Regressive Phonological CLI in Sequential Trilinguals: Testing the Role of Typology

Qualifying Paper 2

Megan Marisa Brown

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Abstract

While previous work on trilingual speech rhythm has found evidence of progressive cross-linguistic influence (pCLI) from a previously known language to a more recently acquired language (Gut, 2010), to date, regressive cross-linguistic influence (rCLI) of speech rhythm from a more recently acquired language to a previously acquired language has not yet been thoroughly investigated. This work examined the degree to which speech rhythm (as measured by %V and VarcoV) in an L3 may influence the speech rhythm of a speaker's L1 and L2, and the degree to which the typological similarity of the languages may influence the degree of rCLI that occurs.

Sequential trilingual participants with either L1 English/L2 German/L3 Spanish or L1 German/L2 English/L3 Spanish along with a set of bilingual L1 English/L2 German and L1 German/L2 English control groups completed an elicited free speech task in each of their known languages. Results found that trilingual participants' English VarcoV values were significantly higher than those of the bilingual control participants, suggesting that the trilingual participants' English rhythm was influenced by rCLI from their L3 Spanish. No evidence of rCLI from Spanish to German was found.

Given these findings, this author proposes the Typological Convergence Hypothesis (TCH), which claims that the previously known languages that are more linguistically similar to the L3 are more vulnerable to rCLI from the more recently acquired L3.

Key Words: Multilingualism, Cross-linguistic influence, Regressive CLI, Speech Rhythm, English, German, Spanish

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List of Abbreviations

AR	Articulation Rate
CEM	Cumulative Enhancement Model
CLI	Cross-Linguistic Influence
CP	Critical Period
FPR	Filled Pause Ratio
IM	Interval Measures
L1	First Language
L2	Second Language
L2SF	L2 Status Factor Model
L3	Third Language
Ln	An additional language beyond the L3 (i.e. L4, L5...)
LPM	Linguistic Proximity Model
MLU	Mean Length of Utterance
pCLI	Progressive Cross-Linguistic Influence
PPH	Phonological Permeability Hypothesis
rCLI	Regressive Cross-Linguistic Influence
SLM	Speech Learning Model
SM	Scalpel Model
TCH	Typological Convergence Hypothesis
TLA	Third Language Acquisition
TPM	Typological Primacy Model

Contents

1 Introduction

Over the past two decades, the field of third language (L3) acquisition and trilingualism research has introduced many important findings related to cross-linguistic influence (CLI) in multilinguals and the factors which might influence CLI from the initial state of L3 acquisition and beyond (for more details, see Hammarberg, 2012; Wrembel, 2015; Puig-Mayenco, González Alonso, and Rothman, 2018). Cabrelli Amaro and Wrembel (2016), however, call attention to a major gap in trilingual CLI literature pertaining to CLI that occurs from a newly acquired language to a previously acquired language, a phenomenon known as regressive CLI.

This gap in the L3 literature is especially critical when examining the current models of trilingualism and L3 acquisition. While a wide array of models have been proposed in an attempt to explain initial state L3 acquisition and progressive transfer from a previously known language to a new language, to date, the only model that makes direct predictions regarding regressive transfer is the Phonological Permeability Hypothesis (PPH: Cabrelli Amaro and Rothman, 2010), which, in short, states that the L2 will be more phonologically vulnerable to regressive CLI from the L3 than the L1 due to neurolinguistic similarities between languages acquired in adulthood (see section 2.1 for more details).

Order of acquisition, age of acquisition, L2 status, and neurolinguistic similarities between known languages have all been argued to play a critical role in progressive CLI in trilinguals (Bardel and Falk, 2007; Falk and Bardel, 2010; Falk and Bardel, 2011; Bardel and Falk, 2012; Falk, Lindqvist, and Bardel, 2015; Falk, 2017; Falk and Lindqvist, 2019), and are therefore critical factors to consider when investigating regressive CLI as well. That being said, these are not the only factors which have been found to play a key role in progressive trilingual CLI. More specifically, typological similarity between the speakers' languages has also been argued to play an important role in progressive CLI (Rothman, 2010; Rothman and Cabrelli Amaro, 2010; Rothman, 2011; Rothman, 2013; Giancaspro, Halloran, and Iverson, 2015; Rothman, 2015; Westergaard, Mitrofanova, Mykhaylyk, and Rodina, 2017). However, typological similarity remains under-explored as a potential factor in regressive trilingual CLI.

In an attempt to address these gaps in the literature, this project examines L3 regressive CLI in high-proficiency sequential L1 English/L2 German/L3 Spanish and L1 German/L2 English/L3 Spanish trilinguals. Participants' speech rhythm in each of their languages is examined for evidence of regressive CLI from L3 Spanish to the L1 and/or L2 in order to investigate the degree to which typological similarity and/or order of acquisition play a role in determining the degree of regressive CLI that occurs. The results are compared to the predictions made by PPH as well as to a new typologically-based hypothesis outlined in this paper.

This paper is organized as follows: Section 2 provides a brief overview of the background literature relevant for this paper, where Section 2.1 discusses general theories of CLI in multilinguals, as well as previous work regarding regressive CLI more specifically, Section 2.2 discusses research related to speech rhythm in both a monolingual and bi/multilingual context, and 2.3 outlines the research question and hypotheses for the current study. Section 3 provides a description of the experimental procedure used and participants. Section 4 discusses statistical methods of data analysis and statistical results. Section 5 relates those statistical results to the previously proposed hypotheses and discusses their implications for the field of L3 CLI research. Section 6 provides an overall summary of the study and discusses possible future directions.

2 Background

2.1 Regressive Cross-Linguistic Influence

Cross-linguistic influence (CLI), sometimes referred to as "interference" or "transfer", between the phonological systems of a sequential bi- or multilingual speaker is a topic which has been of interest to researchers for several decades. However, the vast majority of this research has focused specifically on CLI that occurs from the L1 to the L2 in a bilingual context. This concept of CLI from a previously known language to a more recently acquired language is sometimes referred to as "progressive" CLI (pCLI). Meanwhile, CLI from a more recently acquired language to a previously acquired language remains a less commonly investigated phenomenon in the literature.

Terms that have been used to refer to the phenomenon of change to a native language system as a result of the acquisition and use of a non-native language in a bi- or multilingual speaker include, but are not limited to, regressive CLI, attrition, borrowing (Ulbrich, 2012), restructuring (Ulbrich, 2014), convergence (Flege, 1987), and drift (Chang, 2010). Each of these terms has a distinct meaning in terms of what types of CLI they refer to, depending on, for example, whether the influence is considered a loss or simplification of the L1 system (i.e. attrition) as opposed to simply a change (i.e. convergence, drift). One of the most general terms used in this literature is the term *regressive CLI* (rCLI), which refers to any and all influence that occurs from a more recently acquired language to a previously known language. Because of its overall inclusiveness, this paper will use the term rCLI to refer to all cases of influence from a more recently acquired language to a previously acquired language.

Some of the earliest work related to rCLI in sequential bilingual adult speakers was conducted by Flege (1987) and Flege and Eefting (1987), and looked at French/English and Dutch/English bilinguals, respectively. Both studies found evidence of a convergence of the bilingual speakers' VOT values in both of their languages, resulting in the bilingual speakers' VOT in both their L1 and L2 being significantly different from monolingual controls. These early findings of rCLI led to the initial inclusion of rCLI in more general models of L2 acquisition such as the Speech Learning Model (SLM: Flege, 1980; Flege, 1995; Flege et al., 2006), which claims that L2 phonological acquisition is fundamentally the same as L1 acquisition in that given adequate and sufficient input, L2 learners are able to acquire phonetic properties of L2 speech sounds accurately. SLM posits that the phonetic elements of both the L1 and L2 exist in a "common phonological space", and as a result, the phonological systems of the two languages are able to mutually influence one another, leading to the occurrence of both pCLI and rCLI between the bilingual's different languages.

Since Flege and Eefting's early work, additional research has found evidence of rCLI in segmental features. Examples include Guion's (2003) finding that L1 Quichua speakers who acquired L2 Spanish at a young age produce a higher [ɪ], [ʊ], and [ɑ] in their L1 Quichua compared to speakers who acquired their L2 at an older age. Additionally, Ulbrich (2014) found that L1 German speakers with a high level of L2 English exposure produce a constrictive post-vocalic /r/ in their non-rhotic native language, German. In terms of suprasegmental features, studies of intonation such as Willems's (1982) analysis of L1 Dutch-L2 English bilinguals and Mennen's (2004) investigation of L1 Dutch-L2 Greek speakers both found evidence of an influence of L2 on L1 intonation.

Overall, what this work in the L2 literature brings to our attention is that CLI is not strictly unidirectional, and that the relationship between the languages in a bilingual mind is a complex network. Given these principles, it stands to reason that when rCLI is considered in relation to third language (L3) acquisition, the complexity of the possible relationships between a speaker's languages increases exponentially.

As interest in the relationship between languages in the trilingual mind has drastically increased in recent years, the field of L3 acquisition has mirrored that of L2 acquisition in that early research in this field has focused almost exclusively on pCLI. The topic of of rCLI meanwhile remains underexplored, especially in regards to L3 phonetics and phonology (Cabrelli Amaro & Wrembel, 2016). Studies investigating trilingual phonological rCLI include Sypiańska (2016), Cabrelli Amaro (2016), Tordini, Galatà, Avesani, and Vayra (2018), Tordini (2019) and Liu, Gorba, and Cebrian (2019), all of which are summarized in Table 1 below. Sypiańska (2016) investigated vowel production in L1 Polish/L2 Danish/L3 English trilinguals and found evidence of CLI in every possible direction except for L3 →L2. Cabrelli Amaro (2016) compared sequential L1

Paper	**Languages**	**Phonological Feature(s)**	**Findings**
Sypiańska (2016)	L1 Polish L2 Danish L3 English	vowel production	Evidence of CLI in every direction except L3 to L2
Cabrelli Amaro (2016)	L1/L2 Spanish/English L3 Brazilian Portuguese	perception and production of word-final vowel reduction	Evidence of L3 to L2 rCLI in production but not in perception
Tordini et al (2018), Tordini (2019)	L1 Local Dialect L2 Italian L3 English	phonetic features of L1 coronals and vowels	No evidence of rCLI from L3 to L1
Liu, Gorba, and Cebrian (2019)	L1 Mandarin L2 English L3 Spanish	perception of VOT in English stops	No evidence of rCLI from L3 to L2

Table 1: Summary of previous trilingual phonological rCLI studies and findings

English/L2 Spanish/L3 Brazilian Portuguese and L1 Spanish/L2 English/L3 Brazilian Portuguese speakers in their perception and production of word-final vowel reduction, and found evidence of L3 →L2 CLI in the production results but no difference between groups related to perception. Work by Tordini et al. (2018) and Tordini (2019) examined heritage speakers of local Italian dialects who had standard Italian as an L2 and English as an L3. They found no evidence of rCLI from the L3 English to the L1 in terms of several acoustic features of their vowel and consonant production. Finally, Liu et al. (2019) investigated perception of VOT in English stops in L1 Mandarin/L2 English/L3 Spanish speakers and found no evidence of regressive CLI or negative interference from the trilinguals' L3 Spanish onto L2 English.

