L1 VOWELS OF MULTILINGUALS: THE APPLICABILITY OF SLM IN MULTILINGUALISM

JOLANTA SYPIAŃSKA
Politechnika Koszalińska
jolanta.sypianska@gmail.com

Abstract
Although L1 has been treated as a rigid system which is more likely to act as a sender than a receiver of CLI in bilinguals and multilinguals, recent studies have provided some evidence of the influence of both L2 and L3 on L1. The study is aimed at shedding further light on how Lns can influence the native language and how these changes can be explained by means of the Speech Learning Model. The first and second formant of L1 Polish vowels of three groups of multilinguals were compared. Evidence of a systemic influence of L2 on L1 was observed in the raising and backing of L1 Polish vowels due to L2 English and lowering and backing or fronting of L1 Polish vowels due to L2 German. No systemic influence of L3 on L1 was observed. The predictions derived from equivalence classification of SLM were tested for the Polish vowel /ɛ/ and the closest vowels from Lns. The majority of predictions regarding the convergence or divergence of the particular diaphone were supported by the data.

Keywords: CLI, influence on L1, multilingualism, Speech Learning Model

1. Introduction

The native language is considered to be a rigid system which does not undergo changes after the end of First Language Acquisition. This approach to L1 has led to a situation in which cross-linguistic influence (CLI) from Ln to L1 is considered the unusual, unlikely and insignificant direction both in bilingual as well as multilingual studies. Nevertheless, more and more studies are offering evidence of this direction of CLI which is also supported by holistic models of language acquisition as such and models of phonetic acquisition in particular (e.g. Flege's Speech Learning Model).

This paper presents a part of the results of a larger multilingual study which aims to analyse multilingualism holistically rather than fractionally, that is to say, all the languages in the speakers' linguistic repertoire are taken into consideration as it is assumed that "the presence of linguistic information from various languages is likely to lead to a state of integration of knowledge in the mind." (De Angelis 2007: 14). The part of the results that is presented deals with the investigation of the influence of multilingual acqusition on the speaker's native language in particular whether L2 and L3 influence L1. Another goal of

this study is to investigate the applicability of the Speech Learning Model (Flege 1995) in multilingual acquisition.

2. Theoretical background

2.1. The (lack of) rigidity in L1

The majority of literature on foreign language acquisition has been focused on the formation of the second language as influenced by the first language. Thus, the native language has vastly been treated as the sender and the second language as the receiver of cross-linguistic influence (CLI) in the process of second language acquisition. Due to the fact that L1 is regarded as the more stable linguistic system of the two, thus it is far more likely to influence than to be influenced. It is particularly the phonological system of L1 that is considered rigid and highly influential on L2 which is often portrayed by the so called Joseph Conrad effect. It has been claimed that "the phonological system of a mature L1 is probably so stable that it is impervious to L2 influence" (Schmid and Köpke 2007: 4). However, more and more studies are aimed at analysing the influence of other languages on L1. Thus far, the influence on L1 after the end of the process of first language acquisition has been researched within convergence and imitation (e.g. Pardo, Gibbons, Suppes and Krauss 2012; Babel et al. 2014), phonetic transplantation (Sypiańska and Olender in print), bilingualism (e.g. Flege 1987, 1995) and multilingualism (Sypiańska 2013, Sypiańska in print) and L1 attrition (e.g. Schmid et al. 2004).

Firstly, the change in L1 can be a result of different L1 input rather than a consequence of the acquisition of another language. Phonetic convergence studies show how speakers adjust their speech to the interlocutor due to both recent or prolonged exposure to a particular linguistic environment (Pardo, Gibbons, Suppes and Krauss 2012). Dufour and Nguyen (2013) observed the degree of phonetic convergence of two groups of speakers, the first of which was supposed to imitate the words they heard and the second of which were asked to say the words they heard. After that both groups read the lexical items from the previous task and the degree of their phonetic convergence was measured. The results showed that both imitation and shadowing gave the same degree of phonetic convergence in the reading task. According to the authors, the study gives further evidence that traces of speech are formed during perception (2013) which are then used for production.

Secondly, there is some evidence that L1 phonetic features can be changed rapidly and probably quite consciously when speakers are asked to produce L1 speech with an L2 accent which is referred to as phonetic transplantation (Sypiańska and Olender in print). Study results suggest that the ability to phonetically transplant an L2 accent onto L1 increases with the amount of phonetic training in L2 which develops phonetic awareness.

