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The influence of foreign languages on L1: the case of intervocalic stop occlusion

Abstract

The aim of the article is to investigate cross-linguistic influence (CLI) of foreign languages on the L1 also referred to as L1 drift. The influence is measured by means of the degree of intervocalic stop occlusion in all the languages of L1 Polish, L2 Spanish and L3 English multilinguals. Although Polish is a language with no systemic spirantization of intervocalic stops, the assumption is that if L1 Polish is under the influence of L2 Spanish in multilinguals the degree of intervocalic stop occlusion may be lower in the otherwise non-spirantized context in L1 Polish. The degree of intervocalic stop occlusion is calculated with measures of intensity: Cmin, Vmax; but also with measures of relative intensity used in spirantization research: IntDiff and IntRatio. The results show that only Cmin and Vmax effectively capture the influence of L2 on L1, whereas the extent of the influence is conditioned by how well the speakers master spirantization in their L2 Spanish. Finally, as predicted, the L3 does not constitute a source of influence for the L1.

Keywords: cross-linguistic influence; multilingualism; influence on L1; L1 drift; spirantization; degree of intervocalic stop occlusion

Słowa kluczowe: wpływy międzyjęzykowe; wielojęzyczność; wpływ na język pierwszy; dryft języka pierwszego; spirantyzacja; stopień okluzji w zwartowybuchowych pomiędzy samogłoskami

1. Introduction

The aim of the article is to analyse cross-linguistic influence (CLI) from foreign languages onto the L1. The influence will be measured by means of the degree of intervocalic stop occlusion in all the languages in the repertoire of L1 Polish, L2 Spanish and L3 English multilinguals. Polish is a language with no systemic spirantization of intervocalic stops. However, the assumption is that if L1 Polish is under the influence of L2 Spanish in multilinguals the degree of intervocalic stop occlusion may be lower in the otherwise non-spirantized context in L1 Polish in comparison to Polish with no influence from Spanish.

Negligible influence from L3 English is expected in this particular repertoire due to its infrequent use and much lower level of proficiency in comparison to the L2. Furthermore, study results in the literature find much stronger influence from the L2 than the L3 on the L1 (Sypiańska, 2016: 92; Sypiańska, 2017).

The ordering of the languages in the multilingual repertoire is based on the frequency of use and the level of proficiency rather than on chronology of onset. Thus, the participants started acquiring English earlier than Spanish, however, at the time of the data collection their Spanish had been more frequently used for over 2 years and was at a higher level of proficiency than English.

The article is organized as follows. Firstly, there is a brief description of studies on the influence of other languages on the L1 in which possible sources of influence from the L2 and Ln on the L1 are depicted. Furthermore, the process of spirantization in Spanish and plausible instances thereof in Polish and English are described. This is followed by a synthesis of second language acquisition studies that deal with spirantization. Next, measures of spirantization based on the degree of stop occlusion are explained. The degree of intervocalic stop occlusion in Polish, Spanish and English is examined and compared. Finally, a study which aims at investigating CLI from foreign languages onto the L1 is presented.

2. CLI from other languages on L1

From the earliest works on languages in contact in bilinguals, it has been assumed that some interference is to be expected between both languages of a bilingual person (Weinreich, 1953: 1). CLI, as a more neutral notion than interference with its negative associations, is currently preferred. The notion of CLI is also more inclusive of the different directions of the influence to be expected. Though theoretically the notion itself allows the phenomenon to be understood as bilateral in bilingualism it has always been assumed that the L2 is more prone to CLI from the L1 than vice versa. As an effect, there have been far fewer studies on what is also referred to as reverse transfer (e.g. Gass and Selinker, 2001: 132) from the L2 to the L1.

More recently CLI has been investigated in multilinguals, where the possible directions of influence multiply due to more languages being involved in the process. It is assumed that all languages in a given linguistic repertoire may demonstrate CLI from one another. It should thus follow that all languages in multilinguals may be expected to be subject to CLI. The extent of CLI in each direction between the languages of multilinguals has only begun to be explored. It is difficult as yet to determine which language is more or less prone to influence and what the conditioning factors for the influence are. Especially so, as the vast majority of studies are focused on the sources of CLI onto the L3 and can be subsumed under Third Language Acquisition (TLA).

The idea of a language being more or less prone to influence from others in a multilingual setting has been investigated in the Phonological Permeability Hypothesis (PPH) put forward by Cabrelli Amaro and Rothman (2010: 275) and Cabrelli Amaro (2017: 698). The hypothesis deals with the susceptibility of the L1 and the L2 to influence originating from the L3. According to the PPH, the first language of an adult is less prone to influence from a third language because of a difference in the stability of mental representations. The L1, having more stable mental representations than the L2, should show less influence from the L3.

An important question for the present study is whether the L2 or the L3 will be more likely to influence the L1. Studies in the literature on multilingualism and influence on the L1 suggest that the L2, rather than the L3, is the dominant source of influence on the L1 (Sypiańska, 2017). However, in Sypiańska's study L2 Danish was the language of the surrounding environment, whereas L3 English was mostly used for work purposes, so for a limited, though regular, amount of time. In such circumstances, the frequency of use and the level of proficiency were probably conducive to there being a stronger influence from the L2 than the L3. Yet, some influence was also detected from the L3 on the L1. By means of a comparison of a bilingual L1 Polish, L2 Danish group and a multilingual L1 Polish, L2 Danish and L3 English group, the influence of the L3 on the L1 was established. Voice onset time (VOT) of the Polish dental stop was greater in the latter group, possibly due to some form of combined influence from the two languages, with greater VOT (Danish and English) on the language with the shorter VOT (Polish). In another study by Sypiańska (2016: 92), in which the L1 was the language of the surrounding environment, L1 Polish, L2 English, L3 German speakers were compared to L1 Polish, L2 English, L3 Spanish, but no differences in the first two formants of the entire L1 vowel inventory were found. However, when these speakers were later compared to a group of L1 Polish, L2 German, L3 English multilinguals statistically significant differences were detected between their L1s. In the L2 English groups, L1 Polish vowels were higher and backer than the baseline which consisted of Polish native speakers with marginal knowledge and skills in foreign languages. However, the L2 German speakers' L1 Polish vowels were lower than the baseline. Thus, it was inferred that the L2 played a more significant role than the L3 in CLI from foreign languages on the L1.

