Phonological Changes and Third Language Acquisition

BA Thesis Linguistics

Kiara Edwards 12750492
Supervisor: Suki Yiu
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UNIVERSITEIT VAN AMSTERDAM

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Abstract

Previous research on Third Language Acquisition (TLA) in phonology proposes various sources of Cross-Linguistic Influence. Scholars indicate that the prior language learned (L2), prevails in TLA and is the source of phonological changes in the third language. The field of phonology in TLA is still growing, and there is a lack of research examining sequential bilinguals learning outside the L3-dominant environment. Additionally, a majority of the literature excluded a small set of factors. These factors included, not capturing bilinguals within the initial stages of acquisition, not using bilinguals as their own controls, and only examining a few phonological features. This study investigated if an adult sequential bilingual learning a third language in a formal setting outside the L3-dominant environment experienced any Cross-Linguistic Influence in the initial stages of acquisition. Furthermore, the study aimed to determine the direction of Cross-Linguistic Influence. An L1 Dutch, L2 English speaker learning L3 Spanish was tasked to produce the monophthongal vowels from each language. Acoustic data were collected at two time points six weeks apart. The results revealed that there were phonological changes within the L3. However, these changes could not be attributed to any Cross-Linguistic Influences. Instead, there appeared to be a dissimilarity drift of the L3 phonology from the previous languages. The discussion outlines potential factors for this result.

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1. Introduction

Being immersed in another language environment for an extended period of time can exert phonological changes in one's native language (Chang, 2012, 2013; Mayr et al., 2012). When the sound system of the first language (L1) alters due to acquiring a second language (L2), this is called phonetic drift (Chang 2012). Phonetic drift is often noted in the Voice Onset Time (VOT) or the vowel quality of an L1 drifting toward L2 values. One of the first examples of this phenomenon was seen in Flege's (1987) study. Flege found that L1 English/ L2 French and a mirror-image group living in their L2 environments, produced the VOT of their stops with their L2 VOT values. In other words, L1 English learners of French living in France pronounced the English /t/ with French /t/ VOT values. In contrast, L1 French learners of English living in the U.S. pronounced the French /t/ with English VOT values. Aside from VOT drifts, vowel inventory drifts were recorded in Mayr et al. (2012). Their Dutch informant's F1 drifted toward English F1 vowel norms as a result of living in the U.S for an extended period of time. Observance of phonetic drift is well documented for those in immersive situations mentioned above (Chang, 2012, 2013; Sancier & Fowler, 1997).

Research beyond L2 acquisition and sound system changes is still growing in the domain of third language acquisition (TLA). Unlike learning an L2, where the direction of influence can be traced to one source, acquiring a third language (L3) is a distinct process (Cenoz, 2003). TLA is unique in that L3 learners can draw from their experiences in two languages (Cenoz, 2003). Thus, the addition of another language within a bilingual's linguistic repertoire leads to complex interactions. As a consequence, cross-linguistic influence (CLI) of either the L1 or L2 can emerge in L3 productions. Generally, CLI is the occurrence of transferring elements from one language to another (De Angelis & Selinker, 2001, p.42). Investigating how the previous languages emerge in third language acquisition allows us to observe how multilingual speakers' language systems interact under different contexts. Studying the acquisition of an L3 may provide insight into multilingual language use, processes, and acquisition that cannot be observed in second language acquisition (Flynn et al., 2004, p.15).

To date, research on phonological changes following language acquisition has focused on people immersed in the target language environment. The proposals so far on the directions and sources of CLI are diverse. The main directions of influence noted are progressive L1/L2 → L3 and regressive L3 → L1/L2. Progressive transfer is when the phonological features of the previously acquired languages transfer to the L3 (Cabrelli Amaro et al., 2012, p.42). Whereas, regressive transfer is the opposite situation where the

phonological features of the L3 transfer to the previous languages (Cabrelli Amaro et al., 2012, p.42). In addition, the majority of these publications examined simultaneous and sequential bilinguals that were well past the initial stages of L3 acquisition (Gut, 2010; Kartushina & Martin, 2019; Llisterri & Poch-Olivé, 1987, as cited in Wrembel, 2012, p. 285; Sypiańska, 2016). A simultaneous bilingual is characterized as acquiring their L1 and L2 at the same time (Amengual, 2019, p.956). While, a sequential bilingual acquires their L2 when the L1 is near completion (Amengual, 2019, p.956). Thus far, only a handful of studies have inquired about the phonological changes of sequential bilinguals learning a third language at the initial stages of acquisition in a non-L3 dominant environment. This paper aims to determine if phonological changes can be observed in an adult learner within the initial stages of third language acquisition in a non-immersive environment. Furthermore, this research will explore whether the CLI is progressive or regressive. Specifically, the current study uses a short-term longitudinal design to investigate whether a sequential adult bilingual experiences any phonological changes in the beginning stages of acquiring an L3 in a classroom environment. The paper is structured in the following manner.

First, the section CLI and SLA gives a brief overview of the beginnings of CLI in second language acquisition (SLA). The next section, CLI and L3 acquisition, outlines the possible sources of influence and directions in TLA. The following section gives an overview of relevant models and theories in TLA. From there, the aim, research question, and predictions are presented. Afterward, the vowel inventories of the languages and methodology are described. Lastly, the findings are presented and discussed.