Bilingualism has traditionally been focused on the second language. However, some bilingual studies have also included what has been alluded to as reverse interference (e.g. Felton 1990), or in other words, the seldom analysed direction of cross-linguistic influence (CLI) from L2 to L1. Flege (1987) investigated three groups of L1 English and L2 French speakers and one group of L1 French and L2 English and compared their VOT values in /t/ to the English and French baseline. The three former groups differed with respect to the amount of L2 use and formal instruction. The results showed that the more L2 French was used, the lower L1 English and higher L2 French VOT was observed. Hence, the conclusion that with increased use of L2 there was a tendency to produce a merged category of VOT in L1 and L2. In an attempt to replicate Flege's (1987) study, Lord (2008) showed some evidence of what she referred to as first language phonological modification. She compared VOT of initial voiceless plosives of L1 English and L2 Spanish of bilingual speakers with their respective monolingual baseline and found significant differences in VOT length but only for the velar stop. Greater differences may have been found if the results were controlled for quality of the following vowel. Ulbrich and Ordin (2014) report findings of the influence of L2 English constricted realisation of post-vocalic /r/ on L1 German non-constricted post-vocalic /r/. The influence was noticeable in the decrease of F3 in German post-vocalic /r/ as a result of input from rhotic L2 Belfast English.

Also, the influence of L2 on L1 categories has been understood as a changeable, dynamic phenomenon resulting in adaptations of the phonetic features of L1 to the surrounding language referred to as gestural drift (Sancier and Fowler 1997) or phonetic drift (Chang 2010). Sancier and Fowler (1997) analysed how L1 Brazilian Portuguese and L2 American English of a bilingual speaker is rated by Brazilian Portuguese and American English native speakers in two conditions: after an extended period of time spent in Brazil and after an extended period of time spent in the USA. The results point to an increase in ratings for foreign accent in L1 in the second condition. These results could be attributed to the fact that only L1 undergoes gestural drift. Furthermore, the authors also include an analysis of the VOT values as produced by the speaker in the two conditions which shows that VOT of /p,t/ is longer by 5ms on average after the stay in the USA. Chang (2010) analysed how L2 influences L1 English in novice L2 learners of Korean. Signs of the influence are detected as early as in the second week of classes of L2 Korean by the increased VOT of voiceless stops and $f0$ onset following the stops. Moreover, a general raising of the L1 English vowels was observed as a result of the higher Korean vowels.

L1 in multilingual acquisition, similarly as in bilingualism, has been treated rather as a sender than a receiver of CLI. Nonetheless, some research has been devoted to the possible influence that L2 and L3 can exhibit on L1. According to Cabrelli Amaro and Rothman (2010) and Cabrelli Amaro (2013), L1 will not be as permeable to the influence of other languages in the speaker's linguistic repertoire as it is more stable (Phonological Permeability Hypothesis). Still,

study results show that in multilingual speakers the first language can be influenced by L2 and L3. Sypiańska 2013, Sypiańska accepted) compared two groups of speakers: bilingual (L1 Polish, L2 Danish) and multilingual (L1 Polish, L2 Danish, L3 English). The analysed L1 vowels were not only different from the baseline but also differed in both groups showing an overal tendency for lower F1 and higher F2. In the bilingual group L1 Polish vowels were higher and fronter than the baseline, whereas in the multilingual group this effect was significantly boosted by L3 English.

Finally, there exists a scant body of research on L1 phonological attrition because of the propensity to understand the sound system of L1 as particularly rigid. In this area, there is a tendency to understand changes in L1 in terms of loss or maintenance. Nevertheless, L1 phonological attrition has been analysed in both production and perception of L1. In production, Mennen (2004) analysed peak alignment in L1 Dutch, L2 Greek bilinguals. She provides evidence of the influence of L2 Greek on L1 Dutch peak alignment. In Greek the peak is later than in Dutch, whereas the bilingual Dutch-Greek speakers produce the peak later in Dutch as an influence of L2 Greek in comparison to baseline. When it comes to perception, Eckman, Iverson, Fox, Jacewicz and Lee (2009) compared accent rating scores of four groups of people: Americans residing in the USA and Brazil and Brazilians residing in Brazil and the USA. All of the participants had experience with Portuguese. They listened to native and non-native Brazilian Portuguese speech. The study showed that foreign accent ratings of the listener's L1 is affected by long-term residence in a community in which the L1 is not used as the dominant language. Although all the groups were able to distinguish between native and non-native Brazilian Portuguese, L1 attrition was found in the ability to rate non-native speech as there were significant differences between Brazilians residing in the USA and those residing in Brazil. The authors conclude that since a long period of residence abroad results in the loss of perception of certain distinctions (evidenced in, e.g. Cancila, Celata and Giannini 2005), it may also bring about a loss of "the sensitivity required to rate the degree of foreign accent" (Eckman, Iverson, Fox, Jacewicz and Lee 2009).