The influence of foreign languages on the native language in terms of phonetics is frequently analysed within the area of L1 phonetic drift. Chang (2019) defines L1 drift as an "L2-influenced phonetic change in an individual's L1 system" (p. 191) due to "recent experience in another language (L2)" (p.192). Many studies in L1 drift focus on changes in the L1 due to recent L2 exposure (e.g. Lang and Davidson 2017) in which drift is a response to new input stemming from the L2 at the beginning of L2 exposure. Fewer studies focus on changes in the L1 in advanced L2 users which may proceed from CLI and/or non-usage of the L1. These analyses tend to be subsumed under L1 attrition rather than drift (e.g. de Leeuw, Tuscha and Schmid 2018). Whether mastery of the L2, or a particular element of the L2, may be a precondition to L1 drift remains to be verified.

All in all, there is a scarcity of research on the influence of other languages on L1 phonetics, especially in the case of L1 Polish in multilinguals. The current paper presents a study on the influence of L2 Spanish that results in L1 Polish phonetic drift, measured by means of the degree of occlusion in intervocalic stops.

3. Spirantization in Spanish, Polish and English

Spirantization in Spanish is a well-documented process of the weakening of voiced plosives to fricatives (Navarro Tomás, 1918: 62) or, more frequently, to approximants (Martínez Celdrán, 1991: 250) following vowels, glides, fricatives and /r/ (Navarro Tomás, 1971: 117). This phenomenon may take place word-internally as in, e.g. *hada* but also word-initially as in e.g. *cada día.* Traditionally spirantization has been understood as two allophones in complementary distribution (Navarro Tomás, 1918: 75; Mascaró 1991: 168). However, more recent acoustic and articulatory data point to a continuum of the degree of constriction (Cole et al., 1999: 577; Hualde et al., 2011: 906).

Spirants are not allophonic variants of stops in Polish. However, according to Sawicka (1995) /ɣ/ may be found as a positional variant of /x/ before a voiced obstruent as in *dach domu* /dɑɣ dɔmu/ and in sporadic and non-systemic voicing of intervocalic /x/ in fast speech as in *pojechałem* /pɔjeɣɑwɛm/ (p.154). Furthermore, some degree of intervocalic spirantization in fast casual speech may also be expected in a language which does not possess the spirant allophone. It has been suggested that spirantization of voiced and voiceless stops occurs in fast casual speech in English (e.g., Brown, 1990: 79; Gimson, 1980: 160) though it tends to be much less frequent (Face and Menke, 2009: 39) and primarily styleinduced (Brown, 1990: 79; Gimson, 1980: 160). Gimson (1980: 160) stresses that due to lower articulatory precision in fast colloquial speech the closure of stops is weak, as a result of which plosives are fricativized (/b/ to /β/, /d/ to /z/ and /g/ to /ɣ/). According to Brown (1990: 79), weakening of stops to fricatives (/b/ to /β/, /d/ to /ʐ/, /g/ to /ɣ/) in casual English takes place in non-initial, non-stressed contexts either inter-vocalically, or post-vocalically and pre-consonantally.

4. Spirantization in acquisition studies

Spirantization research in the context of second language learners shows evidence of L1 effects on the L2. The majority of SLA studies on spirantization are focused on the analysis of English native speakers acquiring Spanish. They point to five major factors conditioning the amount of spirantization. The first factor is task and style. More spirantized instances of stops have been found in conversation tasks (González-Bueno, 1995: 72) than in reading tasks (Zampini, 1994: 470). Also, informal speech has been observed to trigger more spirantization (Zampini, 1994: 475; Elliott, 1997: 96). Secondly, place of articulation impacts the percentage of spirantization. /d/ is least likely to be spirantized (Zampini, 1994: 470; González-Bueno, 1995: 72) although a similar sound exists in the English inventory its production may be hindered by it being classified as similar rather than new in the classification according to Flege's Speech Learning Model (1995: 239). /b/ is the stop most likely to be spirantized (González-Bueno, 1995: 72; Zampini, 1994: 470). The third factor conditioning the amount of spirantization is spelling. A higher percentage of spirantization of the bilabial stop could be attributed to spelling hints from the grapheme {v} which tends to be produced as a fricative due to the influence from L1 English (Zampini, 1994: 470). Moreover, level of proficiency has been found to influence the percentage of spirantized instances, which rise together with the level of proficiency (Face and Menke, 2009: 39). A final factor affecting the amount of spirantization is that of position in the syllable and the word. Learners of Spanish are more likely to spirantize in unstressed syllables, though learners with a higher level of proficiency tend to spirantize in stressed and unstressed contexts at a similar rate (Face and Menke, 2009: 39). Furthermore, there is a preference for the word-internal rather than the word-initial context, although the discrepancy is likely to be minimized with increased proficiency.

5. Measuring the degree of occlusion

Measuring the degree of occlusion has typically been carried out with the aim of investigating the process of spirantization. In SLA studies on spirantization, the influence of the L1 on the L2 has been demonstrated by counting the percentage of instances produced as spirants. To this effect, the instances under study were coded into two categories: stop-spirant; or four categories: stop-fricative-approximant-other (Face and Menke, 2009: 39). Since more recent articulatory and acoustic data show the phenomenon of spirantization as a continuum of the degree of constriction, for the purpose of measuring CLI between two or more languages it is advisable to go beyond categorical coding.