These four studies differ from each other critically in terms of their approaches, the languages and phonological features under investigation, and their findings. This makes it nearly impossible to make any clear predictions or models of trilingual rCLI. Meanwhile, L2 models such as SLM do not make clear predictions in a trilingual context.

One of the earliest formal hypotheses regarding regressive phonological CLI in multilingualism is Cabrelli Amaro and Rothman's (2010) Phonological Permeability Hypothesis (PPH). Their hypothesis claims that the phonological systems of languages acquired in adulthood are less resistant than L1 phonological systems to CLI from the L3. This claim is based on the assumption that the L1 system, developed in childhood, is fundamentally and neurologically different and as a result, more stable than that of the L2. In other words, PPH predicts that regressive phonological CLI in trilinguals is more likely to occur from the L3 to the L2 than from the L3 to the L1.

While order of acquisition is a factor that is critical to consider in any trilingual research (Bardel and Falk, 2007; Falk and Bardel, 2010; Falk and Bardel, 2011; Bardel and Falk, 2012; Bardel and Sánchez, 2017; Falk and Lindqvist, 2019; Brown, 2020), there are other factors which, in the bilingual L1 attrition literature, have been shown to also play a role in the degree of rCLI that occurs. A speaker's language use (Mayr, Sánchez, and Mennen, 2020; Olson, 2020), their exposure to native vs. non-native L1 speech (Mayr et al., 2020) and age of reduced contact (Bylund, 2009) have been shown to play a significant role in influencing the degree of L1 attrition that occurs.

One factor which has come to the attention of researchers in both L3 acquisition as well as rCLI/attrition is the role of typological similarity between the languages of a bi- or multilingual. While there are many ways that one might define what makes two languages more typologically similar or distant, the Typological Primacy Model of L3 acquisition (Rothman, 2011; Rothman, 2015) has proposed the following in regards to L3 initial state research. At the initial stage of L3 acquisition, a linguistic parser deems one of the learner's previously known languages as the more similar language, and that language is then used as the source of initial state transfer for the L3. The parser makes this selection by first looking for similarities in the lexicons

of the L3 and the previously known languages, followed by phonological overlap, followed by morphological and then syntactic overlap until it is able to determine the more similar language. While this system was originially proposed as a method of determining the language which transfers at the initial state of L3 acquisition, its implications remain relevant when considering later stages of trilingualism. As a result, the TPM's process of determining the more typologically similar language will be assumed in this paper.

In terms of the L3 acquisition, the typological similarity between an L3 learner's previously known languages and the new L3 has been claimed to to play a critical role in determining what previously known linguistic information transfers at the initial state of L3 development (Rothman, 2010; Westergaard et al., 2017). Meanwhile, in the bilingual attrition literature, Schmid and Köpke (2017) claim that an L1 is most vulnerable to attrition in instances where a bilingual's two languages are more similar to each other, as this may blur the line in regards to the bilingual's sense of what is and is not grammatical in their L1, as opposed to in their L2.

Given that typological similarity has been shown to play a key role in both trilingual pCLI and in bilingual rCLI, it stands to reason that it would also serve as a factor in trilingual rCLI. Additionally, in all of the studies of trilingual rCLI in Table 1, where rCLI was found, it occurred between the two languages which were most typologically similar to each other. To date, the degree to which the typological similarity of a trilingual's languages influences rCLI has not been explored systematically.

2.2 Speech Rhythm

2.2.1 Suprasegmental Features in L3 Research

In addition to the research gap related to L3 rCLI research, Cabrelli Amaro and Wrembel (2016) also call to attention the gap in the L3 phonology literature related to multilingual CLI of suprasegmental features. Among the few studies investigating suprasegmental properties are Gut's (2010) case study on speech rhythm, among other properties, in a set of four sequential trilinguals, all of whom had acquired English and German as two of their three languages. Gut found evidence that a positive effect of the L2 onto the L3 is possible, but was hesitant to make any larger claims or predictions based on this finding, noting that the degree to which CLI occurs can vary from property to property in L3 production. Another example is Cabrelli Amaro and Rothman's (2010) examination of the treatment of codas in L2 Spanish and L3 Brazilian Portuguese in a pilot study of L3 Brazilian Portuguese (BP) speakers with previous knowledge of English and Spanish. They found that the L2 Spanish of sequential bilingual L3 learners was more vulnerable to rCLI than the L1 Spanish of the simultaneous bilingual participants. Finally, Chan and Chang's (2019) investigation of L1 vs L2 Mandarin speakers' perceptions of tone contrasts in Yoruba and Thai found a facilitative effect of both L1 and L2 tonal experience on L3 tone perception, though the effect was greater for the L1. In summary, these studies differ in terms of the language triads that they assess, their methodological approaches, and the suprasegmental features of interest, demonstrating that additional research is required in this area. This project will look to contribute to the literature by considering rCLI in speech rhythm in sequential trilinguals.

2.2.2 Speech Rhythm

One suprasegmental feature which warrants additional investigation in the L3 literature is speech rhythm. Rhythm is the sense of movement in speech, which is derived from the repetition of elements perceived as similar. Those repeated elements are syllables in so-called "syllable-timed" languages, or stressed syllables more specifically in so-called "stress-timed" languages[1]. Early theories of speech rhythm such as Abercrombie (1967) classified languages into distinct categories of stress-timed or syllable-timed. However, more recent work on the subject has found that stress-timed and syllable-timed speech rhythm has no one phonetic correlate. Instead, prosodic rhythm involves various phonological properties. As a result, the concept of stress-timed vs. syllable-timed is no longer seen as categorical. Instead, rhythm is thought of as a spectrum, the poles of which are stress-timed and syllable-timed (Gut, 2010).

In the acquisition literature, native language speech rhythm is known to be one of the earliest features of language acquired by infants. Day-old infants (Mehler et al., 1988; Nazzin, Bertoncini, and Mehler, 1998),

[1]Some languages, such as Japanese, have been proposed to belong to a third rhythmic category of mora-timed languages, which will not be discussed in this paper. For more information, see Warner and Arai (2001).

and even fetuses as early as 35.5 weeks (Minai, Gustafson, Fiorentino, Jongman, & Sereno, 2017) have been shown to be able to discriminate between languages in different speech rhythm classes.

In terms of speech rhythm production in an L1, full development of a native rhythm system is an incremental process which takes a long time. In this process, syllable timing begins as the default setting, and stress timing is a marked feature that is acquired at later stages of language acquisition. Production of a fully adult-like stress timing is not achieved in monolingual children until the age of 11 or 12 (Polyanskaya & Ordin, 2015). However, while it may take many years for children to develop fully adult-like speech rhythm production, for bilingual children, a distinction between the rhythms of their two languages can be detected in their speech much earlier in development. Schmidt and Post (2015) found that in Spanish-English simultaneous bilingual children, where Spanish is categorized as a syllable-timed language and English is categorized as a stress-timed language, speech in the children's two languages was rhythmically separable by around the age of 4, and the children demonstrated two clearly separate rhythm patterns by the age of 6.

The acquisition of speech rhythm in a new language after the critical period (CP), meanwhile, has been found to be particularly difficult, and has been said to be one of the primary factors that contributes to non-native speakers having a 'foreign accent' (Anderson-Hsieh, Johnson, & Koehler, 1992). Research on both the acquisition of a stress-timed L2 by adults with a syllable-timed L1 (Ordin & Polyanskaya, 2015a) as well as the acquisition of a syllable-timed L2 by adults with a stressed-timed L1 (Guilbault, 2002) has found that L2 learners with a high level of proficiency are able to develop a rhythm that to some degree resembles that of the target L2 and is distinct from that of the L1, though only in very rare instances does this rhythm truly resemble that of a native speaker. Additionally, given that speech rhythm represents a spectrum of different rhythmic trends, rather than distinct categories, differences between L1 and L2 speech rhythm can also occur between languages which are categorized as belonging to the same rhythm category. This was the case for the L1 English-L2 German speakers considered by Ordin and Polyanskaya (2015b). As these participants became more proficient in their L2 German, their rhythm patterns become more stress-timed than those of native English speakers or native German speakers.

While these studies, as well as many others, emphasize that overall L2 learners are unlikely to develop an L2 rhythmic system that is comparable to that of a native speaker, they are able to develop a rhythmic system in their L2 which is distinct from that of the L1. In cases where those sequential bilingual learners acquire an L3, that L3 could undergo pCLI of speech rhythm from two potential source languages. As noted above, Gut (2010) remains one of the only studies to consider the unique speech rhythm acquisition situation of trilingual learners, finding evidence of facilitative progressive transfer of speech rhythm patterns from the L2 to the L3 in the case of speakers with both L2 English-L3 German and L2 German-L3 English. This relationship between the rhythmic systems of sequential trilinguals remains underinvestigated not only when considering pCLI, but also in terms of rCLI. This study looks to address these gaps in the literature.

2.2.3 Rhythm Metrics

While speech rhythm research has been active since the 1940s, metrics for acoustically measuring speech rhythm did not begin being proposed until 1999. Since that time, a variety of speech rhythm metrics have been proposed. Fundamentally, all of these proposed metrics derive from a simple segmentation of the speech stream into vocalic and consonantal intervals. Stress-timed languages are anticipated to have a high degree of variation in both their vocalic and consonantal intervals, due to the tendency of stress-timed languages to (1) have a greater contrast in vowel duration between stressed and unstressed syllables and (2) have greater variation in the complexity of consonant clusters compared to syllable-timed languages. Several of the most common measurements of speech rhythm are outlined below.

i. % V (*Percent Vowel*): the sum of vocalic interval durations divided by the total duration of vocalic and consonantal intervals and multiplied by 100 (Ramus, Nespor, & Mehler, 1999).

ii. ΔV (*Delta* V): the standard deviation in the duration of vocalic intervals (Ramus et al., 1999).

iii. ΔC (*Delta* C): the standard deviation in the duration of consonantal intervals (Ramus et al., 1999).

iv. VarcoV: the standard deviation of vocalic interval duration divided by the mean vocalic interval duration and multiplied by 100 (Dellwo, 2006).

v. VarcoC: the standard deviation of consonantal interval duration divided by the mean consonantal interval duration and multiplied by 100 (Dellwo, 2006).

vi. nPVI-V: the normalized Pairwise Variability Index for vocalic intervals (Low, Grabe, and Nolan, 2000; Grabe and Low, 2002).

vii. rPVI-C: the raw Pairwise Variability Index for consonantal intervals (Low et al., 2000; Grabe and Low, 2002).