2. CLI and SLA

Before the sections associated with TLA are introduced, a look into SLA models may provide beneficial insights into interpreting the findings in the current study. In the SLA domain, there are two prominent models that predict how a learner may perceive, produce, and acquire L2 phonological systems. The first model is the Speech Learning Model by Flege (1995). Flege's model posits that the learner's success in L2 productions depends if they perceive the L2 sounds as similar or dissimilar from their L1 sounds. If the learner perceives an L2 sound and an L1 sound as dissimilar then the L2 sound is more likely to have its own category. Assimilation of the L2 sound happens when the L2 learner merges an L2 sound with a similar L1 sound. If the sound is perceived as similar to the L1 sound then the learner will have difficulty separating the L1 and L2 sounds. When the L2 sound is categorized as an L1 sound, this is called equivalence classification. Although, it is not the case that once an L2

sound is assimilated that this category becomes permanent. The learner can dissimilate the phonetic categories as they gain more experience in the L2 (Flege et al., 2003, p. 487). The second, is Best's Perceptual Assimilation Model (PAM; 1995), and Best and Tyler's extended version (PAM-L2; 2007). It should be noted that the PAM models take into consideration how a learner perceives and acquires the L2 phonological system.

While the SLM takes the similarities in the acoustics of the sounds in perception, PAM/PAM-L2 takes the articulatory similarities as well. The model outlines five types of assimilation to determine how the inexperienced learner may perceive the L2 contrasts (Best & Tyler, p.23). The first, *Single-Category Assimilation,* states that discrimination of two sounds will be poor if the learner categorizes two L2 categories into one L1 category. The second, *Two-Category Assimilation*, predicts that if two L2 sounds are perceived as two ideal L1 sounds, then discrimination of the L2 sounds will be excellent. Third, *Category-Goodness Assimilation*, is similar to *Single-Category Assimilation*, but both sounds are perceived as equally good or bad equivalents to the L1 category. One of the two sounds may be perceived as more suitable for the L1 category. Fourth, *Uncategorized-Categorized Assimilation*, one L2 sound is considered equivalent to an L1 sound, and the other is not and remains uncategorized, both leading to excellent discrimination. Lastly, *Uncategorized-Uncategorized Assimilation,* happens when both L2 sounds are unlike any L1 sound and are uncategorized. Discrimination of the L2 sounds may range from poor to moderate based on how close the L2 sounds are to the L1 equivalents. Although, the categorizations are not permanent. In PAM-L2, experienced L2 learners may later form new L2 categories (Best & Tyler, 2007). In brief, the SLA models here state that there is a one-to-one correlation of influence between the two languages. Moreover, the influences are motivated by perceived phonetic similarities. The next section reviews research beyond the L2, which involves increased factors and points of influence that may explain learners' TLA processes.

3. CLI and L3 acquisition

Several studies suggest different sources and factors that condition CLI. The TLA literature commonly observes progressive or regressive directions of influence. The former is attested in the initial stages of acquisition (Hammarberg, 2009; Wrembel, 2010; for L2, see Ringbom, 1987, p.109). While the latter appears in long-term immersive situations (Hammarberg, 2009; for L2 see Mayr et al., 2012). Other less likely configurations, such as combined transfer or exclusive L1 influence, can occur as well (Llisterri & Poch-Olivé, 1987, as cited in Wrembel, 2012, p. 285; Sypiańska, 2016). Combined transfer scenarios emerge as

hybrid VOT and vowel quality values (Sypiańska, 2016; Wunder, 2010, as cited in Wrembel, 2015, p.46). This was evident in Wrembel's (2011) examination of L3 French VOT values of L1 Polish/L2 English sequential bilinguals. She found that the participants had merged the VOT values of their previous languages onto their L3. To further add to the complexity, the factors determining the source and direction are numerous. The main variables mentioned by scholars are recency (Williams & Hammarberg, 1998), proficiency level in one's previous languages (Williams & Hammarberg, 1998; Ringbom, 1987, p.108), L2 status (Hammarberg, 2001; Williams & Hammarberg, 1998) and typological similarity (Cenoz, 2001; Kellerman, 1983 as cited in Rothman, 2013, p.234; Rothman, 2010). The first three factors were observed in one of the most groundbreaking and influential works on CLI. This seminal work was a longitudinal study from Hammarberg (cf. Hammarberg, 2001; Hammarberg & Hammarberg, 2009; Williams & Hammarberg, 1998).

Williams & Hammarberg (1998) followed an L1 English/ L2 German speaker acquiring L3 Swedish while living in Sweden. The informant's language acquisition process was elicited through several production tasks. Native Swedish speakers judged the informant's speech productions. The informant's Swedish speech productions were rated as heavily German-accented. Interestingly, as time progressed, the L2 accent diminished as proficiency of the L3 increased (Hammarberg & Williams, 2009, p.26). Foreign-accent ratings at later time points were judged as L1 accented. Hammarberg and Hammarberg (2009) further explain that the language accent switch was due to a coping strategy to resort to the L2 when the L3 phonology was difficult to master. Additionally, L2's activation as the supplier language at the initial stages of the L3 acquisition was attributed to the high level of proficiency and recent use of the L2 (Williams & Hammarberg, 1998, p.323). The influence of proficiency levels was also observed in another study that employed a similar task. Wrembel (2010) found that the L3 English proficiency of L1 Polish/L2 German participants determined their accent ratings (Wrembel, 2010).

In Wrembel's study, the L1 Polish/L2 German participants with varying levels of L3 English were judged on their English speech productions. The results of the study found that those with fewer years of experience in their L3 (3 years) tended to be rated as L2 accented than those with more experience in their L3 (12 years). Although these studies were impressionistic judgments, a study that implemented empirical methods coincided with the L2 as the source of influence.

Tremblay's (2007, as cited in Llama & Cardoso, 2018) study conducted an acoustic analysis of L3 Japanese VOT voiceless plosives of L1 English/L2 French speakers. A

comparison with Japanese monolinguals revealed that the Japanese VOT values were similar to those of the French values. The values were taken as evidence of L2 influence on the L3. Thus, the L2 is relied on in the initial stages. This reliance is stronger if the learner is an advanced L2 learner and actively uses the L2. However, typological similarity between languages is another factor that influences the supplier language.