Spirantization, understood as the degree of occlusion, may be measured acoustically by means of several methods which are based on the relative intensity of the sound undergoing spirantization and the following vowel. These typically include intensity difference (IntDiff), intensity ratio (IntRatio), spectral tilt (ST) and maximum velocity (e.g. Hualde et al., 2010). The first two are used in the present study.

IntDiff is the difference between the minimum intensity of the consonant (Cmin) and the maximum intensity of the vowel (Vmax). Fig.1 shows the Spanish word *taba* in which the intervocalic consonant is realized as the bilabial spirant /β/. The difference between Cmin and Vmax for the spirant is much smaller than in the Polish word *żaba* in Fig.2 as the latter is expected to be realized as a stop.

IntRatio is the ratio between Cmin and Vmax. In a study by Parrell (2010: 2289), IntRatio was found to be the most accurate measure when compared with articulatory data of lip aperture measured with electromagnetic articulometry.

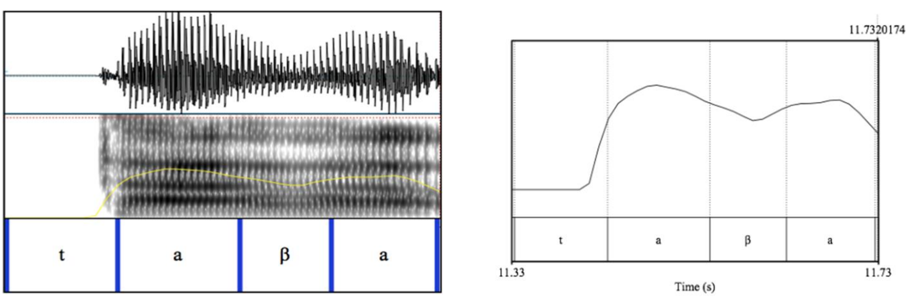

Figure 1: Intervocalic bilabial spirant /β/.

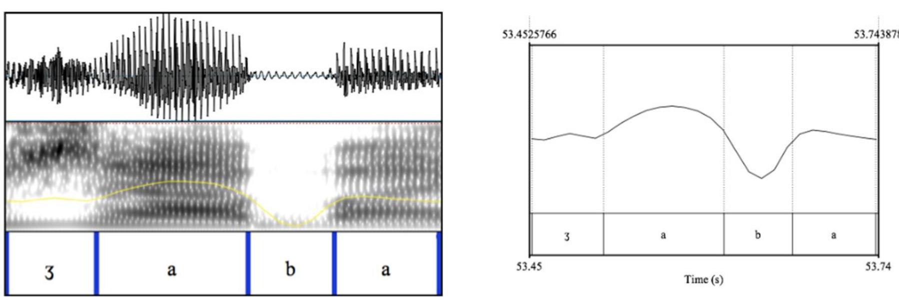

Figure 2: Intervocalic bilabial stop /b/.

The above mentioned examples are clear-cut representatives of the two extremes, i.e. a stop and an approximant production. However, when two languages come into contact with each other in the process of acquisition, if one of those languages has a stop in this particular context and the other language has an approximant, we may expect a certain degree of CLI. This may result in in-between productions that can be located on the continuum between the two extremes of stop and approximant. Figure 3 shows the Polish word *baba* on the left and the Spanish word *taba* on the right as pronounced by one of the participants of the study. Since these are the productions of a person who knows both Polish and Spanish, instead of being clear-cut representatives of a stop in Polish and an approximant in Spanish, as a result of mutual CLI, they are in-between productions.

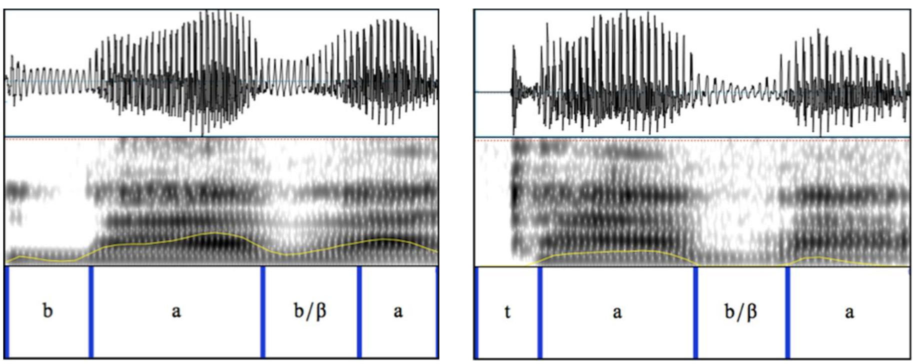

Figure 3: Examples of in-between productions.

In order to exclude the effect of the voice bar (F0), a Hann pass band filter between 500Hz and 10,000 Hz was applied. This procedure is taken from Hualde et al. (2010) who claim that it reduces the effect of high and low frequency noise without influencing the following vowel (Hualde et al., 2010). Additionally, the Hann pass band filter is meant to sift out instances of fricativized plosives due to lower articulatory precision rather than due to CLI from Spanish.

The effect of the filtering procedure is illustrated in Fig.4 and Fig.5. Both figures demonstrate the production of the Spanish word *taba* by a Polish native speaker. In both figures, the left-hand spectrograms are pre-filtering and the right-hand spectrograms are post-filtering. Fig. 4 shows an approximant production in which pre-filtering IntDiff is quite low at 2.24 (pre-filtering: Cmin=60.84, Vmax=63.08; post-filtering: Cmin=55.30, Vmax=61.77). The filtering procedure increases IntDiff to 6.47. Fig. 5 shows a more stop-like production whose pre-filtering Cmin and Vmax are much lower than for the approximant, yet IntDiff is only 5.14 (pre-filtering: Cmin=52.08, Vmax=57.22, post-filtering: Cmin=36.82, Vmax=55.52). However, post-filtering IntDiff is 18.7 which points to a greater difference between the consonant and the vowel, thus specifying a stop.