It should be noted that in the time since the original proposals of these metrics, speech rhythm researchers have begun to question the general validity of durational metrics. In particular, Arvaniti (2009) calls to attention issues such as the fact that in larger-scale studies which considered a wider variety of languages, less rhythmically prototypical languages were deemed impossible to classify. Additionally, the differences in durational-metric scores between languages are often not statistically significant or meaningful when mapped on a scatterplot regression line.

While these arguments against the use of durational metrics may have value in research related to comparative phonetics, typology, and linguistic variation, the scope of this research is not to account for overall cross-linguistic differences between languages, but instead to investigate the interaction or cross-linguistic influence between the phonological systems of a multilingual individual. While it could be the case, as Arvaniti argues, that these measurements are not an effective tool for classifying languages into rhythmic categories, the question remains as to the ability of these measures to reflect trends in non-native speech rhythm.

To address this question, White and Mattys (2007) evaluated the metrics listed above in terms of their ability to quantify the influence of the first language on second language rhythm. White and Mattys worked under the assumption that L2 learners acquiring an L2 which is rhythmically different from their L1 should show an L2 speech rhythm pattern which is distinct from both the L1 rhythm and that of the target L2, an assumption which falls in line with models of L2 phonological acquisition such as SLM (Flege, 1980; Flege, 1995; Flege et al., 2006). The authors found that VarcoV and %V offered the most discriminative analysis in distinguishing between rhythm patterns in native vs. non-native speech, as demonstrated in Figure 1.

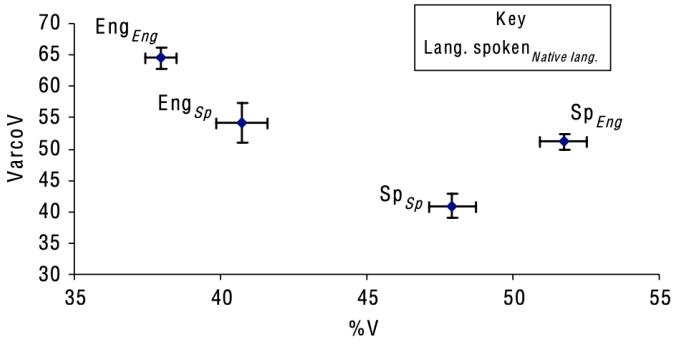

Figure 1: From White and Mattys (2007): Distribution of Spanish and English as first and second languages on the VarcoV, %V plane. Bars represent one standard error around the mean.

Another topic of concern for critics of these speech rhythm metrics is that these metrics have been shown to be sensitive to register and style. Arvaniti (2012) compared the speech metrics of native speakers of two syllable-timed and two stress-timed languages in three different speech styles: sentence reading, story reading, and spontaneous speech. Her results demonstrated clear variation in metric scores depending on register and sentence type. While these findings may also call for criticism of the use of these metrics in research that aims to categorize languages into classes or categories, this criticism is once again not a critical issue for the current study, in that the aim of this study is to look for individual differences in CLI, not larger linguistic trends. Even if the rCLI being considered in this study was only found in one particular speech style, it would still constitute an example of rCLI, thus providing information about the inner workings of the multilingual mind.

Overall, while metrics for measuring speech rhythm are imperfect and have been criticized in the literature, in a controlled experimental setting with a consistent speech style, VarcoV and %V have been found to be valid tools for investigating CLI of speech rhythm in a non-native context.

2.3 Current Study

As was noted in Section 2.1, previous research related to CLI in trilingual speakers has focused almost exclusively on pCLI. A variety of formal models of L3 acquisition and initial state transfer propose a variety of potential linguistic factors which could influence pCLI to the L3. These factors include, but are not limited to, the typological similarity of the speaker's languages (Rothman, 2010), and the neurolinguistic similarities between languages acquired in adulthood (i.e. native vs. non-native status; Bardel and Falk, 2007). It stands to reason that if these factors of typology and order of acquisition have been found to influence the degree of pCLI from each of a speaker's previously known languages, then these factors could also influence the degree of rCLI that occurs from the L3 to a speaker's previously known languages.

Section 2.1 also notes that one of these factors, order of acquisition, has previously been proposed to influence rCLI. Cabrelli Amaro and Rothman's (2010) PPH predicts that the L2 phonology will be more vulnerable to rCLI than the L1. No such hypothesis has yet been proposed in relation to the typological similarity of the trilinguals' languages. If it is the case that typology plays a role in rCLI, there are two possible ways in which this could occur:

- **Hypothesis 1:** The language that is most typologically **similar** to the L3 is more vulnerable to regressive CLI from the L3 than the more typologically distant language.
- **Hypothesis 2:** The language that is most typologically **distant** from the L3 is more vulnerable to regressive CLI from the L3 than the more typologically similar language.

In terms of precedent in the literature for either of these two possibilities, Hypothesis 1 could be seen as an extension of Schmid and Köpke's (2017) work on typology and attrition to a multilingual context. Schmid and Köpke claim that, in a bilingual context, the L1 is most vulnerable to rCLI in cases where the two languages are "sufficiently similar to allow some kind of spillover". In a trilingual context, this would suggest that more rCLI would occur between languages that are more similar to each other.

In terms of Hypothesis 2, to date there are no formal models that predict CLI in any direction to be more likely between more typologically distant languages. However, given the currently limited number of studies investigating trilingual rCLI, coupled with findings such as those of Sypiańska (2016), where rCLI was found between the more typologically distant languages but not between more similar ones, it is critical that this possibility be considered, as it could be a phenomenon that is unique to a trilingual context.

In order to test these two hypotheses, as well as the previously proposed PPH (Cabrelli Amaro & Rothman, 2010), this project examined rCLI in two groups of sequential trilinguals with different orders of L1 and L2 acquisition. This analysis examined the influence of the typological similarity of a multilingual's languages, as well as whether each language was acquired pre- or post-CP (i.e. order of acquisition), on the degree of rCLI that occurs from the L3 to each of the speaker's other languages. These trilinguals were compared to two sets of sequential bilingual controls who had similar L1/L2 backgrounds, but who lacked an L3 from which to experience the type of rCLI that is under investigation in the trilingual participants.

Testing these hypotheses required the use of a language combination in which the speech rhythm of the L1 and the L2 are both similar to each other and distinct from the L3, so that the L3 could potentially show clear rCLI onto the L1 and/or the L2. Additionally, it was necessary for the L3 to be more typologically similar to one of the previously acquired languages than to the other, in order for the results to clearly demonstrate the role of typological distance. The selected language combinations listed below were chosen based on these considerations:

1. L1 English$_{\text{(stress-timed)}}$ L2 German$_{\text{(stress-timed)}}$ L3 Spanish$_{\text{(syllable-timed)}}$
2. L1 German$_{\text{(stress-timed)}}$ L2 English$_{\text{(stress-timed)}}$ L3 Spanish$_{\text{(syllable-timed)}}$
3. L1 English$_{\text{(stress-timed)}}$ L2 German$_{\text{(stress-timed)}}$

4. L1 German(stress-timed) L2 English(stress-timed)

In terms of rhythm, English and German are both described as stress-timed languages, while Spanish is described as a syllable-timed language (Nespor, Shukla, & Mehler, 2011). In terms of typological similarity, while Spanish, a Romance language, is overall somewhat typologically distant from both English and German, which are both Germanic languages, of the two Germanic languages, English demonstrates a higher degree of lexical and morphological overlap with Spanish (Eibensteiner, 2019; Schepens, Dijkstra, Grootjen, and van Heuven, 2013). For this reason, English is most likely to be perceived by the speaker as the more typologically similar language to Spanish, while German is likely to be perceived to be more typologically distant.

3 Methods

3.1 Procedure

3.1.1 Experimental Tasks

Participation in the study involved the completion of three linguistic tasks in each of the participant's languages: a reading task, a LexTALE vocabulary test (Lemhöfer and Broersma, 2012; Izura, Cuetos, and Brysbaert, 2014), and the key task of interest, an elicited free speech task, in that order. This ordering of tasks was selected in an attempt to encourage activation of the target language in each set. While ideally participants would complete the set of tasks in each of their different languages in separate sessions on different days, due to concerns regarding participants reliably returning to the experiment in an online context, as well as overall timing restrictions, participants completed all tasks in all target languages in the same session. As a result, the reading tasks served to aid in the activation of the target language before participants began the of-interest LexTALE tests and spontaneous speech tasks in each language. The reading task data was not used in any analysis of speech rhythm on the basis of Arvaniti's (2012) findings that elicitation tasks involving reading produced significantly different speech rhythm patterns than natural spontaneous speech.

In the reading task, participants were presented with a brief passage in the target language, and were asked to read it aloud while recording themselves. All passages were retrieved from Lingua.com (2020), a free and publicly available language learning website. All reading passages are rated at a B1 proficiency level and all passages, along with English translations, are available in Appendix A.1.

Next, participants completed a brief LexTALE (Lemhöfer and Broersma, 2012; Izura et al., 2014) visual lexical decision task in the target language, which was used as a measure of language proficiency. All participants considered in this study measured at a B1 (intermediate) level or higher on all LexTALE tasks.

After completing the LexTALE task, participants began the elicited free speech task. In this task, participants were presented with a series of four cartoons. Participants were asked to describe what they saw in each cartoon in as much detail as possible in the language in question, as if they were speaking to a monolingual speaker of that language who could not see the image. Participants were not given any time limit on this task. All images used in this task are provided in Appendix A.2.

3.1.2 Experimental Procedure

Data collection took place in an online format, with all participants completing the study from home on their personal device. All experimental tasks were presented via a Qualtrics (2021) survey. After completing the necessary consent procedures, participants were asked to begin recording themselves using their phone's recording device, and to acknowledge via Qualtrics that they were doing so. Once recording, participants began the set of language tasks in one of their languages. The order in which the participants completed the language blocks (English, German, and for the trilingual participants, Spanish) was counterbalanced. This was done in an attempt to control for the potential influence of language activation in the results.