All in all, there appears to be "a strong tendency for L1 speech production to be adjusted in the face of a mismatch between incoming auditory information and a talker's internal target for production" (Chang 2012: 250). This adjustment can be quite rapid as exemplified by phonetic transplantation or take place in different periods of time from short such as convergence to longer as in acquisition of two or more languages. The result can even be a restructuring of L1 to such an extent as to be considered loss rather than change of L1. Thus, it is concluded that L1 is not rigid and can undergo different degrees of change with new input.

2.2. Equivalence classification for L2 influence on L1

The model used in this paper is the Speech Learning Model (SLM) (Flege 1995). There are two reasons for this choice. First of all, the model's assumptions allow to investigate the influence of L1 on L2 but also the influence of L2 onto L1. Secondly, although it is not the only model which assumes a bidirectional influence between the two languages, among others Grosjean's language modes (e.g. 1982), Cook's multicompetence (1991) or Pavlenko (2000), it is certainly one that allows to derive clear and easily verifiable hypotheses. This aspect is of vital importance in multilingual studies in which the number of languages increases and, as a result, the number of characteristics that are analysed multiply. In order to be able to make predictions in a multilingual context, there is a need for hypotheses which can be expanded and adapted as the number of characteristics and the potential influences between them increases.

Firstly, according to SLM cross-linguistic influence is bidirectional in nature (H5 and H6 in Flege 1995). On the basis of the mechanism of equivalence classification, the model predicts two types of effects of the influence that L2 will have on L1. The type of influence that will take place is based on whether or not the L2 sound is perceived by the speaker as a similar or new phone (Flege 1987). In the former case, L1 and L2 sounds become perceptually linked into a diaphone and the tendecy is to merge them. As a result, L1 and L2 sounds become more similar to each other and both are produced differently from their baseline. In the latter case, L1 and L2 sounds do not become perceptually linked and the tendency is to produce them as dissimilarly as possible. This observation is based on studies of bilingual vowel systems. Since L1 and L2 categories "exist in a common phonological space", when vowels are awarded separate categories, the tendency is to maintain auditory contrast between them and disperse the vowels within that space.

Secondly, according to Flege, "phonetic systems reorganize in response to sounds encountered in an L2 through the addition of new phonetic categories, or through the modification of old ones" (1995: 233). This means that both L1 and L2 sounds of a bilingual person can be produced differently from native speaker norms. Even if the L2 sound is perceived to be new and a separate category is established for it in the common phonological space it does not follow that the sound will be produced in line with the native speaker norm.

Thirdly, the assumption of SLM is that there is no age limit for the production of accurate L2 phones. It predicts a gradual decrease in accuracy with the increase of age of onset of learning. However, studies show that with language experience learners may learn to produce L2 phones accurately (e.g. Flege, Bohn and Jang 1997).

Chang (2012) applied SLM's prediction for the analysis of the influence of L2 on L1. He measured VOT and *f*0 and vowel quality of L1 English native speakers who enrolled at a course of Korean. All respondents reported previous foreign language learning (usually French or Spanish). The influence of L2 on

L1 is visible in the significant increase in *f*0 of the stops and the overall decrease of F2 for female speakers and slight increases in F1 and F2 for male speakers. According to the author, the changes of fundamental frequency and vowel quality take place on a global scale rather than by means of perceptual linkages between a phone in L1 and a phone in L2. Also, the changes in L1 are a result of elementary experience in L2 as the speakers were novice learners of Korean. There are two drawbacks of the study. First of all, the speakers were multilingual and not bilingual as reported by the author. They had all learned another foreign language for a period of up to 15 years. Thus, the particular changes in L1 that are presented may not have been an influence of only one language (the newly started Korean) but combined CLI from one or more of the other languages and Korean. The participants are called bilingual because the author decided to analyse two languages from their linguistic repertoire. This is an example of a bilingual bias in which two languages from the linguistic repertoire are taken into consideration in the study and other languages from the repertoire are ignored (De Angelis 2007). Second of all, the Speech Learning Model SLM is clearly meant for bilinguals "who have spoken their L2 for many years, not beginners." (1995: 238) whereas Chang uses this model for the analysis of the speech of novice learners of Korean.