The absolute values for Cmin and Vmax are somewhat different, but the relative difference expressed by IntDiff is almost the same. The application of the filter increases the stop-like qualities of the stop by increasing IntDiff without significant alterations to the more approximant-like production.

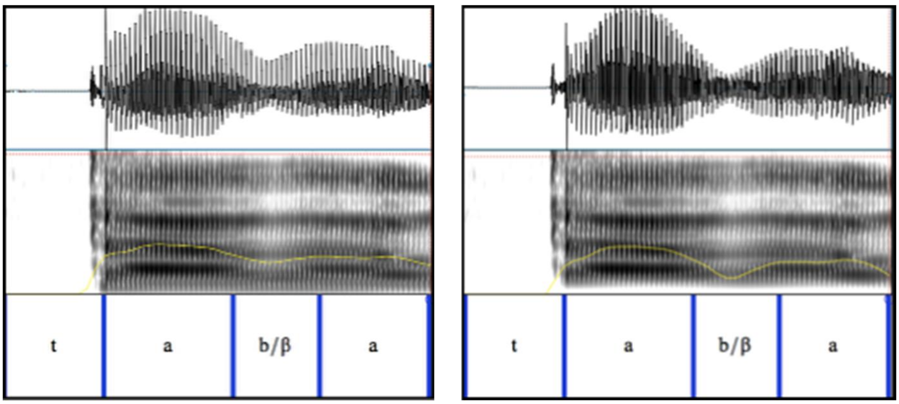

Figure 4: Approximant production in *taba*.

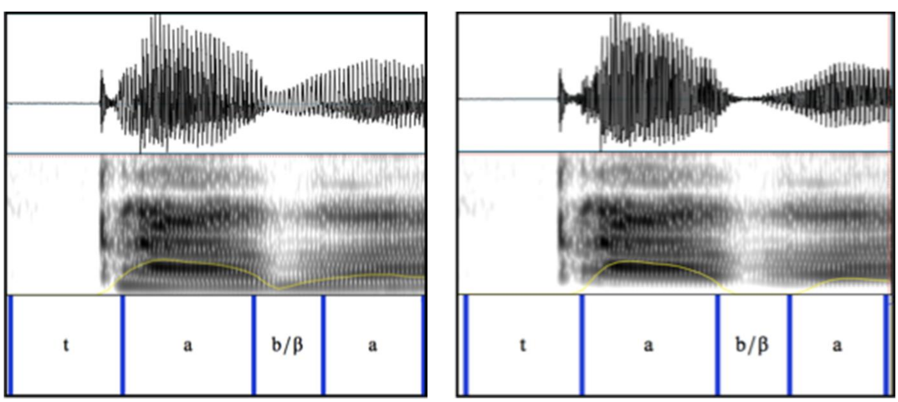

Figure 5: Stop production in *taba*.

5.1. Degree of intervocalic stop occlusion in Polish, Spanish and English

As mentioned before, Spanish possesses intervocalic spirantization, whereas Polish and English do not. In order to measure CLI of L2 Spanish and L3 English on L1 Polish in such a configuration and in such a phenomenon, the degree of intervocalic stop occlusion will be measured. Cmin, Vmax, IntDiff and IntRatio for Polish, Spanish and English are presented in Table 1. These are mean values as produced by non-prototypical native speakers (Dziubalska-Kołaczyk, Weckwerth, 2012: 225) of each language. They are based on the results from the first three groups in the study and can be treated as reference values for these languages that allow the differences between the languages to be shown.

The values in Table 1 are provided without differentiation into place of articulation (POA). The mean results are taken from a total of 48 tokens. Polish has an IntDiff three times as high as Spanish and an IntRatio twice as high. Cmin is much lower, but also the intensity of the following vowel is lower. Although English has an intervocalic stop, as in Polish, the measurements of intensity are somewhat different than for the Polish stop. Both Cmin and Vmax values in English are lower than in Polish, which results in a similar IntDiff in the two languages. However, in English the Cmin is twice as low as in Polish, with only a minor difference in Vmax which contributes to a much higher IntRatio.

Language	Cmin	Vmax	IntDiff	IntRatio
Spanish	60.36	71.60	11.24	1.18
Polish	23.19	55.66	32.46	2.4
English	13.93	48.69	34.76	3.49

Table 1: The degree of intervocalic occlusion in Polish, Spanish and English.

The differences in the degree of occlusion for different POAs are demonstrated on the basis of IntDiff only. As shown in Table 2, the three languages do not manifest differences across POA in the degree of intervocalic stop occlusion.

	POA		
Language	bilabial	dental	velar
Spanish	11.64	11.08	11.02
Polish	34.67	33.14	30.07
English	31.61	29.53	33.16

Table 2: IntDiff for different POA in Polish, Spanish and English.

6. The study

6.1. Aim

The main aim of the study was to analyse CLI from foreign languages onto the L1. The influence was measured by means of the degree of intervocalic stop occlusion in all the languages in the repertoire of L1 Polish, L2 Spanish and L3

English multilinguals. L1 Polish is a language with no spirantization of intervocalic stops. However, the assumption is that if L1 Polish is under the influence of L2 Spanish in multilinguals the degree of occlusion of intervocalic stops may be lower in the otherwise non-spirantized context in L1 Polish.