After completing the elicited free speech tasks in all of their languages, participants were allowed to stop recording and submit their recording to the researcher via Qualtrics upload or via email. The final step in the experiment was a brief language background questionnaire, conducted in English, which requested information about participants' perceived proficiency, frequency of use, and language dominance in each of their languages. All questions used in the language background survey are provided in Appendix A.3. In total, the entire experiment took about 30-45 minutes to complete.

3.2 Participants

In order to accurately test the hypotheses listed in Section 2.3, it was necessary that participants considered in this analysis met the following criteria:

1. All participants must be sequential bi- or trilinguals who acquired their L2 and L3 after the age of 7, since that is the age by which phonetic categories or mental representations of speech sounds in the L1 are predicted to have stabilized, and after which foreign accents may arise (Flege, 1999).

2. Participants must have sufficient proficiency and fluency in all of the target languages, as determined by a vocabulary test, Mean Length of Utterance (MLU), and filled pause ratio calculations (see sections 3.1 and 3.3 for more details).

3. The order in which the participants learned their languages must match one of the four target language background groups listed in 2.3.

4. Participants must have no knowledge of other languages besides the target languages of the experiment.

While the data collection process for this project involved the participation of 43 bilingual and trilingual speakers, only 13 of these participants fully matched all of the criteria listed above. The number of participants in each of the language groups is provided in Table 2 below. The data from these 13 participants (10 female, mean age = 33, age range = 18-57) will be discussed in this paper. Additionally, the distribution of the factors which led to the omission of the other 30 participants is provided in Appendix B.

Language Background	**Number**
L1 English/L2 German/L3 Spanish	4
L1 German/L2 English/L3 Spanish	2
L1 English/L2 German	4
L1 German/L2 English	3

Table 2: Number of participants in each language background group.

3.3 Analysis

The recordings of the participants' elicited free speech responses in each of their languages were analyzed using Praat (Boersma & Weenink, 2009). For each participant, a representative sample of about 1 minute of speech was taken from their recording in each of their languages, most commonly from the beginning of the description of the second picture, roughly 1-2 minutes into the recording. These samples were annotated via TextGrids. This annotation involved marking the duration of all consonants and vowels in the speech stream. Using this duration data, each participant's % V and VarcoV scores were calculated for each of their languages using the following formulas:

$$\%V = \frac{\text{sum of all vocalic interval durations}}{\text{total duration of vocalic and consonantal intervals}} \times 100$$

$$VarcoV = \frac{\text{the standard deviation of vocalic interval duration}}{\text{the mean vocalic interval duration}} \times 100$$

Additionally, TextGrids were marked for syllable duration, utterance duration, and filled pause duration, which in combination with vocalic duration and consonantal duration were used to measure participants' mean length of utterance (MLU) in syllables per utterance, articulation rate (AR), and filled pause ratio (FPR). These additional measures were used as measures of phonological proficiency in each of the participant's languages, but do not directly relate to speech rhythm. The formulas for MLU, AR, and FPR, are provided below.

$$MLU = \frac{\text{total number of syllables}}{\text{total number of utterances}} \times 100$$

$$AR = \frac{\text{total number of syllables}}{\text{total duration of syllables}}$$

$$FPR = \frac{\text{total duration of filled pauses}}{\text{total duration of utterances}}$$

4 Results

Before discussing the results of the linguistic analysis, it is necessary to emphasize that data collection in this project remains ongoing, and that this researcher intends to further strengthen the preliminary results outlined in this paper with additional data to be collected and processed at a later date. Researchers such as Plonsky (2015) would discourage the use of statistical analysis on a data set of this size, suggesting instead the exclusive use of descriptions and effect sizes. However, this author intends to continue and expand this project to a wider data set where statistical analysis will become necessary, with the ultimate goal of collecting responses from 20 participants per language background group, a number that was determined via a power analysis assuming a power level of .7 and a medium effect size. Given this intention to eventually collecetion a larger data set which would require a full statistical analysis, this author has made the decision to include preliminary statistical results in this paper.

Additionally, visual representations of non-statistically significant results were generally not included in this results section of this paper in order to avoid misconceptions regarding what may or may not be an emerging trend in the data. However, these additional graphic visualizations of non-significant results, as well as visualizations of individual participant variation not explicitly discussed in this paper are provided in Appendix C.

4.1 L3 Spanish Rhythm

First, it was necessary to determine that the target trilingual participants had in fact developed a rhythm system in their L3 that was distinct enough from their L1 and/or L2 systems to potentially instigate rCLI. In order to test this, all trilingual participants' speech rhythm measurement scores in each of their languages were compared. This included both the L1 English/L2 German and the L1 German/L2 English trilinguals. For %V, a one-way analysis of variance (ANOVA) yielded significant variation among the three languages, $F(2, 16) = 27.77$, $p < 0.0001$. A post hoc Tukey test showed that the trilinguals' Spanish %V differed significantly from that of both English and German at $p < 0.01$. No significant difference was found between the %V values of the trilinguals' English and German. These findings are shown in Figure 2.

For VarcoV, a one-way ANOVA also yielded significant variation, $F(2, 16) = 7.78$, $p < 0.01$. A post hoc Tukey test on this data found a significant difference between Spanish and German ($p < 0.01$), as well as English and German ($p < 0.05$) but not between English and Spanish. These results are shown in Figure 3.

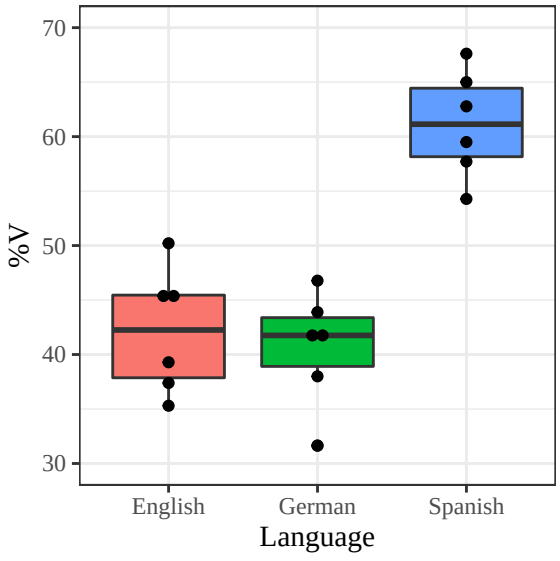

Figure 2: %V values of trilingual participants in each of their languages

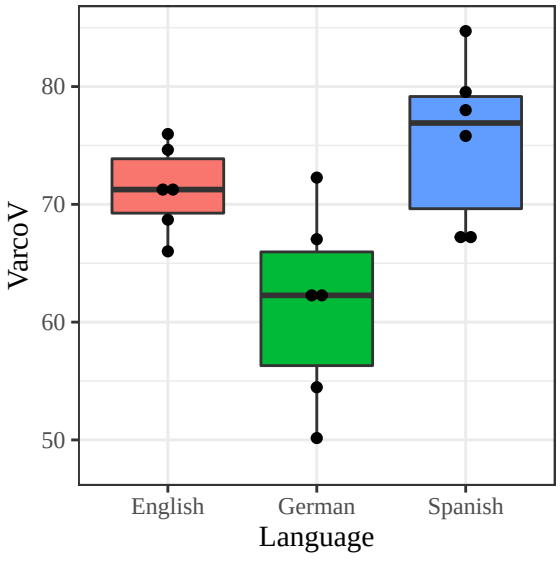

Figure 3: VarcoV values of trilingual participants in each of their languages

Overall, these findings suggest that all trilingual participants have developed a rhythm in their L3 Spanish that is distinct from their L1 and L2 rhythm in terms of %V, and in the case of German, also in terms of VarcoV. Given these findings, we can proceed to investigate the degree to which having developed this distinct L3 rhythm may have affected the trilingual participants' L1 and L2 speech rhythm compared to the bilingual controls.

4.2 rCLI of Rhythm by Language

This section compares the trilingual participants' %V and VarcoV scores in English and German with those of bilingual control participants. This is done in order to test the degree to which L3 Spanish may have an effect on the trilingual participants' speech rhythm in their previously known languages (English or German), regardless of the order of acquisition of those languages.

4.2.1 rCLI to English Rhythm

The four trilingual participants' English %V (M = 42.2, SD = 5.72) was compared with that of the four bilingual control participants (M = 46.1, SD = 4.6). The results of an independent-samples t-test show that the trilinguals demonstrated no significant difference, in %V scores compared to their bilingual peers/ Addititionally, a very small effect size was calculated between the two groups ($t(11) = +1.35$, $p > 0.05$, $g = 0.12$).

In terms of VarcoV meanwhile, an independent-samples t-test found that the trilingual participants' English VarcoV values ($M = 71.3$, $SD = 3.7$) were slightly but significantly higher than those of the bilingual control participants ($M = 64.7$, $SD = 4.4$) ($t(11) = -2.9$, $p < 0.05$. $g = 0.26$). This difference is depicted in Figure 4 below. It should be noted that in their analysis of L2 rhythm metrics, White and Mattys (2007) claim that while both %V and VarcoV serve as acceptable metrics of L2 rhythm out of the available speech rhythm measures, of the two White and Mattys found VarcoV overall to be a better measure for assessing fine-grained individual differences in non-native speech rhythm. Therefore, given the conflicting findings in terms of %V, vs. VarcoV, VarcoV should be considered the more reliable measure.

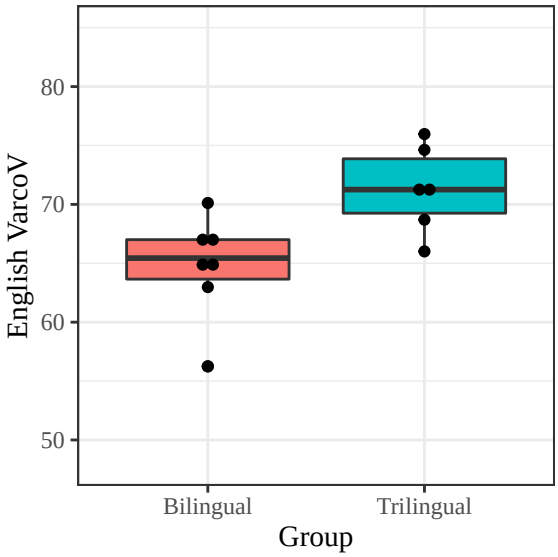

Figure 4: **English** VarcoV values of bilingual vs. trilingual participants

4.2.2 rCLI to German Rhythm

Trilingual %V and VarcoV in German was also compared to bilingual control participants. Bilingual and trilingual participants showed no significant difference in terms of their German %V (bilinguals: $M = 41.2$,

$SD = 6.7$; trilinguals: $M = 40.6$, $SD = 5.26$; $t(11) = +0.16$, $p > 0.05$, $g = 0.47$) or VarcoV (bilinguals: $M = 56.6$, $SD = 6.3$; trilinguals: $M = 61.4$, $SD = 8.1$; $t(11) = -1.15$, $p > 0.05$, $g = 0.89$). Overall the German data shows no evidence of a difference in speech rhythm between the bilingual and trilingual participants.