If one of the prior languages is typologically close to the L3, then the learner may prefer to borrow from that language (Cabrelli Amaro et al., 2015, p. 46; Cenoz, 2001). The typology can either be genetic or psychological. Kellerman (1983, as cited in Rothman, 2013, p. 234) calls this 'psycho-typology' - the supplier language becomes the one that the learner feels is similar to the L3. Typological influence was exemplified in a study of two groups of speakers with different L2s. Pinto's (2013) lexical study found that L1 Arabic/L2 Spanish/L3 Portuguese and L1 Arabic/L2 French/L3 Portuguese transferred from the L2 to the L3.

In contrast, the L1 has also been shown to be the supplier language. Llisterri and Poch-Olivé's (1987, as cited in Cabrelli Amaro et al., 2012, p. 285) study examined the production of L3 English and L3 French in simultaneous Catalan-Castilian bilinguals. They found no differences in the L3's productions when compared to Catalan monolinguals. The authors concluded that the data indicated L1 influence. The authors further deduced that the L1 influence was evidence for the L1 Full Transfer Hypothesis (Schwartz & Sprouse, 1996). According to this hypothesis, during the beginning stages of L2 learning, the entire L1 grammar is transferred to the L2. Initially, the L2 is a copy of the L1. As the learners progress through L2 acquisition, they reset the copied L1 values to the L2 values. Despite this finding, the theory has been disproved (Bardel & Falk, 2007; Rothman, 2010). Currently, the TLA models put forth were developed in the domain of morphosyntax. Nevertheless, a few of the models are relevant to the previously stated factors in determining CLI sources.

3.1 CLI Models and Theories

There are two other explanations for CLI that are often referenced with the factors stated in section 3. As mentioned before, typology can play a role in determining the source language. This is explained in Rothman's Typological Primacy Model (TPM) (2010, 2011, 2013, 2015). This model states that the supplier language is the one that is typologically closer to the L3. The proximity can be motivated by being from the same language family or a psychotypology. On the other hand, a majority of the literature suggests that the L2 appears to be the most influential factor (Bardel & Falk, 2007; Falk & Bardel, 2011; Williams & Hammarberg, 1998). This factor is often called the L2 status factor (Bardel & Falk, 2007;

Falk & Bardel, 2011). The L2 status factor is the tendency to rely on one's second language due to the similarity of the language learning process and foreign language status of their L2 and L3 (Bardel & Falk, 2007; Falk & Bardel, 2011; Hammarberg, 2001). Bardel and Falk (2007) argued that L2 status may even be more influential than typological proximity. The data from their study on negation placement in L3 Swedish/Dutch learners revealed that the participants' L2 influenced the application of negation placement. The authors further comment that "...in L3 acquisition, the L2 acts like a filter, making the L1 inaccessible" (Bardel & Falk, 2007, p. 480). Another reason for L2 influence may be that the learner categorizes their non-native languages as a "foreign language" (De Angelis, 2005, p.12). Therefore, the learner's L1 is excluded from this category. De Angelis (2005, p.12) coined this as "association of foreignness". Thus, the L2 status overcomes typological influences. For example, Llama et al. (2010) found that the L3 Spanish VOT of voiceless plosives in L1 French/ L2 English learners were higher than the L1 English/ L2 French VOT values. English VOTs are characterized as having longer VOTs than French. L2 influence led the L1 French group to produce L3 voiceless plosives with L2-like VOT values.

In summary, the literature on CLI in TLA observes multiple sources of influence. Directions of influence include progressive, a combination, and regressive. Progressive influence is often stronger in the initial stages, and regressive influence is seen in immersive situations. Furthermore, when concerning the onset of TLA, most authors report the L2 as the supplier language for phonological influence (Hammarberg & Hammarberg, 2009, p.82; Williams & Hammarberg, 1998; Llama et al., 2010). Thus far, the literature indicates that the previously acquired language (L2) is the main contributor to phonological influences. Namely, that L2 influence is often progressive.

However, as evident in the methodologies employed, the majority of the participants were several months to several years into acquisition. Additionally, many of these studies used monolingual productions as a baseline measure. The aforementioned literature compared the participants' production data to monolingual norms. It has been shown that multilingual speakers' productions are not comparable to monolingual productions (Cruz-Ferreira, 2010). Interpersonal variations may affect monolingual comparisons. Such as vocal tract differences and regional accents. Therefore, baseline references from monolinguals may not fully represent multilingual learners. The ideal baseline for multilingual learners should be bilinguals with similar language profiles or learners acting as their own control (Cabrelli, 2013, p.103). Applying this methodology would inform researchers what aspects of the language system have altered.

3.2 Current Study

The aim of this study is to further investigate cross-linguistic influences in third language acquisition. The main question is whether there are phonological changes in an adult learner during the initial stages of third language acquisition in a formal setting of a non-immersive environment. The focus of this research is to examine if there is progressive influence on the vowel qualities of an adult Dutch-English sequential bilingual acquiring L3 Spanish. Specifically, the paper will observe if there are any changes in the vowel quality of one's previous languages due to learning a third language. To determine if any phonological alterations took place, acoustic data will be gathered at two-time points (beginning and end of the language course). Employing this method ensures which alterations occurred and accounts for using the participant as their own control.

Furthermore, studies on CLI in TLA have neglected directly testing the participants' L1 or have only focused on a small number of phonological segments. A few phonological processes and segments investigated were vowel reduction (Gut, 2010), close/close-mid vowels (Kamiyama & Vaissière, 2009), and a subset of vowels (Amaro & Rothman, 2010; Sypiańska, 2016). Therefore, the current study will expand its focus to monophthongs in all of the learner's background languages. It may prove fruitful to examine a larger phonological inventory to see how extensive phonological influences are in the onset of TLA. It should also be noted that research into the language combination (L1 Dutch/ L2 English/ L3 Spanish) in this study has not been explored. In addition, the results of this paper may aid in detecting the role of pronunciation in language learners. This will help highlight the importance of CLI in pedagogical situations. In doing so, it can aid language learners and instructors in being conscious of possible language interferences. This knowledge could provide useful information for improving pronunciation in the target language.