Finally, Kim (2012) analysed the vowel system of L1 Korean, L2 English and L1 English, L2 Korean bilinguals with different degrees of fluency in both their languages. The author found a tendency to produce backer vowels in all the groups. Also, many repondents produced "melded vowels" (2012: 118) as a result of the clustering of several vowels from both language and possibly also collapsing into one. The author concludes that existing models of bilingual speech, including SLM, explain the influence of L2 on L1 merely partially and that there is a need for a more comprehensive model which would support both the influence of L1 on L2 but also vice versa.

Both Chang (2012) and Kim's (2012) results point to the fact that it is possible to apply SLM in order to analyse the influence of L2 on L1. However, Chang (2012) claims that though SLM predicts the behaviour of individual vowels it does not foresee a systemic influence of L2 on L1. In this paper, it is maintained that it is the recognition of the ability of L2 to reorganise the common phonological space that makes it possible to predict a systemic influence of L2 on L1.

2.3. Equivalence classification in multilingualism

Although SLM does not explicitly include L3, the question is whether it is possible to extend it to trilingual acquisition. Bearing in mind the theoretical basis of SLM that phonetic systems reorganise in response to sounds encountered in an L2, it may be claimed that the same phonetic system may reorganize in response to sounds encountered in an L3. The influence of L3 on L1/L2 has not been widely researched. There have been few studies which

addressed the issue directly (Cabrelli Amaro 2013, Cabrelli Amaro 2016, Sypiańska 2013). Cabrelli Amaro (2013) describes a case study in which both F1 of /e/ and F2 /o/ in L2 Spanish were higher due to increased input in L3 Brazilian Portuguese but no influence on L1 was observed. Also, in a comparison of two groups (L1 English, L2 Spanish, L3 Brazilian Portuguee and L1 Spanish, L2 English, L3 Prazilian Portuguese) the influence of L3 Brazilian Portuguese was visible in the increase of vowel height in back vowels in L2 Spanish. This effect was not observed in the group of L1 Spanish and L2 English. Sypiańska (2013, in print) shows that L3 English raises F1 of certain vowels and lengthens VOT in L1 Polish the result of which is a systemic influence of L3 on L1. Moreover, some Third Language Aquisition studies also research the matter indirectly but do not necessarily show any influence of L3 on L1 (e.g. Wrembel 2014).

In SLM importance is placed on age effects on language acquisition. Although there is no age limit for the production of accurate L2 phones, the accuracy decreases with the increase of age of onset. According to Chang (2012), age is a proxy for language experience which underlies difference between L1 and L2 speech learning. There is more experience in L1, thus L2 is more heavily influenced by L1. Whereas with language experience in L2, it may be possible to improve accuracy. The participants of the present study, especially since their L3 is defined by means of chronology, have less experience in their third language than in their second language. This, in turn, leads to the assumption that L3, in comparison with L2, will have a less significant influence on L1.

All in all, SLM allows to predict that both L2 and L3 will have an effect on L1 but the influence of the latter will be less significant. In cases where L2 differs from L3, it may be assumed that L2 will be more prevalent. These assumptions will now be introduced to an attempt at applying equivalence classification for trilingual acquisition of vowel categories on the basis of the three groups of speakers whose speech is analysed in the present paper.

The vowels chosen for the analysis of individual vocalic categories are Polish /ɛ/, English /ɛ/, German /e, ɛ/ and Spanish /e/. The choice of the vowels was determined by the notions of similar and new sounds as proposed in SLM. The vowels from the four languages are all front and mid, whereas they include half-open and half-closed vowels. These differences can allow to determine whether the multilinguals perceive them as similar or new and allow to propose hypotheses to test the application of the model. The groups have the following combinations of the above mentioned vowel categories:

a) Group 1: L1 half-open, L2 half-open, L3 half-open and half-close
b) Group 2: L1 half open, L2 half-open, L3 half-close
c) Group 3: L1 half-open, L2 half-open and half-close, L3 half-open

In the first two groups both L1 and L2 possess half-open /ɛ/ which, according to equivalence classification, should undergo category convergence and lead to a merger of the two vowels whose quality should approximate each other. The two groups differ with respect to L3 of which one has both vowels and the other only the half-open vowel. It is then predicted that in Group 1 the half-open vowel will lead to an even greater merger of the category for all three languages[1] whereas the half-close vowel should diverge from the merged vowel category and may even result in overshoot. In Group 2 the merger between L1 and L2 vowel should be slighter as there is no half-open vowel in L3 to boost this effect. L3 vowel should diverge from the other two with possible overshoot. Group 3 should display category merger of the half-open vowel in L1 and L2 which should be boosted by a similar vowel in L3 whereas the half-close vowel in L2 should undergo category divergence and become as dissimilar as possible even resulting in overshoot. Hence, predictions based on equivalence classification result in the same scenario for two groups in which the languages are the same but they are acquired in different chronological order. However, if the factor of language experience is taken into consideration, then it may be claimed that the half-close vowel which should undergo category divergence may be acquired better when it belongs to L2 than L3. This can be measurable as a greater difference between the half-open and half-close vowels when they belong to L2 (Group 3) and a smaller difference when they belong to L3 (Group 1).