It was assumed that L1 Polish would demonstrate some degree of influence from L2 Spanish rather than L3 English for three reasons. Firstly, some study results suggest that the L2, rather than the L3, is the dominant source of influence on the L1 (Sypiańska, 2016: 92; Sypiańska, 2017). Secondly, the present group of multilinguals know L2 Spanish better than the L3 English and use it more frequently. Finally, L1 Polish non-spirantized stops will be under the influence of L2 Spanish intervocalic spirantization, rather than L3 English non-spirantized stops, because of perceived proximity between Spanish and Polish by Poles in general and by the study participants in particular.

The measurements included the minimum intensity of the consonant (Cmin), maximum intensity of the following vowel (Vmax) and measures of spirantization that rely on the previous two: IntDiff and IntRatio. Spirants have smaller IntDiff and IntRatios, whereas stop productions have greater IntDiff and IntRatios. All in all, four measurements were obtained: Cmin, Vmax, IntDiff and IntRatio.

Another aim of the study was to determine which measure of the degree of intervocalic stop occlusion, Cmin, Vmax, IntDiff or IntRatio, was the most effective in showing the influence of L2 spirantization on L1 full stop production.

Once the influence of foreign languages on the L1 was ascertained, a final goal of the study was to determine whether there is a relationship between how well the speakers produced intervocalic spirants in L2 Spanish and the degree of influence of the L2 on the L1.

6.2. Research questions and hypotheses

The research questions that guided this study were the following:

- Is CLI from foreign languages on the L1 visible in the degree of intervocalic stop occlusion?
- Does CLI on the L1 come from the L2 or the L3 or both?
- How do the measures of the degree of intervocalic stop occlusion (Cmin, Vmax) and spirantization (IntDiff, IntRatio) capture this CLI?

The hypotheses that were put forward are the following:

1. CLI from the L2 on the L1 will take place in the form of lower degree of occlusion in intervocalic L1 Polish stops due to spirantization of intervocalic stops in L2 Spanish. In L1 Polish, Cmin and Vmax will be higher, thus contributing to a lower IntDiff and IntRatio due to the influence of L2 Spanish.

2. The influence on L1 Polish from L3 English will be negligible due to the reasons described in 6.1. but if present it will be noticeable in the form of decreased Cmin and Vmax and increased IntDiff and IntRatio.
3. IntDiff and IntRatio should be the best measures of CLI on the L1 manifested in the form of spirantization in the L1. These are measures that have been shown to capture spirantization in the L2 thus should be applicable to the L1 as well. In case CLI is noticeable though small, it is hypothesized that Cmin alone may be able to capture CLI in the L1 which IntDiff and IntRatio being more complex calculations may be unable to tap into. Vmax, on the other hand, is vowel-specific (e.g. Fairbanks, House, Stevens, 1950: 457) and is not directly linked with the process of spirantization, thus it should not be affected by CLI. What is more. the tokens only include low central vowels, hence no influence of the type of vowel on the extent of Vmax is expected.

If CLI from the L2 on the L1 is established the following research question will be addressed:

- Is the influence on L1 Polish based on how well the speakers master spirantization in L2 Spanish?

This question stems from the predictions of the Activation Threshold Hypothesis (ATH) (Paradis, 2004). According to the ATH, each "item" (p.28) or aspect of language has its activation threshold in the form of a particular number of neural impulses that are needed to activate the item. Thus, with greater frequency of activation, the threshold is lowered. However, there is a consequence of a lowered activation threshold of one item because "its competitors are simultaneously inhibited" (p.28) resulting in raised activation thresholds. Originally constructed for bilingualism, the ATH is applicable to multilingualism as well. The activation threshold refers both to a particular language as well as to a particular aspect of language. In the present case L3 English has the lowest frequency of use and so the intervocalic stop with a greater occlusion should have a very high activation threshold. L1 Polish, as the language of the surrounding environment with the highest frequency of use, should have a low activation threshold. However, since L2 Spanish is used very frequently, in fact on a daily basis, the number of activations of the intervocalic spirant increases, thus lowering its threshold and raising the threshold for the plosive variant. This will effect CLI from L2 Spanish on L1 Polish by means of reducing the occlusion of intervocalic stops in L1 Polish. What is more, it is foreseen that the better the speakers are at producing the spirant in L2 Spanish, the more CLI on the L1 is to be expected.

Furthermore, if the lowered activation of the L2 Spanish spirant indeed increases the activation threshold for the L1 Polish plosive variant, then the L2 pronunciation should have a smaller degree of occlusion than this sound in the same context in the L1. In other words, the precondition for such influence on the L1 is the mastery of spirantization in the L2. Hence the question whether, in congruence with the predictions of the ATH, the influence on L1 Polish from L2 Spanish is based on how well the speakers master spirantization in the latter. Since there is no opposition of spirant versus stop, but rather a continuum of the degree of occlusion, no cut-off point for achieving mastery in L2 spirantization can be established. We can only speak of a relationship between the degree of occlusion in L2 Spanish and L1 Polish in a particular context which requires spirantization in the former and full occlusion in the later.

6.3. Research procedure and stimuli

Intervocalic tokens of /β̞,ð̞,ɣ/ in Spanish and /b,d,g/ in Polish and English unstressed syllable-onset positions were taken and were measured for degree of oral occlusion using the intensity curve in Praat version 5.3.77 (Boersma, Weenink, 2014). In Spanish, the tokens were obtained from the following contexts: /β/: *haba* 'broad bean', *taba* 'ankle bone'; /ð/: *hada* 'fairy', *cada* 'each'; /ɣ/: *haga* 'do' in the subjunctive, *paga* 'pay' in the subjunctive. In Polish, they were measured in: /b/: *żaba* 'frog', *baba* 'woman' colloquial; /d/: *rada* 'a piece of advice', *lada* 'counter'; /g/: *waga* 'weight', *zgaga* 'heartburn'. Finally, in English they were obtained from: /b/: rubber, cupboard /d/: ladder, sadder /g/: dagger, bugger (vulgar, slang). In all three languages the preceding sound was a low vowel as it was found to be conducive to greater spirantization of the consonant, at least in the /dV/ context (Hualde et al., 2010). The participants were asked to read out loud the words in carrier sentences. For Spanish the carrier sentence was: Digo ___ otra vez; for Polish: Mówię ___ jeszcze raz; for English: I say ___ once again. The stimuli are available in Appendix 1. The recordings were carried out in a sound-treated room. Cmin, Vmax and then IntDiff and IntRatio were measured as described in point 4.