3.3 Vowel Inventory

3.3.1 Spanish Vowels

The Spanish vowel inventory contains the following five vowels /a, e, i, o, u/ (Bradlow, 1995). The Spanish vowels create a symmetrical triangle if visualized on a vowel chart according to the place of articulation. In comparison to Dutch and English, the vowels of Spanish occupy the perimeter of the vowel space (Goudbeek et al., 2008, p. 112). Table 1, shows average F1 and F2 values.

Table 1

Mean F1 and F2 frequencies (Hz) of Spanish vowels

	i	e	a	o	u
F1	331	502	718	533	376
F2	2241	1872	1479	1156	773

Note. Adapted from Cervera et al. (2001)

3.3.2 Dutch Vowels

The Northern Standard Dutch vowel inventory contains nine monophthong vowels (Adank et al., 2004). The following vowels are /i, y, a, u, ɪ, ʏ, ɛ, ɑ, ɔ/ (Adank et al., 2004; Sebregts, 2020). The schwa /ə/ was not included in this study. The first two formants are displayed in table 2 for reference.

Compared to Spanish, the F1 values of the Dutch /i/ and /u/ are lower. The F1 of Dutch /a/ is higher than its Spanish equivalent. The Dutch /i/ has a higher F2 value than the Spanish /i/. While Dutch /a/ and /u/ have slightly higher F2 values when compared to their Spanish equivalents /a/ and /u/.

Table 2

Mean F1 and F2 frequencies (Hz) of female Dutch vowels

	i	y	a	u	ɪ	ʏ	ɛ	ɑ	ɔ
F1	294	305	912	286	399	417	535	758	419
F2	2524	1918	1572	938	2276	1830	1990	1280	918

Note. Adapted from Adank et al. (2004)

3.3.3 English Vowels

General American English contains ten nonrhotic monophthong vowels in its inventory excluding schwa /i, ɪ, e, ɛ, æ, ɑ, ɔ, ʊ, u, ʌ / (Ladefoged, 2006). The available acoustic data is presented in table 3. In comparison to Spanish, the English monophthongal values have higher F1 and F2 values.

Table 3

Mean F1 and F2 frequencies (Hz) of female American English vowels

	i	ɪ	e	ɛ	æ	ɑ	ɔ	ʊ	u	ʌ
F1	437	483	536	731	669	936	781	519	459	753
F2	2761	2365	2530	2058	2349	1551	1136	1225	1105	1426

Note. Adapted from Hillenbrand et al. (1995)

3.4 Predictions

Following the predictions of the L2 status factor, the L3 learner will rely on their L2 when learning their L3. This is due to the fact that the learning experience is more similar to learning their L2 than their L1. In the case of the bilingual group in this study, English is taught as a compulsory subject from the age of nine (Edwards, p. 27). The learning process of Spanish in a classroom setting may be akin to learning English for this group. Therefore, influence from their L2 may be more likely due to the similarity. Hence, participants are expected to pronounce Spanish vowels with the equivalent English vowel formant values by the end of the language course. The influence of English will raise the F1 value of the Spanish vowels, as evident in the few vowel production studies (Mayr et al.,2012; Kartushina & Martin, 2019). As seen in tables 1-3, the English vowels are higher than the Spanish vowels. Thus, progressive influence is anticipated.

Moreover, the literature indicates that the L2 influences the L3 during the beginning stages of acquisition. However, these studies involved participants in immersive language environments. The target group in the current study has less contact with the L3. As a result, the decrease in F1 values will not be as drastic. However, an alternative finding may be that the participants will show no changes in their vowel productions. The reason may be that the learning environment is not immersive and the period of time is too brief to discern any phonological influences. Lastly, L3 influence on the L1 or L2 is not expected. The reasoning behind this is that regressive influence is only observed within extensive immersive environments or long-term immersive situations.

4. Methodology

4.1 Participants

Adult Dutch-English bilingual participants currently taking the 1b Spanish course at the University of Amsterdam were invited to take part in this study. An advertisement was

placed on the Canvas message board and an in-person announcement was made to students taking the Spanish course. Suitable candidates had a proficiency level of at least C1 in Dutch and English and had no extensive experience or proficiency in other languages. The cut-off proficiency for languages other than those mentioned above was A2 level. Proficiency levels follow the Common European Framework of Reference (CEFR) (Council of Europe, 2022). One Dutch-English bilingual adult was recruited for this experiment. The participant was recruited via in-person recruitment. A background questionnaire was administered to ensure the participant fit the criteria. The questionnaire prompted the participant to self-report their basic demographic information, language history, and proficiency (see appendix B). Questions of proficiency and language usage were modified from LEAP-Q (Marian et al., 2007) and Edwards (2016, p. 81). The questionnaire informed the participant of the purpose and nature of the study. Informed consent was provided by clicking a statement before proceeding through the questionnaire. Results from the questionnaire confirmed the participant fit the proficiency criteria. The participant reported being a female native Dutch speaker who used the American variety of English. No extensive experience or proficiency in other languages was reported.

4.2 Stimuli

The target vowels were monophthong vowels from Dutch, English, and Spanish. Target vowels from the three languages were placed in similar phonetic environments. Stimuli were inspired and modified from Mayr et al. (2012) and Bradlow (1995). The initial phoneme was a bilabial plosive /b/ or /p/, and the phoneme after the target vowel was either the alveolar stop /t/ or /d/. Due to the nature of the stimuli, the Dutch stimuli contained a non-word exemplifying the vowel /y/. The target stimuli are displayed in Table 4. Each word was repeated five times. The number of stimuli for each language was 45 for Dutch, 55 for English, and 25 for Spanish. A total of 125 words were read by the participant.