4.3 rCLI of Rhythm by Order of Acquisition

Given the findings above that the trilingual speakers have a significantly higher English VarcoV score compared to the bilingual controls, the next step is to investigate whether this difference can be further broken down based on order of acquisition of English and German.

The small sample size in this work poses an unfortunate limitation to the degree of statistical analysis that can be performed in order to address this question, with only 2-4 participants in each of the four groups (Bilingual: L1 English/L2 Spanish; Trilingual: L1 English/L2 German/L3 Spanish; Bilingual: L1 German/L2 English; and Trilingual: L1 German/L2 English/L3 Spanish). An ANOVA comparing English VarcoV between these four groups finds no significant differences ($F(3, 9) = 2.47$, $p > 0.05$). However, Figure 5 demonstrates an interesting trend that is worth further investigation.

This figure shows that while both groups of trilinguals overall have higher English VarcoV values, the trilingual participants with L1 English appear to have much higher values than the trilinguals with L2 English. Interestingly, a similar trend can been seen in a graph of the German VarcoV data, provided in Figure 6, except that in that case, the participants with L1 German show generally higher German VarcoV values.

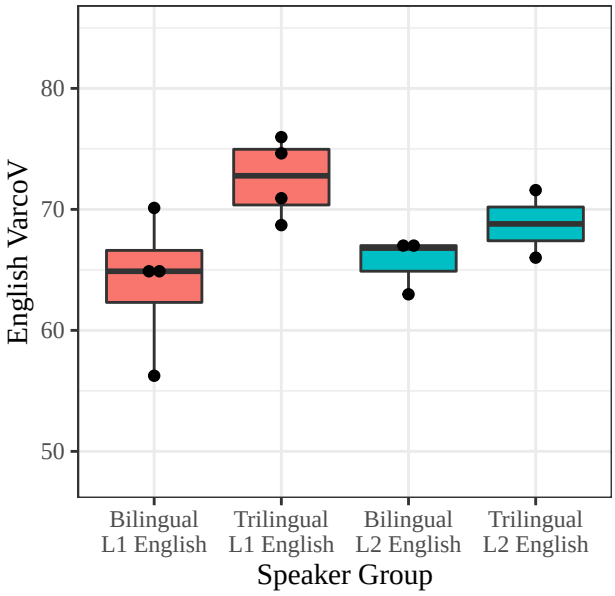

Figure 5: **English** VarcoV values of bilingual vs. trilingual participants

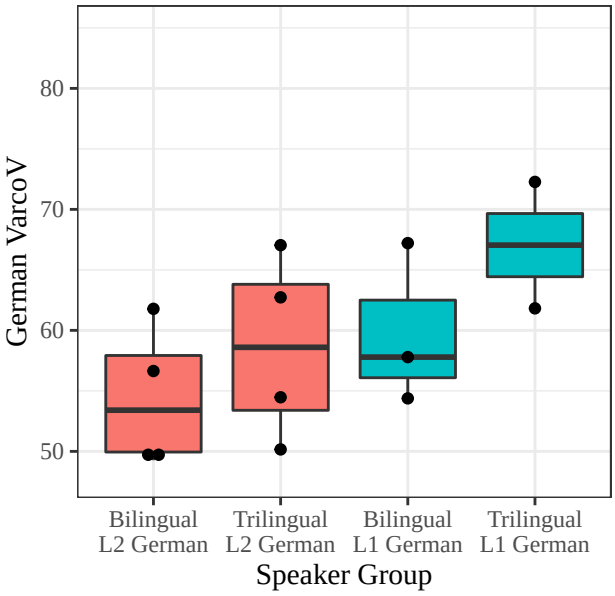

Figure 6: **German** VarcoV values of bilingual vs. trilingual participants

At this point, I will reiterate that no statistically significant findings have come from the investigation of order of acquisition in this work to date, and that the difference discussed above could simply be the result of individual variation. However, the trends noted above could potentially reflect an increased influence of the L3 on all trilingual participants' L1, a interesting possibility which warrants further investigation.

5 Discussion

This project looked to explore the degree to which typological similarity of a trilingual's languages, as well as order of acquisition of those languages, plays a role in the degree to which a trilingual speaker experiences rCLI from the L3 to their L1 and/or L2. This was done by examining speech rhythm, and more specifically the speech rhythm measures of VarcoV and %V, in two sets of trilingual participants (L1 English/L2 German/L3 Spanish and L1 German/L2 English/L3 Spanish) compared to bilingual controls (L1 English/L2 German and L1 German/L2 English). Three main points should be taken from the results described in the previous section.

First, it should be noted that all trilingual participants in this study were found to have a significantly higher %V in their L3 Spanish compared to their L1 and L2. While the topic of development of speech rhythm in an L2 that is in a different rhythm class than the L1 has been examined in the literature (i.e. Ordin and Polyanskaya, 2015a), to this researcher's knowledge, this is the first case in the L3 phonology literature to show the successful acquisition of a distinct L3 speech rhythm pattern where the L3 falls into a different rhythm class than both the L1 and L2 (L1/L2 English and German being considered stress-timed, while L3 Spanish is considered syllable-timed). Only after developing this distinct L3 rhythm system can that L3 rhythm pattern then serve as the source of rCLI and influence the speech rhythm of the participants' other two previously acquired languages.

In terms of rCLI, results found that across all trilingual participants, English VarcoV values were significantly higher than those of the bilingual controls. Given the trilingual participants' high VarcoV values in L3 Spanish, these findings suggest that the trilinguals' higher English VarcoV values are the result of rCLI from Spanish to English. Meanwhile, no significant differences were found between bilingual and trilingual participants in terms of their German speech rhythm measures, providing no evidence of rCLI from Spanish to German.

Given the claims from Section 2.3 that the trilingual speakers are most likely to perceive English as the more typologically similar language to Spanish, and German as more typologically distant based on lexical and morphological overlap (Eibensteiner, 2019; Schepens et al., 2013), these findings for VarcoV fall in line with Hypothesis 1, which states that the language that is most typologically **similar** to the L3 is more vulnerable to rCLI from the L3 than the more typologically distant language.

In addition to considering which language may undergo rCLI in this data, another result which was not explicitly outlined in the original hypothesis, but warrants discussion, is the direction of the rCLI. Theoretically, if a previously known language and a new language are typologically similar and the previously known language is to undergo rCLI, then there are two possible directions in which that rCLI could occur. On the one hand, it is possible that the previously known language will be influenced in a direction which converges, or makes the previously known language more similar, to the new language, a phenomenon which Flege (1987) called "convergence". An alternative possibility is that in order to more clearly distinguish between the two languages, the previously known language could shift in the opposite direction in order to make the differences between the two languages more distinct.

In the case of the findings described above, the first of these two possibilities seems to be the case. The trilingual speakers' English VarcoV values appear to have risen in a way that makes them more similar to the speakers' Spanish VarcoV values. Given these findings, this author proposes the **Typological Convergence Hypothesis (TCH)** which claims that proficient trilinguals are most likely to experience rCLI in a previously known language which is most similar to the more recently acquired source language. Additionally, this rCLI will occur in a direction which makes the previously known language more similar to (or "converge with") the newly acquired language. TCH assumes the same definition of typological similarity proposed by TPM, with an emphasis on the role of lexical and phonological overlap as determiners of similarity/vulnerability to CLI. Assuming that a trilingual's three languages exist in a shared phonological space in the underlying representation, languages which share the most overlap of their phonological systems overall are more likely to converge with each other in regards to specific distinct phonological features such as speech rhythm.

In addition to the findings related to linguistic similarity, Section 4.3 outlines some preliminary findings related to the role of order of acquisition on the degree of rCLI that occurs in the trilingual participants. While

the small sample size considered in this work makes it impossible to conclusively show significant findings on this topic, the trends found in this data are interesting and warrant additional future research. Figures 5 and 6 in Section 4.3 show that in the case of both English and German, the highest VarcoV values (i.e. the cases which show the most evidence of rCLI from Spanish) occur in the cases of the trilingual participants who are speaking their native language. In other words, in English, trilingual participants with L1 English/L2 German/L3 Spanish had a higher English VarcoV value than the trilingual participants with L1 German/L2 English/L3 Spanish. Meanwhile, when speaking German, the participants with L1 German/L2 English/L3 Spanish had a slightly higher German VarcoV value than those with L1 English/L2 German/L3 Spanish. Within each language, native speakers of that language appear to show more evidence of rCLI than non-native speakers. This finding, if found to be significant in future work, would go against the predictions of the PPH (Cabrelli Amaro & Rothman, 2010) and would instead suggest that the native language would be most vulnerable to rCLI. Additionally, when these tentative results are considered alongside this paper's findings related to typological similarity discussed above, this suggests that there could be some sort of interaction at play between age/order of acquisition in a sequential trilingual context and the typological similarity of the languages. Future research should consider investigation of this preliminary finding.

It should be noted that in terms of the data related to %V, no significant differences were found between bilingual vs. trilingual participants in either of the languages considered in this study, a finding which conflicts with the claims made in this section as well as the predictions of the TCH. The decision to measure both VarcoV and %V in this study was based on the finding of White and Mattys (2007) that VarcoV and %V offered the most discriminative analysis in distinguishing between rhythm patterns in native vs. non-native speech. However, White and Mattys also note that of these two metrics, while %V better discriminates between the hypothesized "rhythm classes" in non-native speech, VarcoV was found to be the more reliable measure for examining individual variability in non-native rhythm such as perceived foreign accentedness. It is for this reason that results for VarcoV were prioritized over those of %V in this study. However, further investigation which includes a larger array of speech rhythm metrics would benefit this work.