6.4. Participants

The participants were divided into four groups. Each of the first three groups consisted of 12 native speakers of respectively L1 Polish, L1 Spanish and L1 English. The speakers of the first two groups had had instruction in English as a foreign language in school but were unable to produce the language. They did not use English or any other foreign language at work or for any other purposes. The speakers in the third group had had instruction in French as a foreign language but were unable to produce the language. They did not use French or any other foreign language at work or for any other purposes. All speakers had only resided in their countries of origin where their L1 was spoken. The purpose of choosing speakers who had minimal skills in a foreign language was to obtain speech that was minimally affected by other languages and from speakers who in traditional terminology might be referred to as monolingual. The author of the present contribution is of the opinion that monolingual speech is not obtainable as the vast majority of populations under investigation for this paper have had some contact with foreign languages. However, it is possible to analyse speech with minimal cross-linguistic influence of other languages that may serve as a reference value.

The fourth group consisted of L1 Polish, L2 Spanish and L3 English multilinguals who knew and used all three languages, though to different degrees. They were 2nd and 3rd year students of Spanish philology at Adam Mickiewicz University in Poznań and they had 14 Spanish classes sessions of 45 minutes per week. They also had two 45 minutes classes of English per week. All in all, they used L2 Spanish more often than L3 English. According to the syllabus for the 2nd and 3rd year of Spanish philology at the university they were at the level of C1 according to the Common European Framework of Reference (CEFR) in their L2 Spanish and at the level of B1 in their L3 English. Their mean age was 22. There were 5 males and 20 females. Detailed biodata of the participants is given in Appendix 2.

6.5. Results

The first research question addressed in the results is whether CLI from foreign languages on the L1 is visible in the degree of intervocalic stop occlusion. In order to answer this question mean results of Cmin, Vmax, IntDiff and IntRatio for the L1 Polish of the group under study compared to the controls are presented (Table 3). L1 Polish displays higher Cmin and Vmax and lower IntRatio. There is no difference in IntDiff as both components of IntDiff increased. The bilabial sound seems to be influenced the most, especially in Cmin and Vmax. For the bilabial sound Cmin increased by approximately 11dB compared to approximately 6dB for Cmin of the dental and velar sound. Vmax of the bilabial sound increased by approximately 10dB in comparison to approximately 4dB for the dental sound and approximately 7dB for the velar sound. The dental sound was affected the least.

	Bilabial	Cmin	Vmax	Intdif	IntRatio
Research group Control group		30.54 19.71	63.99 54.38	33.44 34.67	2.23 2.75
	Dental	Cmin	Vmax	Intdif	IntRatio
Research group Control group		30.18 24.08	61.3 57.22	31.12 33.14	2.23 2.37
	Velar	Cmin	Vmax	Intdif	IntRatio
Research group Control group		30.85 25.38	62.02 55.45	31.17 30.07	2.1 2.31

Table 3: Means report for Cmin, Vmax, IntDiff and IntRatio for L1 Polish compared to controls.

In order to investigate the statistical significance of these differences, one-way between groups (research, control) ANOVAs were run for each dependent variable (Cmin, Vmax, IntDiff and IntRatio). The results are presented in Table 4.

The F value reached statistical significance for Cmin (p=0.00279), Vmax (p=0.00006) and IntRatio (p=0.026) for the bilabial sound. The F value shows statistical significance only for Vmax (p=0.04535) of the dental sound. When it comes to the velar sound, both Cmin and Vmax were statistically significant (p=0.03753 and p=0.00122 respectively). None of the results for IntDiff reached statistical significance.

Bilabial					
ANOVA	d.f.	SS	MS	F	p-value
Cmin	1	556.81786	556.81786	9.41771	0.00279
Vmax	1	437.75033	437.75033	17.66301	0.00006
IntDiff	1	7.15297	7.15297	0.08614	0.76978
IntRatio	1	1.96948	1.96948	5.11327	0.026
Dental					
ANOVA	d.f.	SS	MS	F	p-value
Cmin	1	176.73117	176.73117	3.56155	0.06222
Vmax	1	79.23055	79.23055	4.11446	0.04535
IntDiff	1	19.29734	19.29734	0.37043	0.54424
IntRatio	1	0.36054	0.36054	1.66626	0.19993
Velar					
ANOVA	d.f.	SS	MS	F	p-value
Cmin	1	168.96618	168.96618	4.44596	0.03753
Vmax	1	243.09539	243.09539	11.09025	0.00122
IntDiff	1	6.7227	6.7227	0.14358	0.70557
IntRatio	1	0.24835	0.24835	0.96821	0.32755

Table 4: One-way ANOVA results.

The second research question was whether CLI on the L1 comes from the L2 or the L3. In order to answer the question L1 Polish was compared to

L2 Spanish and L3 English. Table 5 presents the means of Cmin, Vmax, IntDiff and IntRatio of L1 Polish, L2 Spanish and L3 English. These are compared to the control group which are given in the brackets.