Table 4

Target Stimuli

Spanish Stimuli		English Stimuli		Dutch Stimuli	
Word	Vowel	Word	Vowel	Word	Vowel
Bita	i	Beat	i	Biet	i
Beta	e	Bit	ɪ	Pit	ɪ
Bata	a	Bet	e	Poeder	u
Bota	o	Bed	ɛ	Pet	ɛ
Puta	u	Bat	æ	Bad	ɑ
		Pot	ɑ	Baat	a
		Bought	ɔ	Pot	ɔ
		Put	ʊ	Buut	y
		Boot	u	Put	ʏ
		But	ʌ		
		Boat	oʊ		

4.3 Procedure

Two phases of the experiment took place. The first phase took place during the beginning of the participant's language course. The second was during the last week of their language course. The procedure for both was identical and was conducted to see what aspects of the phonological systems were altered. Acoustic data was collected at the UvA speech lab. The participant completed the background questionnaire before the acoustic data was collected. The questionnaire prompted the participant to self-report their language history, proficiency, age, and gender. From there, they were presented with the stimuli on a laptop. Stimuli from each language were presented in three blocks representing each language. An optional break was given after every block. Instructions were given verbally in English and presented in each language visually on screen for each block. The participant's task was to read aloud each word at a comfortable pace and manner. The participant moved at their own pace by clicking on the mousepad to proceed to the next word. The stimuli were produced five times. The reading task took approximately ten minutes to complete. Acoustic productions were made in a soundproof room. The participant's speech productions were

recorded with a Neumann TLM103 microphone and a Denon dn-500 solid-state recording device at 44.1 kHz sampling frequency in WAV format. A month later, the participant was invited to go through the same procedure as in phase one. Data were acoustically analyzed with Praat (Boersma & Weenink, 2022). Afterward, the first two formants of the target vowels were extracted and run through R (RStudio Team, 2021) for statistical analysis. From there, the results were compared from the two points to observe if any phonological changes in the participant's vowels took place during third language acquisition.

5. Results and data analysis

Acoustic data from the two-time points were compared for analysis. The first time point (T1) was taken two weeks into the language course and the second time point (T2) was taken from the 8th week of the language course. The audio was assessed for quality at the end of data collection for T1 and T2. Recordings containing unclear audio and erroneous productions such as mispronunciations, sighs, and coughs were removed from the analysis. The English stimulus "boat" was not included in the analysis. Formant tracking and the spectrogram revealed that the vowel /oʊ/ was pronounced as a diphthong.

Acoustic analysis of the first two formants of the remaining 120 stimuli were extracted with a modified Praat script from Stanley (2017). The following settings were applied, a maximum number of formants of 5, a maximum frequency of 5500 Hz, window length of 0.025 seconds with a pre-emphasis of 50db. The maximum number of formants and maximum frequency was manually adjusted if formant tracking was unstable. Formant frequencies were extracted at the midway point of the vowel. Stable portions of the vowel were manually marked in Praat. The onset vowel portion was marked where the formants of the vowel could easily be seen at the end of the preceding consonant. The offset was marked where the last transition to the following consonant began, and where the vowel formants could clearly be seen.

The average formant values for each vowel were recorded into a CSV file and sent to R (R core team, 2022) for statistical analysis. The average value of F1 and F2 were then compared to the F1 and F2 for each language's respective vowel productions. A multiple linear regression model was applied to each language's vowel data, with the independent variables as time (T1 and T2) and the vowels from each language. The average F1 and F2 of the vowels were the dependent variables. Data from T1 and T2 were compared to determine if there were any significant differences in formant values between the beginning and end of the Spanish 1b course.

Figure 1 depicts the participants' average formant values for each language two weeks into the Spanish 1b course. The average vowel formant values from each language at T1 are placed in tables 4-6 below.

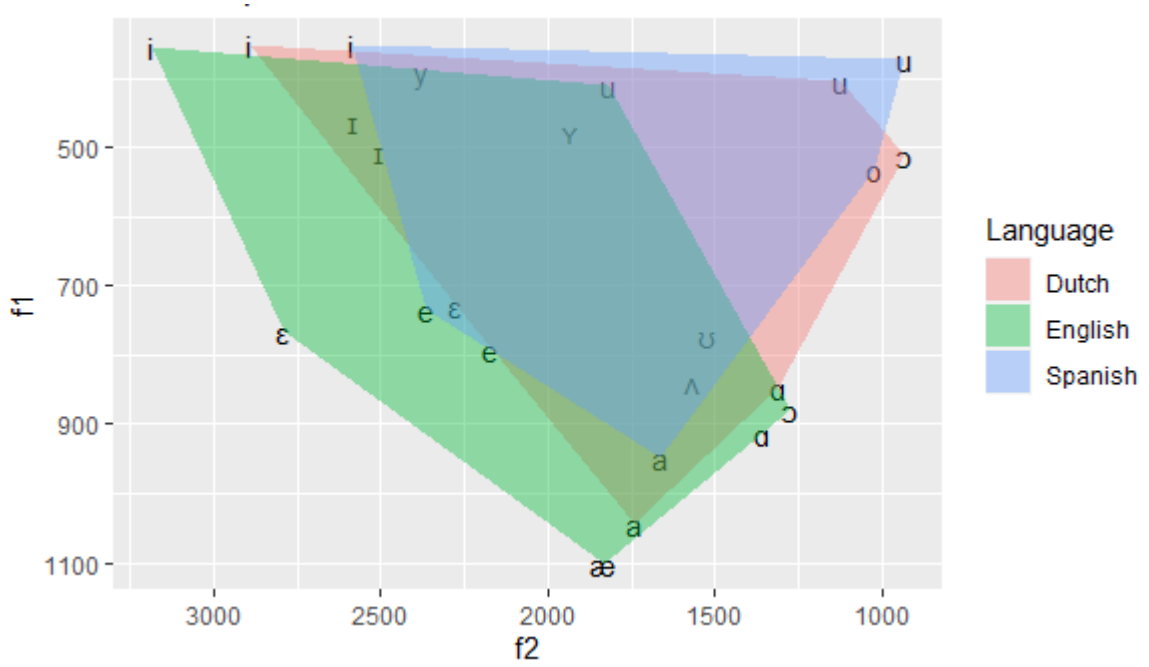

Figure 1. Vowel space at T1: Average baseline formant values for Dutch, English, and Spanish.

