because you are a speaker of Slovenian and/or English and we believe that you can make an important contribution to the research. You should only participate if you want to; choosing not to take part will not disadvantage you in any way. Before you decide whether you want to take part, it is important for you to understand why the research is being done and what your participation will involve. Please take time to read the following information carefully and discuss it with others if you wish. If you do not wish to participate you do not have to do anything in response to this request.

Who is organising the research?

The research is organized by the researcher (Mihaela A. Nolimal) in association with Anglia Ruskin University as part of the doctoral research programme.

What will happen if you agree to take part?

If you agree to take part in this research, you will be asked to first complete a background questionnaire. You may then be asked to participate in either the production part of the experiment, where you will be asked to read selected words and possibly longer passages presented on a computer screen, or the perception part of the experiment, where you will be asked to listen to recordings and respond to them. All of these procedures will be recorded with a digital recorder and external microphone. The experiment should not take longer than one hour. After taking part you will be given the chance to ask additional questions.

What will happen to the results of the study?

All information and recordings provided by you, and their subsequent analysis, will be stored anonymously on a password-protected computer or in a locked cabinet. In order to ensure your anonymity your data will be allocated to a random number code. The results from this analysis will be available in one or more of the following sources: PhD thesis, scientific papers in peer reviewed academic journals, presentations at academic conferences and seminars. In any sort of report we make public we will not include any information that will make it possible to identify you. Any recorded material will be destroyed after it has been transcribed, which we anticipate will be within six months. All these procedures are in accordance with the principles of the Data Protection Act 1998 and the EU Directive 95/46 on Data Protection.

Are there any risks involved?

There are no known risks associated with this study. Agreement to participate in this research will not compromise your legal rights or safety in any way. There are no special precautions you should be taking before, during or after taking part in this study.

Withdrawal from the study

Taking part in this study is completely voluntary and you can refuse to take part. If you decide to take part, you are free to withdraw at any time by filling out the Withdraw section on the Consent Form. You may withdraw any data/information you have already provided up until it is transcribed for use in the final report.

Contact for further information

If you have any questions or require more information about this study, please contact the researcher using the following contact details: Mihaela A. Nolimal; man128@student.anglia.ac.uk

YOU WILL BE GIVEN A COPY OF THIS TO KEEP,
TOGETHER WITH A COPY OF YOUR CONSENT FORM

11 Appendix: Linear mixed-effects model for extralinguistic factors (additional analysis)

Random effects

Groups	Name	Variance	Std.Dev.
Word	(Intercept)	0.002321	0.04818
Residual		0.06346	0.25191

Fixed effects

Column1	Estimate	Std. Error	df	t value	Pr(>|t|)
Intercept	1.67E+00	7.79E-02	2.59E+02	21.458	< 2e-16
LORbinbiShort	-1.96E-02	8.37E-02	1.01E+03	-0.234	0.8149
LORbinmono	1.86E-02	8.37E-02	1.01E+03	-0.225	0.8217
Vowele	-2.11E+00	1.10E-01	2.59E+02	-19.116	< 2e-16***
Vowelɛ	-1.10E+00	1.12E-01	2.749e+02	-9.802	< 2e-16***
Voweli	-2.58E+00	1.10E-01	2.59E+02	-23.457	< 2e-16***
Vowelo	-2.11E+00	1.72E-01	3.482e+02	-12.278	< 2e-16***
Vowelɔ	-1.41E+00	1.34E-01	3.28E+02	-10.558	< 2e-16***
Vowelu	-2.53E+00	1.10E-01	2.59E+02	-22.989	< 2e-16***
formantF2	-2.25E+00	1.03E-01	1.01E+03	-21.903	< 2e-16***
LORbinbiShort:Vowele	1.97E-02	1.19E-01	1.01E+03	0.166	0.8681
LORbinmono:Vowele	-1.29E-01	1.17E-01	1.01E+03	-1.109	0.2679
LORbinmono:Vowelɛ	-2.57E-02	1.19E-01	1.01E+03	-0.065	0.9482
LORbinbiShort:Vowelɛ	-7.90E-03	1.22E-01	1.01E+03	-0.217	0.8285
LORbinbiShort:Voweli	-1.82E-02	1.18E-01	1.01E+03	-0.154	0.8778
LORbinmono:Voweli	-1.05E-01	1.17E-01	1.01E+03	-0.9	0.3682
LORbinbiShort:Vowelo	1.60E-01	1.83E-01	1.01E+03	0.875	0.3818
LORbinmono:Vowelo	6.37E-02	1.80E-01	1.01E+03	0.354	0.7238
LORbinbiShort:Vowelɔ	2.42E-01	1.46E-01	1.01E+03	1.655	0.0983
LORbinmono:Vowelɔ	3.58E-01	1.40E-01	1.01E+03	2.55	0.0109*
LORbinbiShort:Vowelu	1.03E-01	1.18E-01	1.01E+03	0.876	0.3811
LORbinmono:Vowelu	3.67E-02	1.17E-01	1.01E+03	0.315	0.7528
LORbinbiShort:formantF2	1.30E-01	1.18E-01	1.01E+03	1.094	0.274
LORbinmono:formantF2	1.47E-01	1.17E-01	1.01E+03	1.259	0.2082
Vowele:formantF2	3.61E+00	1.45E-01	1.01E+03	24.838	< 2e-16***
Vowelɛ:formantF2	2.30E+00	1.49E-01	1.01E+03	15.45	< 2e-16***
Voweli:formantF2	4.26E+00	1.45E-01	1.01E+03	29.255	< 2e-16***

Vowelo:formantF2	1.64E+00	2.30E-01	1.01E+03	7.131	1.90e-12***
Vowelɔ:formantF2	1.04E+00	1.78E-01	1.01E+03	5.826	7.63e-09***
Vowelu:formantF2	1.86E+00	1.45E-01	1.01E+03	12.805	< 2e-16***
LORbinbiShort:Vowele:formantF2	-1.05E-01	1.68E-01	1.01E+03	-0.627	0.5309
LORbinmono:Vowele:formantF2	1.33E-01	1.65E-01	1.01E+03	0.805	0.4209
LORbinbiShort:Vowelɛ:formantF2	-2.63E-01	1.72E-01	1.01E+03	-1.53	0.1264
LORbinmono:Vowelɛ:formantF2	-3.26E-01	1.68E-01	1.01E+03	-1.941	0.0525
LORbinbiShort:Voweli:formantF2	-5.53E-02	1.67E-01	1.01E+03	-0.331	0.7404
LORbinmono:Voweli:formantF2	1.04E-01	1.65E-01	1.01E+03	0.631	0.5283
LORbinbiShort:Vowelo:formantF2	-3.94E-01	2.59E-01	1.01E+03	-1.523	0.128
LORbinmono:Vowelo:formantF2	-2.31E-01	2.55E-01	1.01E+03	-0.905	0.3655
LORbinbiShort:Vowelɔ:formantF2	-4.25E-01	2.07E-01	1.01E+03	-2.058	0.0398*
LORbinmono:Vowelɔ:formantF2	-4.33E-01	1.98E-01	1.01E+03	-2.182	0.0293*
LORbinbiShort:Vowelu:formantF2	-7.88E-02	1.67E-01	1.01E+03	-0.472	0.6368
LORbinmono:Vowelu:formantF2	-1.38E-01	1.65E-01	1.01E+03	-0.839	0.4019

Signif. codes: 0 '*' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1**

Note: LORbin is a binary extralinguistic factor of AOA and LOR

Note: statistical significance further evident in vowel sound /ɔ/