As already established, Cmin and Vmax were higher in L1 Polish compared to the controls (Table 3 and 4). Also IntRatio was significantly lower, though only for bilabial sound. In L2 Spanish Cmin and Vmax were lower and IntDiff and IntRatio were higher than the Spanish control for all three sounds in question. In L2 Spanish both Cmin and Vmax were even greater and IntDiff and IntRatio were lower than those of L1 Polish (Table 5) which is an indication that the participants did make some spirantization of the sounds in L2 Spanish even if the amount of spirantization did not reach the level noticed for the controls (Table 1 and 2). This indicates that the influence on the L1 came from L2 Spanish rather than L3 English.

L3 English did not seem to influence the L1. Cmin and Vmax were higher and IntDiff and IntRatio lower in the L1, whereas the influence from the L3 would have to manifest itself in lowering the former and increasing the latter values in the L1.

	Cmin		
	Bilabial	Dental/Alveolar	Velar
English	28.78 ()	38.65 (29.53)	32.17 (33.16)
Polish	30.73 (19.7)	31.33 (24.07)	31.04 (25.37)
Spanish	41.41 (60.59)	42.05 (59.23)	39.03 (62.16)
	Vmax		
	Bilabial	Dental/Alveolar	Velar
English	58.26	59.44	59.44
Polish	65.32 (54.38)	62.45 (57.21)	62.45 (55.45)
Spanish	64.32 (72.75)	62.54 (70.34)	62.54 (71.83)
	IntDiff		
	Bilabial	Dental/Alveolar	Velar
English	29.47 (31.61)	20.66 (29.53)	27.27 (33.16)
Polish	34.6 (34.67)	30.82 (33.14)	31.41 (30.07)
Spanish	22.91 (12.16)	22.6 (11.10)	23.51 (9.67)
	IntRatio		
	Bilabial	Dental/Alveolar	Velar
English	2.16	1.65	1.95
Polish	2.34 (2.87)	2.08 (2.44)	2.11 (2.3)
Spanish	1.79 (1.01)	1.64 (1.18)	1.71 (0.86)

Table 5: Means report for L1 Polish, L2 Spanish and L3 English.

The third research question pertained to the effectiveness of the measures utilized in the study in capturing the CLI observable in the degree of intervocalic stop occlusion. As shown in Table 4, the differences between the research and the control groups were mostly visible in Vmax as it reached statistical significance for all three sounds. Differences in Cmin reached statistical significance for two out of the three sounds (bilabial and velar). However, Cmin for the dental sound was close to statistical significance (p=0.06222). IntRatio only reached statistical significance for the bilabial sound, whereas IntDiff was not statistically different for any of the sounds which means that it did not allow the differences between the two groups to be captured.

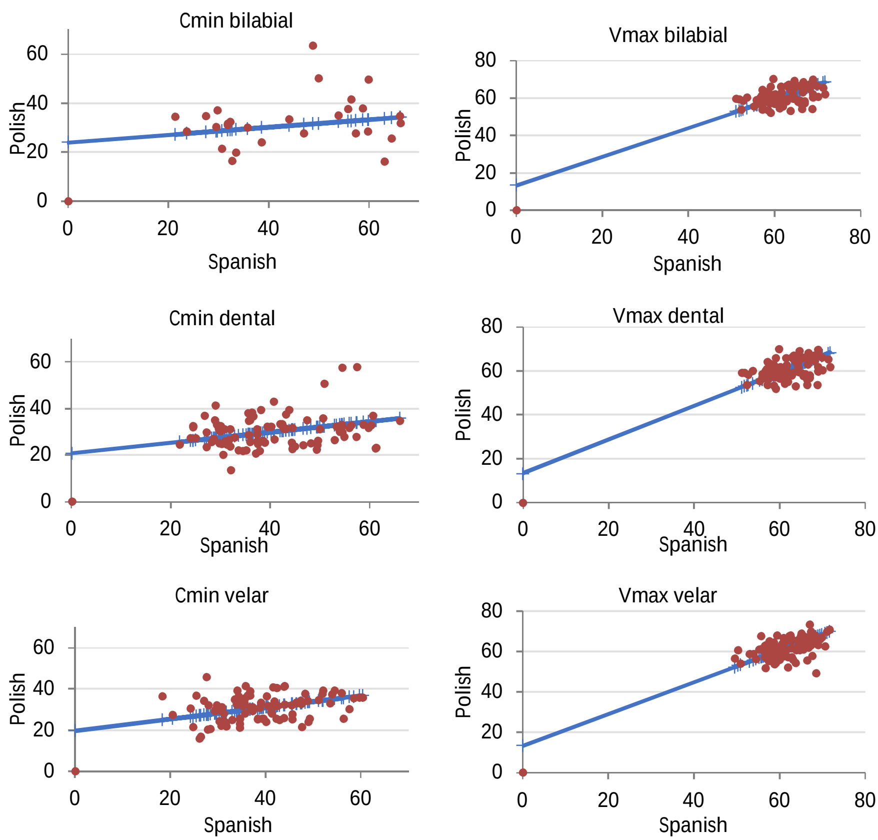

Figure 6: Regression lines for Cmin and Vmax.

Since CLI from L2 on the L1 has been established, the research question regarding the relationship between how well the speakers master spirantization in L2 Spanish and the amount of influence in L1 Polish will now be addressed. To analyse this relationship, simple linear regressions were calculated to predict L1 Polish Cmin and Vmax based on L2 Spanish Cmin and Vmax for each sound separately. IntDiff and IntRatio were not taken into consideration because they did not allow the influence of L2 Spanish on L1 Polish to be captured by differentiating the research group from the control group. Significant regression equations (Fig.6) were found for both Cmin and Vmax in all three sounds (Fig.1). The weakest relationship was obtained for Cmin of the bilabial sound F(1.92)= 6.4815, p<.05, with an $R^2 = 0.0658$. This was followed by F(1.92)= 12.0319, p<.00, with an $R^2 = 0.1179$ for Cmin of the dental sound and F(1.92)= 19.7249, p<.00, with an $R^2 = 0.1749$ for Cmin of the velar sound A much stronger relationship was observed in the regression equations for Vmax starting with F(1.92)= 157.8516, p<.00, with an $R^2 = 0.6317$ for Vmax of the bilabial sound followed by F(1.92)= 154.6331, p<.00, with an $R^2 = 0.6321$ for Vmax of the dental sound and F(1.92)= 164.8129, p<.00, with an $R^2 = 0.6392$ for Vmax of the velar sound.