Table 4

Mean F1 and F2 frequencies (Hz) of Spanish vowels at T1

	i	e	a	o	u
F1	351.55	732.87	948.73	529.13	370.60
F2	2586.76	2364.90	1663.38	1023.79	935.32

Table 5

Mean F1 and F2 frequencies (Hz) of Dutch vowels at T1

	i	y	a	u	ɪ	ʏ	ɛ	ɑ	ɔ
F1	350.97	389.58	1044.07	403.26	460.78	476.70	727.50	846.45	511.38
F2	2889.87	2377.86	1742.96	1121.55	2582.06	1934.10	2275.93	1312.26	933.44

Table 6

Mean F1 and F2 frequencies (Hz) of American English vowels at T1

	i	ɪ	e	ɛ	æ	ɑ	ɔ	u	ʌ	ʊ
F1	354.45	505.68	792.21	766.38	1101.48	912.31	879.21	408.46	837.32	770.26
F2	3186.15	2499.20	2175.25	2790.87	1831.01	1355.22	1273.23	1818.85	1565.02	1517.76

In Figure 1, the F1 of /i/ in all languages appears to be quite similar. The difference is larger between the F2 values of /i/. As this is the first study that compares the vowel qualities of a bilingual with an L1 Dutch, L2 English, and L3 Spanish background, no direct comparisons can be made regarding the data in tables 4-6. As mentioned in section 3.1, bilingual vowel qualities deviate from monolingual norms. Take for example the American English values from Table 3 and the participant's values from Table 6. A comparison of the data from the tables reveals that the participant's F1 values are higher. Although the participants /a/ and /u/ are lower.

The following Figure 2 depicts the average formant values eight weeks into the Spanish 1b course. The average vowel formants for each language at T2 are in tables 7-9 below.

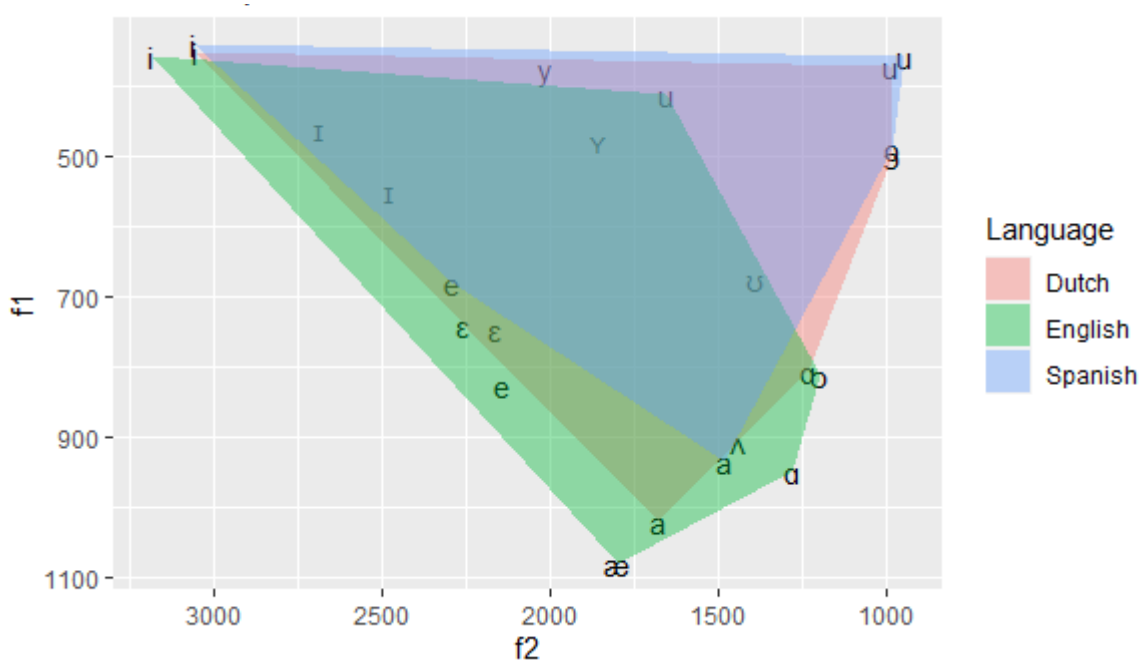

Figure 2. Vowel space at T2: Average formant values of the Dutch, English, and Spanish vowels, 6 weeks after T1.

Table 7

Mean F1 and F2 frequencies (Hz) of Spanish vowels of T2

	i	e	a	o	u
F1	339.01	680.56	933.95	486.42	355.42
F2	3056.08	2290.73	1485.42	985.21	949.38

Table 8

Mean F1 and F2 frequencies (Hz) of Dutch vowels at T2

	i	y	a	u	ɪ	ʏ	ɛ	ɑ	ɔ
F1	349.55	373.01	1020.36	369.51	459.35	475.37	740.63	806.53	497.94
F2	3051.68	2010.86	1676.32	990.44	2683.52	1859.81	2254.76	1233.92	984.73

Table 9

Mean F1 and F2 frequencies (Hz) of American English vowels at T2

	i	ɪ	e	ɛ	æ	ɑ	ɔ	u	ʌ	ʊ
F1	355.88	548.77	826.75	746.43	1080.20	948.69	811.02	409.45	904.34	770.26
F2	3183.38	2477.22	2143.99	2162.11	1797.55	1279.24	1196.93	1653.82	1439.79	1517.76

The visualization of the acoustic data in Figure 2 suggests that the Spanish vowel space drifted toward the Dutch vowel space. Visually, the F2 of Spanish /i/ and /u/ changed drastically. The shift of the Spanish vowels depicts the vowels becoming more front.