3. The study

3.1. Aim

The aim of the study was to analyse if and how L3 and L2 influence L1. This influence was measured on three groups of multilingual speakers with the same L1 but different combinations of L2 and L3. The particular aim was to analyse this influence on L1 vowel quality as measured by the first and second formants. Moreover, the influence was examined on the entire L1 vowel inventory but also on chosen vowels. The final goal of the study was to investigate the Speech Learning Model's applicability in trilingual acquisition.

3.2. Research questions and hypotheses

The research questions and hypotheses are connected with the systemic influence of Lns on L1. The first research question was whether L2 influences L1 and how this influence is manifested in L1 vowels. The second research

[1] It has been noticed that when L3 has a similar feature to L2, say long VOT in voiceless plosives, as opposed to L1, there is a combined influence of L2 and L3 on L1 which results in a boost of said feature in L1 (Sypiańska 2013).

question referred to whether or not L3 influences L1 and whether this influence is of greater or lesser magnitude than that of L2. Thus, there were two hypotheses:

a) H1: L3 influences L1 vowel quality to a lesser extent (than L2)
b) H2: L2 influences L1 vowel quality to a greater extent (than L3)

3.3. Participants

There were 33 native speakers of Polish and they were divided into three groups. The first group included 11 multilingual speakers with L1 Polish, L2 English and L3 German. The second group included 11 multilingual speakers with L1 Polish L2 English and L3 Spanish. Both groups included students of English philology at Adam Mickiewicz University in Poznań, Poland. At the time of the recording, they were finishing their first year of studies. The sample included 18 females and 4 males. Mean age was 20,5 with a maximum of 21 and a minimum of 19. Mean AofO of L2 was 8,35 with a maximum of 12 and a minimum of 7. Mean AofO of L3 was 14,35 with a maximum of 20 and a minimum of 7. Mean length of instruction in L2 was 11,6 with a maximum of 14 and a minimum of 8. Mean length of instruction in L3 was 5,78 with a maximum of 13 and a minimum of 1. Only 4 participants reported longer stays in the L2 or L3 countries, the longest stay being of 10 months and the shortest of 1 month. As usual in multilingual studies, the linguistic repertoire of the participants turned out to be much more complex upon examination than was acknowledged by the participants while they were being recruited for the study. While filling out the biodata questionnaire, 10 participants revealed that they had some instruction in a fourth language and 2 of them in a fifth language. These languages were Russian, French, Chinese and Portuguese. In the majority of cases the instruction lasted under one year.

The third group was comprised of 11 native speakers of Polish with L2 German and L3 English[2]. At the time of the recording they were third year students of German philology at Koszalin University of Technology, Poland. The sample included 1 male and 10 females. Mean age was 20,9 with a maximum of 23 and a minimum of 19. Mean AofO of L2 was 7,4 with a maximum of 11 and a minimum of 7. Mean AofO of L3 was 10,7 with a maximum of 17 and a minimum of 7. Mean length of instruction in L2 was 13,54 with a maximum of 15 and a minimum of 8. Mean length of instruction in L3 was 10,2 with a maximum of 19 and a minimum of 3. No particapnt reported longer stays in L2 or L3 countries. Three participants revealed that they had minor instruction in a fourth language and one participant in a fifth language.

[2] In an earlier version of this paper, Group 3 included bilingual speaker of L1 Polish, L2German.

3.4. Stimulus and procedure

As previously mentioned, this paper presents a part of a multilingual study in which all vowels of the four languages were analysed. The part deals with the influence of Lns on L1. Thus, the vowels under analysis include all the Polish vowels /a, ɛ, u, ɔ, i, ɨ/ and chosen vowels from the other languages English /ɛ/, German /e, ɛ/ and Spanish /e/ to compare with the Polish /ɛ/.