Overall, this work demonstrates evidence of rCLI from L3 Spanish onto L1 or L2 English, but does not find significant evidence of rCLI from L3 Spanish onto L1 or L2 German. This finding brings to attention the complex relationship between the languages in the multilingual mind and the important role that linguistic similarity plays in that relationship.

6 Conclusion

This work looked to examine the degree to which knowledge of L3 Spanish influenced the speech rhythm of sequential trilinguals in their L1 and/or L2: English and German. Results found a significant difference in speech rhythm, as measured by VarcoV, between trilingual participants and bilingual control participants in terms of their English speech rhythm. No significant difference was found between trilinguals and bilinguals in terms of their German speech rhythm.

Given these findings, in combination with the fact that English has overall more lexical and morphological overlap with Spanish than German does with Spanish, this paper proposes the Typological Convergence Hypothesis (TCH), which claims that previously known languages that are more linguistically similar to the L3 are more vulnerable to rCLI.

The collection of a larger data set could more strongly support TCH and could also more definitively examine the trends related to order of acquisition discussed in this paper. However, in addition to the potential benefits of additional data, future research on this topic could consider the following:

1. The examination of longer-term changes, developments, and influences in rCLI, which could be examined via longitudinal research.
2. The degree to which these production-related findings correspond to perception and the degree to which the differences in speech rhythm between bilingual and trilingual speakers found in this study correspond with having an "accent" in L1/L2 speech. One way to test this question would be by submitting the recordings from this study to accent raters.
3. The consideration of additional language combinations. In particular, cases where the disparity between previously known languages in terms of typological similarity to the L3 is more pronounced/greater such as L1/L2 English/Mandarin, L3 Spanish.
4. The inclusion of other types of trilingual participants, such as participants who simultaneously acquired their L1 and L2, as another potential control or comparison group. This group could help to better tease apart the factors of typological similarity and L2 status/order of acquisition, as well help to include the consideration of additional variables such as language dominance.
5. Additional examination of how factors such as proficiency and frequency of use of all three languages may also play a role in the degree to which a previously known language is vulnerable to rCLI.

The consideration of these additional factors could help the field to develop more complete and inclusive models of the impact of L3 acquisition and development on the phonological systems of a multilingual's previously known languages.

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A Appendix 1: Experimental Task Materials

A.1 Reading Task Passages

A.1.1 English Reading Task Passage

The Empire State Building

When exploring New York City, there are several different options for activities during a day trip. Some visitors come to see a show, visit art museums, or simply to shop in many of the city's high-end retailers. However, many tourists simply come to New York City for the sightseeing. One of the most visited landmarks in New York City is the Empire State Building.

The Empire State Building, constructed in 1931, is a 102-story skyscraper, the ninth highest building in the world, and the fourth tallest structure in the United States. It is located in Midtown, Manhattan. This skyscraper is an iconic symbol of the city, having been featured in over 90 popular movies (as of 2018) throughout film history. Tourists come from all over the world to visit this building and view the city from its famous observation decks.

Matthew, an enthusiast of historic buildings, was excited for this trip to New York City because he has always appreciated architectural design. Matthew purchased a ticket that granted him access to beautiful 360-degree views of the city. The ticket included an elevator ride that stopped at two different vantage points, one at the 86th floor and the other at the rooftop observatory on the 102nd floor. From these observation decks, Matthew took incredible photographs of the entire New York City skyline. The rooftop views granted Matthew perfect aerial perspectives of Central Park, the Brooklyn Bridge, Times Square, the Statue of Liberty, and many other important city landmarks.

A.1.2 German Reading Task Passage

German Passage

Ein Tag in München

Ich mag Fußball und habe zum Geburtstag Eintrittskarten für ein tolles Fußballspiel in der Allianz Arena bekommen. Das Fußballstadion ist die neueste Sehenswürdigkeit in München. Das Stadion hat außen 3.000 Luftkissen, die mit LED-Beleuchtung in vielen Farben leuchten können. Auf diesen Anblick freue ich mich.

Ich habe den ganzen Tag Zeit und möchte etwas von München kennenlernen. Der Marienplatz ist ein guter Ausgangspunkt für eine Stadtbesichtigung. Hier steht das Rathaus. München ist die Landeshauptstadt von Bayern. Das Rathaus schaut alt aus, ist aber erst 1905 im neugotischen Stil erbaut worden. In dem prächtigen Bauwerk ist der Sitz des Oberbürgermeisters. Mit dem Lift fahre ich auf die Aussichtsplattform und bewundere die fantastische Aussicht.

Es ist nicht weit zur Frauenkirche. Diese Kirche mit den zwei Zwiebeltürmen und ist ein Wahrzeichen der Stadt. Der Anblick der Türme ist sehr bekannt. Von dort oben hat der Besucher einen Blick über die ganze Stadt. Der Englische Garten ist das Freizeitparadies der Stadt. Die Münchner machen auf der Wiese Picknick, spielen Fußball, treffen Freunde. Der Park ist ideal für einen Spaziergang. Es gibt viele Gaststätten.

München ist für die Biergärten bekannt. Gemütlichkeit und Gastfreundschaft lerne ich hier kennen. In zentraler Lage befindet sich das weltberühmte Hofbräuhaus. Kellnerinnen und Kellner in bayerischer Tracht servieren typische Köstlichkeiten wie Schweinshaxen, Weißwurst, Leberkäs oder Steckerlfisch. Das Bier wird im Maßkrug serviert. Der enthält einen Liter Bier.

English Translation of German Passage

A day in Munich

I like soccer and for my birthday I got tickets for a great soccer game in the Allianz Arena. The soccer stadium is the newest attraction in Munich. The stadium has 3,000 air cushions outside, which can shine in many colors with LED lighting. I'm looking forward to this sight.

I have all day and I want to get to know something about Munich. Marienplatz is a good starting point for a city tour. Here is the town hall. Munich is the state capital of Bavaria. The town hall looks old, but was only built in the neo-Gothic style in 1905. The mayor's office is in the magnificent building. I take the lift to the viewing platform and admire the fantastic view.

It is not far to the Frauenkirche. This church with the two onion domes is a landmark of the city. The sight of the towers is very well known. From up there, the visitor has a view of the whole city.

The English Garden is the city's leisure paradise. The people of Munich picnic in the meadow, play soccer, and meet friends. The park is ideal for a stroll. There are many restaurants.

Munich is known for its beer gardens. I get to know comfort and hospitality here. The world- famous Hofbräuhaus is in a central location. Waitresses in traditional Bavarian costumes serve typical delicacies such as pork knuckle, white sausage, meat loaf or fish on a stick. The beer is served in a mug. It contains a liter of beer.

A.1.3 Spanish Reading Task Passage

Spanish Passage

Comparaciones

No sé qué ropa ponerme. Ahora hace calor, pero después hará más frío. ¿Qué me pongo? ¿Pantalón corto o pantalón largo? Creo que la mejor opción es el largo porque estaré fuera todo el día.

Hoy me voy a comprar un vehículo, pero no sé cuál elegir. Me gustan tanto los coches como las motos. Sin embargo, las motos son más económicas que los coches, aunque menos seguras. No sé qué hacer. Quiero un vehículo confortable y bonito, ¡el más bonito de todos!

Después iré a un cursillo de pintura. Conoceré las obras de muchos pintores antiguos y las de otros más modernos. También practicaré tanto pintura al óleo como acuarela.

Por la tarde volveré a casa cansado, pero más feliz que por la mañana. Además, en casa tengo dos animales de compañía muy simpáticos, aunque poco tranquilos. Tengo un perro muy grande y un pájaro de color verde. El pájaro es mucho más pequeño que el perro. Los dos son muy inteligentes y juegan muchísimo entre ellos. Todavía son jóvenes, aunque el perro es dos años más viejo que el pájaro. Me encanta ver la televisión con ellos para saber qué cosas pasan en el mundo. Nos sentamos todos en el sofá y somos muy felices.

English Translation of Spanish Passage

Comparisons

I can't decide what to wear. It is hot now, but it will be colder later. What do I wear? Short pants or long pants? I think the best option is the long one because I will be away all day.

Today I'm going to buy a vehicle, but I don't know which one to choose. I like both cars and motorcycles. However, motorcycles are cheaper than cars, but less safe. I do not know what to do. I want a comfortable and beautiful vehicle, the most beautiful of all!

Then I'll go to a painting class. I will learn the works of many ancient painters and those of more modern ones. I will also practice both oil painting and watercolor painting.

In the afternoon I will go home tired, but happier than in the morning. Also, at home I have two very nice pets, although not very calm. I have a very large dog and a green bird. The bird is much smaller than the dog. They are both very intelligent and play a lot with each other. They are still young, although the dog is two years older than the bird. I love watching television with them to find out what is happening in the world. We all sit on the sofa and we are very happy.

A.2 Elicited Free Speech Task Pictures

A.2.1 Pictures used in English Free Speech Task

Figure 7: English Image 1: This Image is used with the permission of Andrews McMeel Universal.

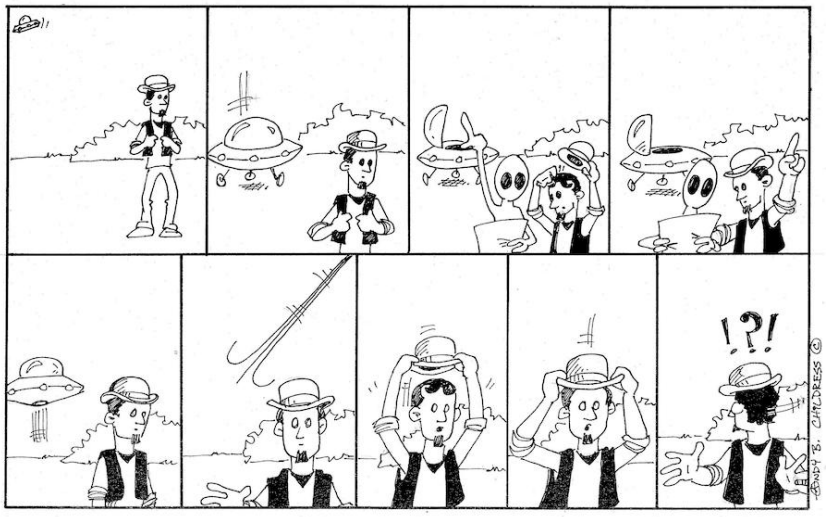

Figure 8: English Image 2: This Image is used with the permission of Andrew B. Childress.