The results from multiple linear regression models revealed a shift in Spanish vowel quality. Six weeks of Spanish 1b formal language learning proved enough for phonological changes. Statistically, the difference between the two time points on the F1 of the Spanish vowels was significant, $p = .0298$, $t(4) = -3.306$, 95% CI [-50.60Hz, -4.41Hz]. The shift in F1 from T1 to T2 was estimated to be -27.5 Hz. In other words, the F1 values lowered. Even though Figure 2 depicts a drastic shift of the F2, the change from T1 to T2 was not statistically significant, $p = .749$, $t(4) = 0.343$, 95% CI [-272.93 Hz, 349.99 Hz]. The estimated change in F2 from T1 to T2 was 38.5 Hz.

The difference in terms of vowel quality for L1 and L2 did not reach significance. Results of F1 data for Dutch proved to be non-significant, $p = .0509$, $t(8) = -2.294$, 95% CI

[-26.39 Hz, 0.07 Hz] . The difference in F1 going from T1 to T2 was -13.2 Hz. The same conclusions were seen for the F2 data, p = 0.383, t(8) = -0.923, 95% CI [-164.81 Hz, 70.58 Hz]. F2 values differed approximately by -47.11 Hz.

Lastly, English had no noticeable shifts in F1, p = .896, t(9) = -0.134, 95% CI [-38.71 Hz, 34.37 Hz]. The F1 shift was minuscule with a difference of -2.2 Hz from baseline formant values. Results were also nonsignificant for the F2 values, p = .054, t(9) = -2.220, 95% CI [-259.97 Hz, 2.43 Hz]. Estimated changes from T1 to T2 were -128.77 Hz.

6. Discussion

In line with previous literature, the data revealed that the F1 values of the L3 Spanish vowel inventory drifted. Statistical analysis revealed that these changes affected only the Spanish vowel inventory, as changes in the English and Dutch vowel systems were statistically nonsignificant. Taking into account the six-week timeframe, data visualization, and statistical analysis, none of the subsequent languages appear to have induced this change. The F1 shift was observed in the lowering of the F1 values of Spanish. This is in contrast with the hypothesis that the Spanish vowels would have a higher F1 value. Based on the average formant values for Spanish and Dutch (tables 1-9), it would appear that the participant's Dutch and English F1 values are higher than their Spanish equivalents. Statistical analysis indicates a significant change in the F1 of the Spanish vowels lowering. The F1 changes in Dutch and English were deemed nonsignificant. Thus, the results indicate a dissimilatory drift from the L1 and L2 sound systems. The F2 changes seen in Figure 2 as an overlap of the Spanish vowels onto the Dutch equivalents proved to be statistically nonsignificant. The current suggestions from TLA cannot explain this development. However, insights from an established model from SLA may provide an explanation. Flege's SLM describes complementary situations regarding reasons for dissimilatory drift. One of the reasons put forth in SLA studies is that the learner is creating a new L3 category and wants to preserve their previous language's categories while building a new one. The second reason is that to make the phonological systems more distinct, they may have employed articulatory strategies.

The first reason stems from the possibility that the participant is at a stage of the language learning process where they are beginning to construct a new category for their L3 sounds. According to SLM, a learner may begin to dissimilate their L2 sounds from their L1 sounds when they start to perceive differences between the two languages. As their experience in the L2 progresses, a new category may form for the L2 sounds. For example,

an SLA study by Huffman et al. (2017) found that native English speakers learning Japanese dissimilated their English voiceless stops from their equivalent Japanese stops by increasing the VOTs of the English stops. The authors suggested two reasons for this development. The first was to further contrast the differences between the Japanese voiceless stops from their equivalent English ones. Secondly, this increase may have aided in maintaining this contrast in order to prevent assimilatory drifts of the L1 toward the L2. The Dutch/English participant may have discerned differences between their previous phonological systems and the new L3 system. Decreasing the F1 of the L3 may have been a strategy to maintain separate phonological systems and prevent phonological drifts. In turn, aiding in making room for the new L3 system.

Another example of learners dissimilating phonological inventories was seen in the articulation of L2 vowels. Flege et al.'s (2003) Italian-English bilinguals often over-articulated the English vowel /eɪ/. The overemphasis of the /eɪ/ was produced to dissimilate the English vowel from the Italian vowel /e/. Consequently, Spanish F1 changes could also be attributed to a higher tongue body and possible lip rounding. Even though the change in F2 was not statistically sound, this may be an explanation for irregular F2 shifts. Even though the F2 shift for the Spanish vowels was unreliable, an explanation for the overlap of Spanish over the Dutch ones seen in Figure 2, may stem from perceptual similarity. Flege (2007) hypothesizes that sounds that are perceptually linked will be produced similarly (p. 241). There is a potential for this possibility. However, the current study focused on vowel productions. For now, a perceptual link of the vowel is speculation. It should be noted that the SLM regards SLA in terms of L2 perception and production. There are no current models in L3 phonology that make similar predictions about L3 phonological acquisition. Unfortunately, due to the current design of the study, these factors can not be addressed. In order to validate this factor, future research would need to consider both perception and production links. Despite the tentative conclusions put forth, the results indicate that phonological changes are possible during the initial stages of TLA within a non-dominate L3 environment. Although, the L3 changes observed in this study could not be attributed to CLI.

7. Conclusion

This study investigated whether CLIs in the initial stages of TLA in a sequential bilingual learning an L3 in a non-immersive setting could be observed. In addition, this study set out to determine if any CLIs were progressive or regressive. The findings revealed that

there were observable phonological changes within a six-week timeframe of TLA. The data showed a lowering of the Spanish F1 vowels. On this account, this indicated that the Spanish vowels drifted away from both Dutch and English. It was proposed that this was affected by perceived differences in the L3 phonological system. This was contrary to previous findings demonstrating a predominant L2 influence. A plausible reason put forth involved proposals from the SLM. The participant's decrease in the Spanish F1 values could be an attempt to distinguish the L3 vowels from the L1 and L2. However, due to the methodology employed in this study, this factor could not be confirmed. This also highlights a few limitations of this study.