The stimulus included words with the target vowels which the participants were asked to say in the following carrier phrases: (1) Polish: Mówię ___ jeszcze raz.; (2) English: I say ___ once again.; (3) German: Ich sage ___ noch einmal.; (4) Spanish: Digo ___ otra vez. Moreover, for the two aspirating languages, English and German, the context of the voiced bilabial plosive was used /b V C V (C)/ whereas for the voicing languages, Polish and Spanish, the context of a voiceless bilabial plosive was used /p V C V (C)/. The vowels under analysis were inserted in the following words for Polish: *pasza* for /a/, *poszła* for /ɔ/, *peszył* for /ɛ/, *puszyć* for /u/, *pisze* for /i/ and *pyszne* for /ɨ/. The Spanish word was *peso* for /e/, the English *better* for /ɛ/ and the German words *besser* for /ɛ/ and *beten* for /e/. The list also included filler words which constituted 20% of the entire list.

The recordings were made in quiet rooms at Adam Mickiewicz University in Poznań and at Koszalin Politechnics in Koszalin. The data were analysed in PRAAT version 5.3.37 (Boersma and Weenink, 2013) at a sampling rate of 16kHz. The formant frequencies at steady-state were obtained by means of the automatic formant tracker whose findings were then verified manually. The measurements were normalised using Nearey 1 with the online tool by Thomas and Kendall (2007).

3.5. Baseline data

The baseline data used for Polish are taken from Strycharczuk and Jurgec (2008): /ɛ/ F1=600Hz, F2=1900Hz; /a/ F1=825Hz, F2=1450Hz; /i/ F1=300Hz, F2=2300Hz; /ɨ/ F1=425Hz, F2=1800Hz; /ɔ/ F1=575Hz, F2=1200Hz; /u/ F1=380Hz, F2=1100Hz. The baseline data used for American English are taken from Ladefoged and Johnson (2011) where F1 is 550Hz and F2 is 1770Hz. The German baseline was taken from Steinlen (2005) where F1 of /e/ is 320Hz and F2 is 2100Hz whereas F1 of /ɛ/ is 550Hz and F2 is 1750Hz.

3.6. Systemic influence

The first hypothesis stated that L3 will have an effect on L1. In order to verify this, Group 1 and Group 2 were compared. Figure 1 presents individual vowel formant values of speakers (Group 1- blue, Group 2 - red). As visible in Fig. 1., there were no differences between the two groups. Thus, no influence of L3 on L1 was observed. The second hypothesis stated that L2 will have an effect on

L1. In order to verify this, the Polish vowels of Group 3 were compared to those produced by Group 1 and Group 2 (now merged into one group). The difference between these groups is visible in Fig. 2. The merged group uses a smaller vowel space and there seems to be less variation for each vowel when compared to Group 3. Moreover, the merged group produces backer front vowels and fronter back vowels but also higher /ɛ, ɔ/.

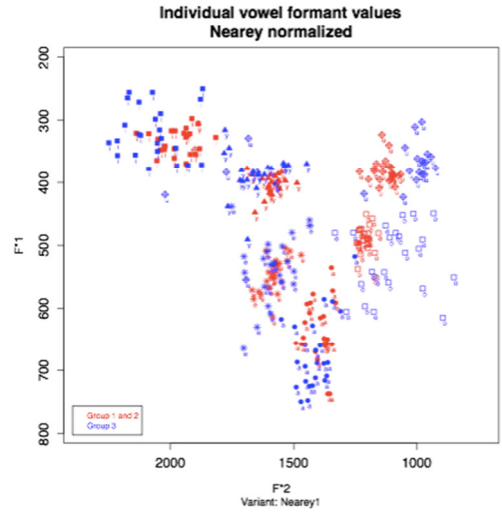

Figure 1. Individual vowel formant values. Comparison between Group 1 and Group 2.

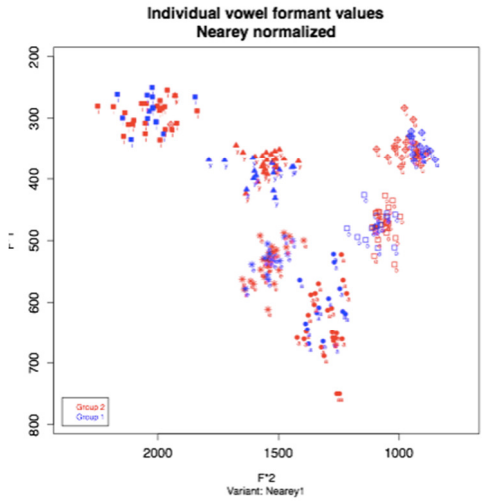

Figure 2. Individual vowel formant values. Comparison between Group 1, 2 and Group 3.