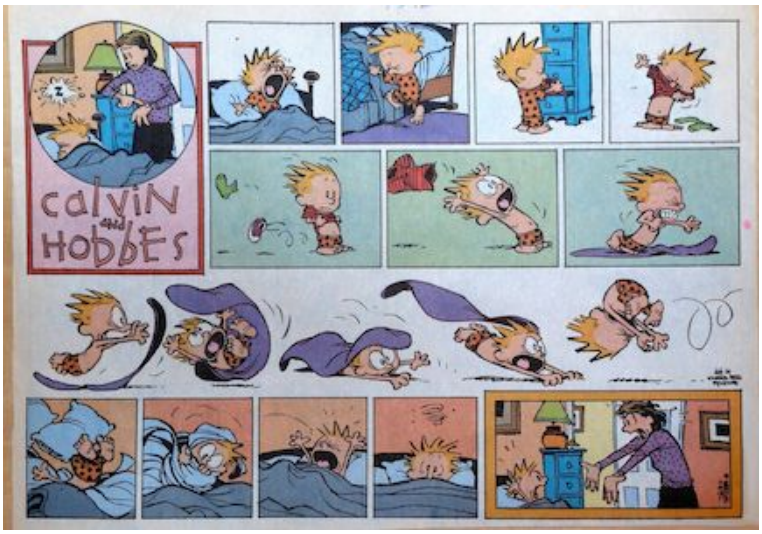

Figure 9: English Image 3: This Image is used with the permission of Andrews McMeel Universal.

Figure 10: English Image 4: This Image is used with the permission of Andrews McMeel Universal.

A.2.2 Pictures used in German Free Speech Task

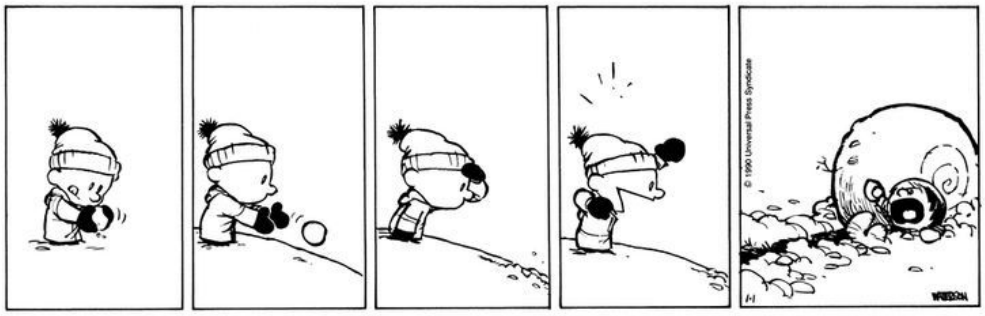

Figure 11: German Image 1: This Image is used with the permission of Andrews McMeel Universal.

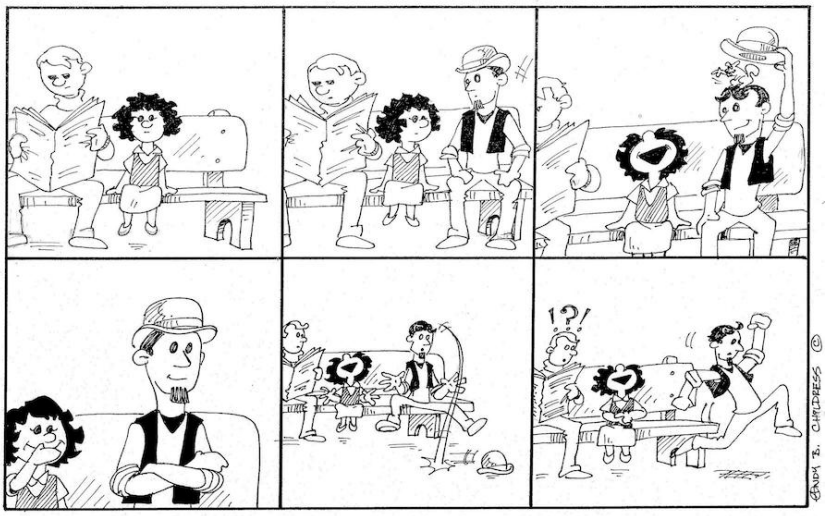

Figure 12: German Image 2: This Image is used with the permission of Andrew B. Childress.

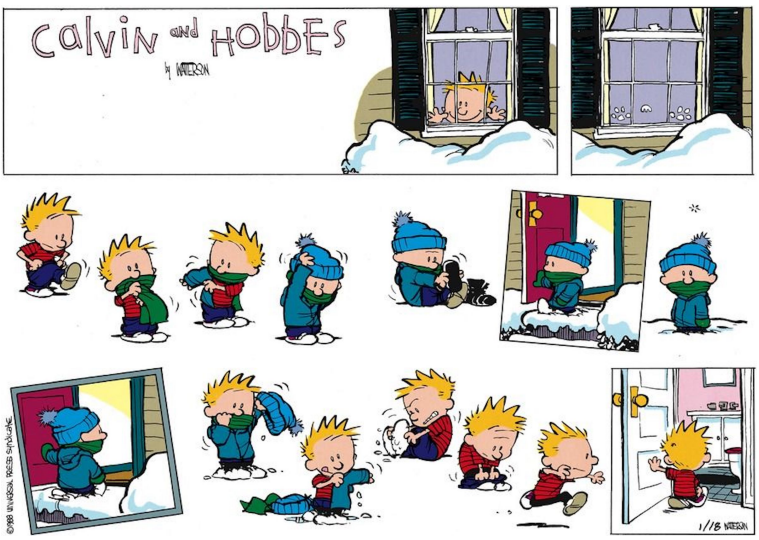

Figure 13: German Image 3: This Image is used with the permission of Andrews McMeel Universal.

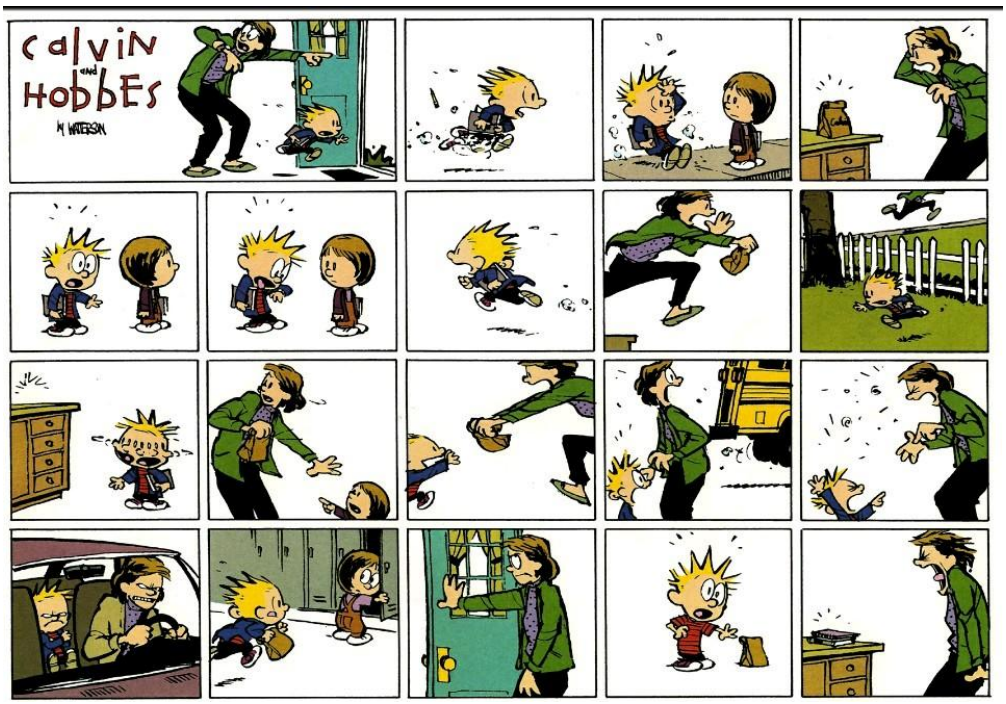

Figure 14: German Image 4: This Image is used with the permission of Andrews McMeel Universal.

A.2.3 Pictures used in Spanish Free Speech Task

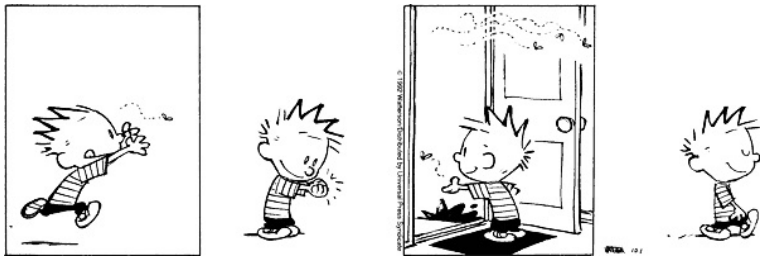

Figure 15: Spanish Image 1: This Image is used with the permission of Andrews McMeel Universal.

Figure 16: Spanish Image 2: This Image is used with the permission of Andrew B. Childress.

Figure 17: Spanish Image 3: This Image is used with the permission of Andrews McMeel Universal.

Figure 18: Spanish Image 4: This Image is used with the permission of Andrews McMeel Universal.

A.3 Language Background Questionnaire

Below is a complete list of questions included in the Language Background Questionnaire. Questions Marked with a * were only presented to the **trilingual** participants.