First, the data is based on productions from one participant. Thus, it is unknown if other L3 learners would produce similar results. Accordingly, data comparisons were not available to investigate factors that may induce F1 changes in the L3. Moreover, since there is no existing literature on the language combinations and language environment used in this study, comparisons with previous literature could not be made. Lastly, the data captured a very small timespan. It could be argued that the Spanish vowel data may alter further as learning progresses. Therefore CLI from one of the previous languages may be feasible, but the current study is too brief to observe this influence. Accordingly, if CLI developments do occur, they may only be captured once the learner is past what could be considered the initial stages of acquisition (6 months or more). Perhaps future considerations can incorporate the above factors. In all, L3 phonological research is still growing. Thus, there are opportunities to examine broader aspects of this field.

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Appendix A

Joey Stanley's script for formant extraction

```
writeInfoLine: "Extracting formants..."

# Extract the names of the Praat objects
thisSound$ = selected$("Sound")
thisTextGrid$ = selected$("TextGrid")

# Extract the number of intervals in the phoneme tier
select TextGrid 'thisTextGrid$'
numberOfPhonemes = Get number of intervals: 1
appendInfoLine: "There are ", numberOfPhonemes, " intervals."

# Create the Formant Object
select Sound 'thisSound$'
To Formant (burg)... 0 5 5500 0.025 50

# Create the output file and write the first line.
outputPath$ = "C:\Users\krmed\OneDrive\Desktop\language\formants.csv"
writeFileLine: "'outputPath$'", "file,time,phoneme,F1,F2,F3"

# Loop through each interval on the phoneme tier.
for thisInterval from 1 to numberOfPhonemes
   #appendInfoLine: thisInterval

   # Get the label of the interval
   select TextGrid 'thisTextGrid$'
   thisPhoneme$ = Get label of interval: 1, thisInterval
   #appendInfoLine: thisPhoneme$

   # Find the midpoint.
   thisPhonemeStartTime = Get start point: 1, thisInterval
   thisPhonemeEndTime   = Get end point:   1, thisInterval
   duration = thisPhonemeEndTime - thisPhonemeStartTime
```

```
    midpoint = thisPhonemeStartTime + duration/2

    # Extract formant measurements
    select Formant 'thisSound$'
    f1 = Get value at time... 1 midpoint Hertz Linear
    f2 = Get value at time... 2 midpoint Hertz Linear
    f3 = Get value at time... 3 midpoint Hertz Linear

    # Save to a spreadsheet
    appendFileLine: "'outputPath$'",
            ...thisSound$, ",",
            ...midpoint, ",",
            ...thisPhoneme$, ",",
            ...f1, ",",
            ...f2, ",",
            ...f3

endfor

appendInfoLine: newline$, newline$, "Whoo-hoo! It didn't crash!"
```

Appendix B

Background Questionnaire

Q1 Do you know any other languages aside from Dutch, English, and Spanish?

- ○ Yes
- ○ No

Q2 Are the other languages you know at a higher proficiency than A2* level?
Can understand sentences and frequently used expressions related to areas of most immediate relevance (e.g. very basic personal and family information, shopping, local geography, employment). Can communicate in simple and routine tasks requiring a simple and direct exchange of information on familiar and routine matters. Can describe in simple terms aspects of his/her background, immediate environment and matters in areas of immediate need.

- ○ Yes
- ○ No

Q3 Gender

- ○ Male
- ○ Female
- ○ Prefer not to say

Q3 Age

- ○ 18
- ○ 19
- ○ 20
- ○ 21
- ○ 22
- ○ 23
- ○ 24
- ○ 25
- ○ 26
- ○ 27
- ○ 28
- ○ 29
- ○ 30+

Q4 Please rank the languages you know in order of acquisition

	Native language/ First language	Second language	Third language
Dutch	☐	☐	☐
English	☐	☐	☐
Spanish	☐	☐	☐

Q5 Write the age you acquired Dutch, if since birth write birth

_____

Q6 Write the age you acquired English

_____

Q7 Write the age you began acquiring Spanish

_____

Q8 Please indicate your level of proficiency in each language

	Native	Advanced	Intermediate	Beginner
Dutch	○	○	○	○
English	○	○	○	○
Spanish	○	○	○	○

Q9 Please list what percentage of the time you are currently exposed and on average exposed to each language per week (your percentages should add up to 100%)

Dutch : _____
English : _____
Spanish : _____
Total : _____

Q10 Please list what percentage of the time you currently speak on average each language per week (your percentages should add up to 100%)

Dutch : _____
English : _____
Spanish : _____
Total : _____

Q11 Please list the number of years/months/weeks you spent in each language environment
If less than a week than add 0

	Years	Months	Weeks
Dutch speaking country			
English speaking country			
Spanish speaking country			

Q12 In your perception how much of a foreign accent do you have in Dutch?

- ○ None
- ○ Light
- ○ Moderate
- ○ Heavy

Q13 In your perception how much of a foreign accent do you have in English?

- ○ None
- ○ Light
- ○ Moderate
- ○ Heavy

Q14 Which type of English do you aim for when you speak English?

- ○ American English
- ○ British English
- ○ A standard native model with some Dutch ‘flavour’
- ○ I don't care
- ○ None of the above

Q15 If you were to name the type of English you actually speak, what would you call it?

- ○ American English
- ○ British English
- ○ Dutch English
- ○ None of the above

Q16 In your perception how much of a foreign accent do you have in Spanish?

- ○ None
- ○ Light
- ○ Moderate
- ○ Heavy