The results were confirmed by ANOVA and post-hoc tests. The f value reached statistical significance for F1 (/a/ $F(2,64)=65,37$; /ɔ/ $F(2,64)=62,54$; /ɛ/ $F(2,64)=31,07$; /u/ $F(2,64)=21,66$; /ɨ/ $F(2,64)=18,57$; /i/ $F(2,64)=9,94$ $p=.00$) and F2 for all vowels (at p=.00 /i/ $F(2,64)=102,70$; /a/ $F(2,64)=61,33$; /ɛ/ $F(2,64)=61,10$; /ɨ/ $F(2,64)=58,48$; and p=.05 for /u/ $F(2,64)=3,79$) apart from F2 of /ɔ/ ($F(2,64)=0,46$ $p=.85$), whereas between group differences reached statistical significance only between Group 1 and 3 and Group 2 and 3. There were no differences between Group 1 and 2 as noticed on the vowel spaces.

In order to assess the kind of systemic influence that was displayed in the groups, F1 and F2 values for all vowels in all groups were compared to their baseline. For /i/ only Group 3 reached statistical significance for F1 which was higher by 38,25Hz ($t(21)=3,31$ $p=.00$). Moreover, all groups produced a lower F2 ($t(21)=13,31$ $p=.00$; $t(21)=4,81$ $p=.00$; $t(21)$ $p=5,98$ $p=.00$). All groups displayed significant differences for F1 and F2 of /ɛ/ when compared to the Polish baseline data. In Group 1, F1 was lower by 64Hz ($t(21)=10,08$ $p=.00$) and F2 by 336Hz ($t(21)=30,53$ $p=.00$). In Group 2, F1 was lower by 69Hz ($t(21)=11,14$ $p=.00$) and F2 by 368Hz ($t(21)=26,16$ $p=.00$). In Group 3, a different tendency was observed as F1 was higher by 37Hz ($t(21)=2,54$ $p=.01$) and F2 lower by 115,65 ($t(21)=4,77$ $p=.00$). Groups 1 and 2 produced /ɨ/ with a significantly different F1 ($t(21)=9,73$ $p=.00$; $t(21)=6,45$ $p=.00$) whereas the values for F2 reached significance in all three groups (t(21)=12,099 p=.00; $t(21)=8,61$ $p=.00$; $t(21)=2,55$ $p=.01$). Group 1 and 2 produced F2 lower by 235Hz and 228Hz and Group 3 higher by 71Hz. F1 of the vowel /ɔ/ was lower by 102Hz in Group 1 ($t(21)=19,88$ $p=.00$) and 98Hz in Group 2 ($t(21)=15,77$ $p=.00$) but higher in Group 3 ($t(21)=2,87$ $p=.00$). F2 of /ɔ/ was also lower for all three groups ($t(21)=21,62$ $p=.00$; $t(21)=6,77$ $p=.00$; $t(21)=3,57$ $p=.00$). F1 of the vowel /u/ was lower in Group 1 and 2 ($t(21)=7,22$ $p=.00$; $t(21)=7,13$ $p=.00$) but higher in Group 3 ($t(21)=3,05$ $p=.00$). The differences for F2 reached statistical significance only for Groups 1 and 2 ($t(21)=2,48$ $p=.02$; $t(21)=21,24$ $p=.00$) and was lower by 101Hz and 183Hz respectively. Finally, F1 of /a/ reached statistical significance only for Group 1 and 2 ($t(21)=15,19$ $p=.00$; ($t(21)=17,00$ $p=.00$) and was lower by 194Hz in Group 1 and 215Hz in Group 2. F2 was significantly lower in Group 1 and 2 ($t(21)=6,39$ $p=.00$; $t(21)=8,41$ $p=.00$) but higher in Group 3 ($t(21)=4,15$ $p=.00$).

3.7. Segmental influence

The segmental influence of Lns on L1 was carried out on the following vowels: Polish /ɛ/, English /ɛ/, German /ɛ,e/ and Spanish /e/. Table 1 provides the results of a comparison of Euclidean distances between the baseline vowels and the vowels actually pronounced by the speakers of this study. Out of the eight predictions on the basis of SLM, five were supported by the results. It was predicted that /ɛ/ of L1 Polish and L2 English would merge in Group 1 and 2, whereas the results point to divergence as the Euclidean distance doubled for

both groups. The third prediction which was not supported by the data referred to L3 German of Group 1. It was assumed that the half-close vowel /e/ would be considered as a new category and consequently be produced as divergently from L1 as possible. On the other hand, /ɛ/ would converge with the similar vowel in L1. However, it turned out that both German vowels were considered different and both diverged from the vowel in L1 Polish. The other predictions were confirmed.