- Age
- Gender
    a. Male
    b. Female
    c. Other/Prefer not to answer
- Highest level of education
    a. Some high school
    b. High school diploma
    c. Some college
    d. College degree
    e. Graduate degree
- What language do you consider to be your first/native language?

a. English

b. German

c. Other

- What language do you consider to be your second language?

  a. English

  b. German

  c. Other

- If you know any languages other than English, German (*and Spanish), please list them here and describe your level of proficiency. You may also provide any other information about your language background that you see as relevant.
- How old were you when you started learning **English**? (If you have been exposed to English since birth, please write "0")
- Please describe the highest level of formal education that you have had in **English**.
- Have you ever lived in a primarily **English-speaking** country or community?
  - (If answered "Yes" above) Where and for how long?
- How would you rate your *speaking* ability in **English**?

  a. Excellent

  b. Good

  c. Fair

  d. Poor

  e. None

- How would you rate your *listening* ability in **English**?

  a. Excellent

  b. Good

  c. Fair

  d. Poor

  e. None

- How would you rate your *reading* ability in **English**?

  a. Excellent

  b. Good

  c. Fair

  d. Poor

  e. None

- How would you rate your *writing* ability in **English**?

  a. Excellent

  b. Good

  c. Fair

  d. Poor

e. None

- Please rate your overall proficiency in **English**?
  a. Excellent
  b. Good
  c. Fair
  d. Poor
- Do you think that your **English** has influenced the way that you speak **German**?
  - (If answered "Yes" above) Please in what ways you feel that your **English** has influenced your **German**.
- *Do you think that your **English** has influenced the way that you speak **Spanish**?
  - *(If answered "Yes" above) Please in what ways you feel that your **English** has influenced your **Spanish**.
- How old were you when you started learning **German**? (If you have been exposed to German since birth, please write "0")
- Please describe the highest level of formal education that you have had in **German**.
- Have you ever lived in a primarily **German-speaking** country or community?
  - (If answered "Yes" above) Where and for how long?
- How would you rate your *speaking* ability in **German**?
  a. Excellent
  b. Good
  c. Fair
  d. Poor
  e. None
- How would you rate your *listening* ability in **German**?
  a. Excellent
  b. Good
  c. Fair
  d. Poor
  e. None
- How would you rate your *reading* ability in **German**?
  a. Excellent
  b. Good
  c. Fair
  d. Poor
  e. None
- How would you rate your *writing* ability in **German**?
  a. Excellent
  b. Good

c. Fair

d. Poor

e. None

- Please rate your overall proficiency in **German**?

  a. Excellent

  b. Good

  c. Fair

  d. Poor

- Do you think that your **German** has influenced the way that you speak **English**?

  – (If answered "Yes" above) Please in what ways you feel that your **German** has influenced your **English**.

- *Do you think that your **German** has influenced the way that you speak **Spanish**?

  – *(If answered "Yes" above) Please in what ways you feel that your **German** has influenced your **Spanish**.

- *How old were you when you started learning **Spanish**? (If you have been exposed to Spanish since birth, please write "0")
- *Please describe the highest level of formal education that you have had in **Spanish**.
- *Have you ever lived in a primarily **Spanish-speaking** country or community?

  – *(If answered "Yes" above) Where and for how long?

- *How would you rate your *speaking* ability in **Spanish**?

  a. Excellent

  b. Good

  c. Fair

  d. Poor

  e. None

- *How would you rate your *listening* ability in **Spanish**?

  a. Excellent

  b. Good

  c. Fair

  d. Poor

  e. None

- *How would you rate your *reading* ability in **Spanish**?

  a. Excellent

  b. Good

  c. Fair

  d. Poor

  e. None

- *How would you rate your *writing* ability in **Spanish**?

a. Excellent

b. Good

c. Fair

d. Poor

e. None

- *Please rate your overall proficiency in **Spanish**?

a. Excellent

b. Good

c. Fair

d. Poor

- *Do you think that your **Spanish** has influenced the way that you speak **English**?
  - *(If answered "Yes" above) Please in what ways you feel that your **Spanish** has influenced your **English**.
- *Do you think that your **Spanish** has influenced the way that you speak **German**?
  - *(If answered "Yes" above) Please in what ways you feel that your **Spanish** has influenced your **German**.
- In the following table, please outline the percentage of the time that you use each of your languages when speaking, listening, reading, and writing.

	English	**German**	***Spanish**	**Other**
Speaking				
Listening				
Reading				
Writing				

- In the following table please outline the percentage of the time that you use each of your languages in each of the given situations.

	English	**German**	***Spanish**	**Other**
At home				
At work				
At school				
To read				
To watch TV				
In social activities				
To listen to the radio, music, podcasts, or other listening- based entertainment				

B Appendix 2: Additional Data Collected

Data from an additional 30 participants was collected during the course of this study which was not included in analysis described above. The reasons for the exclusion of each of these participants was one of the following:

1. Age of L2/L3 Acquisition (L2/L3 AoA): Participants who had acquired their L2 (and in one case, also their L3) before the critical period age limit of 7 set in this study.

2. L2/L3 Proficiency: Participants with scores below B1 level on the LexTALE vocabulary test (Lemhöfer and Broersma, 2012; Izura et al., 2014), L2/L3 MLUs below 2 syllables/utterance, or an FPR over .35 in their L2/L3.

3. Knowledge of an additional syllable-timed language which preceded the acquisition of the target L3 Spanish (e.g. a participant with L2 French, L3 German, L4 Spanish), or in the case of the bilingual participants, any knowledge of a syllable-timed language. Trilingual participants who learned an additional syllable-timed language after the acquisition of the L3 Spanish were not excluded.

4. Trilingual participants who had the correct set of languages (English, German, and Spanish), but who had acquired those languages in an order different from the target order from the study (e.g., L1 English/L2 Spanish/L3 German)

The number of participants excluded for each reason is provided in Table 3 below.

Reason	**Number of Participants Excluded**
L2/L3 AoA	10
L2/L3 Proficiency	8
Additional Language Knowledge	8
Order of Acquisition	4

Table 3: Number of participants excluded from analysis for each reason.

C Appendix 3: Additional Results and Graphs

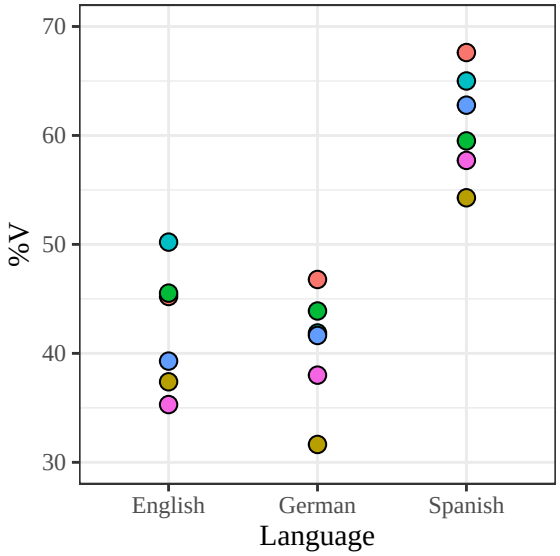

Figure 19: Individual variation in %V between the different langauges of the trilingual participants. Each color represents an individual trilingual participant.

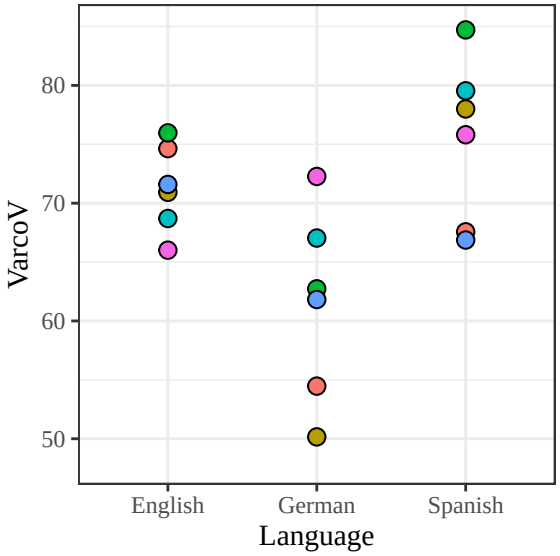

Figure 20: Individual variation in Varco between the different langauges of the trilingual participants. Each color represents an individual trilingual participant.

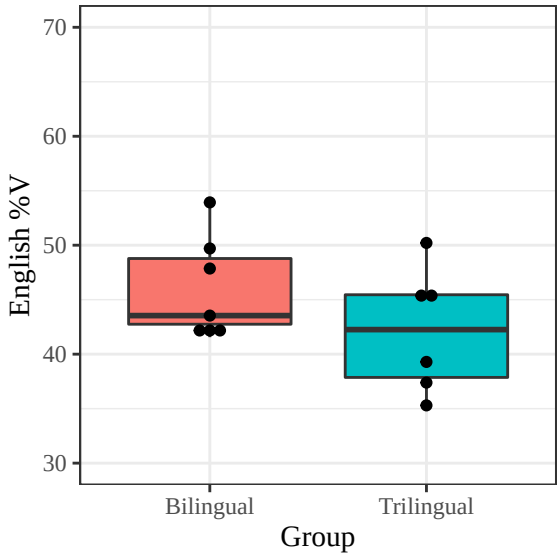

Figure 21: English %V values of bilingual vs. trilingual participants. No statistically significant difference was found in these results.

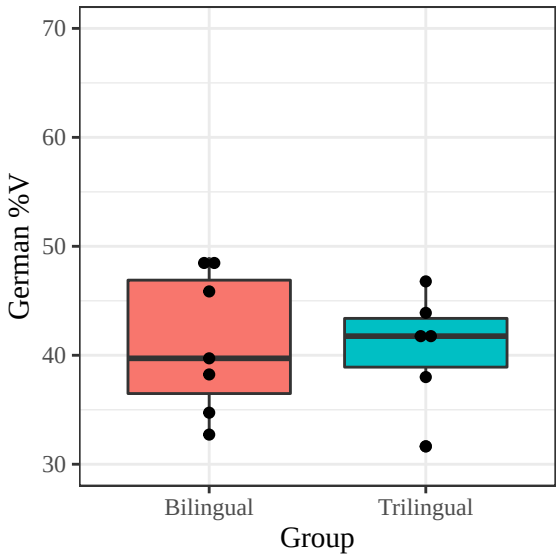

Figure 22: German %V values of bilingual vs. trilingual participants. No statistically significant difference was found in these results.

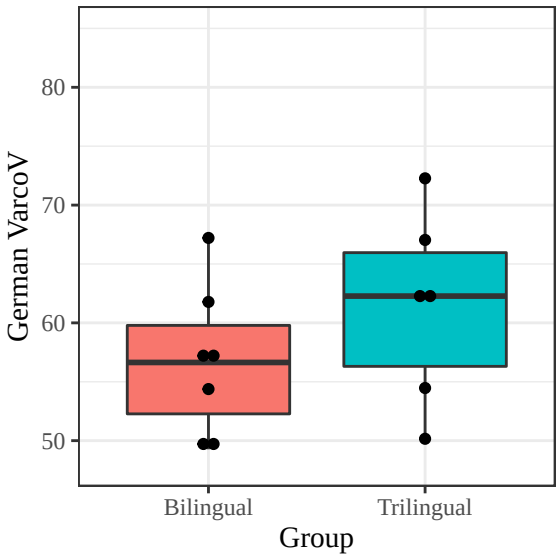

Figure 23: German VarcoV values of bilingual vs. trilingual participants. No statistically significant difference was found in these results.