Table 1. Euclidean distances between vowels.

Group	Language pair	V	Baseline (Euclidean distance)	Prediction	Results (Euclidean distance)
1	L1 Polish - L2 English	ɛ	139	convergence	divergence (285)
2	L1 Polish - L2 English	ɛ	139	convergence	divergence (280)
3	L1 Polish - L3 English	ɛ	139	convergence	convergence (65)
3	L1 Polish - L2 German	e	344	divergence	divergence (828)
3	L1 Polish - L2 German	ɛ	158	convergence	convergence (31)
1	L1 Polish - L3 German	e	344	divergence	divergence (620)
1	L1 Polish - L3 German	ɛ	158	convergence	divergence (364)
2	L1 Polish - L3 Spanish	e	273	divergence	divergence (472)

3.8. The discussion

No differences were observed between Group 1 and 2. Thus, it can be assumed that L3 did not influence L1 in the first two groups. The difference between Group 1/2 and Group 3 points to the influence of L2 on L1. The analysis of the systemic influence of Lns on L1 yields two tendencies, one for Group 1 and Group 2, the other for Group 3. Group 1/2 produced vowels that were higher (/i,ɛ,ɨ,ɔ,u/) or the same as the baseline (/a/) and backer (/a,ɛ,u,ɔ,i,ɨ/). On the other hand, Group 3 produced vowels that were lower (/i,ɛ,ɔ,u/) or the same as the baseline (/ɨ,a/) and backer (/i,ɛ,ɔ/), fronter (/a,ɨ/ or the same as the baseline (/u/). All in all, L2 English influence on L1 Polish is visible in the raising and backing of vowels. The fact that Group 3 manifested significantly different values from the baseline and the other groups may be treated as influence of L2 German on L1. This could, however, also be a manifestation of a combined cross-linguistic influence of L2 German and L3 English on L1 Polish.

When it comes to the segmental influence of Lns on L1, the analysis based on Euclidean distances shows that SLM is to some extent able to predict category behaviour. The predictions that were not supported by the data refer to

L2 English and L3 German. In both cases a convergence of categories was predicted whereas the speakers diverged the vowels. This may be explained as follows. Since in Groups 1 and 2 no influence of L3 on L1 was noticed then it was L2 which can be considered as the only source of influence on L1. It is possible that the speakers reached a level of proficiency or had had enough language experience in L2 so that it enabled them to develop a distinction between the very similar L1 and L2 /ɛ/. SLM predicts that with language experience it is possible to acquire accuracy in the production of an L2 phone. In this case accuracy implies the acquistion of a distinction between the phone in L1 and L2 rather than a production that is on-target with respect to the native baseline.

Furthermore, the same scenario has been predicted for the German half-close vowel regardless if it belongs to L2 or L3. The only possible difference was foreseen to stem from the greater language experience in L2 and the manifest itself in greater distance between the L2 vowel and its diaphone. The results confirm this prediction as the Euclidean distance is greater for the half-close vowel when it belongs to L2 (Group 3=828) and smaller when it belongs to L3 (Group 1=620).

4. Conclusions

All in all, the study has provided evidence of the influence of other languages on L1 vocalic categories. In particular, the study showed how two different L2s influence the whole system of L1 in different ways. The systemic influence of L2 English was observed in the raising and backing of L1 Polish vowels whereas L2 German in the lowering and backing or fronting of L1 Polish vowels. However, the latter can also be a manifestation of a combined CLI of L2 and L3 on L1.

Moreover, the study attempted to apply the Speech Learning Model to analyse the behaviour of vocalic segments in multilingual speakers particularly the way Lns influence L1. Five out of eight predictions based on equivalence classification were confirmed whereas the rest may be explained by means of language experience in L2 and L3. Hence, it would be vital to analyse the effect of language experience on the behaviour of vocalic categories in multilingual acquisition in further research, especially in order to examine the relationship between language experience in L2 and L3 and its influence on L1 in multilinguals. From a methodological point of view, there is a need to establish a threshold of the level of language experience that is necessary for the language to start influencing other languages in the linguistic repertoire.

Finally, the results point to the fact that multilingual acquisition has to be approached from two perspectives. On the one hand, the addition of Ln to the linguistic repertoire brings about a shift of categories in the global phonological space. On the other hand, the shift of the categories is manifested in the vectors

for individual pairs of sounds that are likely to be linked as diaphones. Depending on the particular features of Ln, a different shift of categories on a global scale is to be expected, which then brings about a difference in the vectors between the diaphones.

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