6.6. Discussion

The first hypothesis was that CLI from the L2 on the L1 would take place in the form of lower degree of occlusion in intervocalic L1 Polish stops due to spirantization of intervocalic stops in L2 Spanish. In L1 Polish, Cmin and Vmax were predicted to be higher, thus contributing to a lower IntDiff and IntRatio due to the influence of L2 Spanish. This hypothesis was partly confirmed as Vmax and Cmin were both higher. However, they increased proportionately, so the resulting IntDiff remained at a similar level when compared to the control group. IntRatio was only lower for the bilabial sound.

The results show that CLI from the L2 on the L1 was visible in the form of a lower degree of occlusion in intervocalic L1 Polish stops due to the spirantization of intervocalic stops in L2 Spanish. However, this influence was captured by the basic intensity measures of Cmin and Vmax, rather than the derivative measures of IntDiff and IntRatio. It was expected that out of the two basic measures, Cmin and Vmax, only Cmin would be affected, as the intensity of the consonant is directly linked with the degree of occlusion. Vmax is a language-specific value and is not directly connected with the process of spirantization, however it still was affected. Due to the fact that both Cmin and Vmax increased proportionately, the calculations of IntDiff and IntRatio did not change significantly.

The second hypothesis was that the influence on L1 Polish from L3 English would be negligible due to the reasons described in 6.1. but if present would be noticeable in the form of decreased Cmin and Vmax and increased IntDiff and IntRatio. The hypothesis was confirmed, as the L1 manifested overwhelming influence from the L2, rather than L3. Both Cmin and Vmax increased, making the stop more similar to the values of L2 Spanish. Even if IntDiff and IntRatio did not reach statistical significance for all sounds, they did decrease towards the values for Spanish, rather than increase towards the values for English.

The third hypothesis referred to the effectiveness of the measures employed in the study. It was hypothesized that IntDiff and IntRatio should be the best measures of CLI on the L1 manifested in the intervocalic stop occlusion in the L1. Cmin was predicted to be able to capture CLI in the L1 if IntDiff and IntRatio, which are more complex calculations, was unable to measure it. Vmax was treated as a language-specific feature that is only indirectly linked with the degree of spirantization, thus should not in itself be useful in measuring the extent of the occlusion. The results, however, show the exact opposite tendency. Vmax was the most effective way to differentiate between the research and the control groups. The one-way ANOVA showed a steady difference for all three sounds in Vmax. Cmin was the second-best measure of CLI observable in the degree of occlusion. It constituted a statistically significant difference between the research and the control group for the bilabial and velar sounds and nearly so for the dental sound (p=0.06222). IntRatio was only useful in differentiating between the two groups when it came to the bilabial sound. This was probably due to the fact that the bilabial sound manifested on the whole the smallest degree of occlusion. Finally, IntDiff, as a measure of the degree of spirantization, was ineffective. This may be attributed to the fact that Cmin and Vmax increased proportionately in the L1. Thus the relation between the two measures remained unchanged.

Since CLI from the L2 on the L1 has been established, it is now possible to discuss the last hypothesis. Its prediction, stemming from the ATH, was that as a consequence of using L2 Spanish on a daily basis, the number of activations of the intervocalic spirant would increase, thus lowering its threshold and raising the threshold for the plosive variant. It was foreseen that the better the speakers are at producing the spirant in L2 Spanish, the more CLI on the L1 is to be expected. The precondition for such influence on the L1 is the mastery of spirantization in the L2. It was also stated that since there is no opposition of spirant versus stop, but rather a continuum of the degree of occlusion, no cut-off point for achieving mastery in L2 spirantization can be established. We can only talk about a relationship between the degree of occlusion in L2 Spanish and L1 Polish in the particular context which requires spirantization in the former and full occlusion in the latter.

The results show that the research group did not reach the degree of spirantization in L2 Spanish observed for Spanish native speakers in the control group. In L2 Spanish, mean Cmin was approximately 20dB lower for all three sounds, mean Vmax lower approximately 7 to 10dB, IntDiff was higher by approximately 10 to 14dB and, finally, IntRatio was lower by 0.50dB. However, these values were still very different from L1 Polish. Cmin and Vmax were higher and IntDiff and IntRatio were lower in L2 Spanish than in L1 Polish. This is an indication of a greater degree of spirantization in L2 Spanish than L1 Polish among the research group. Since there is a greater degree of spirantization in L2 Spanish than L1 Polish the precondition for the influence of the mastery of spirantization in the L2 on the L1 is met, even if mastery in this case did not entail production of spirantization at a native level of proficiency.

Results from the regression analysis provided full support for the last hypothesis. Both Cmin and Vmax in L1 Polish were significantly influenced by, respectively, Cmin and Vmax in L2 Spanish. A stronger relationship was observed for Vmax than for Cmin. There was a tendency for greater statistical significance for backer sounds. All in all, it may be concluded that the better the speakers were at producing intervocalic spirants in the L2, the less occlusion was produced in intervocalic stops in their L1.

7. Conclusions

The aim of this paper was to show CLI from foreign languages onto the L1. The influence was measured by means of the degree of intervocalic stop occlusion in all the languages in the repertoire of a group of L1 Polish, L2 Spanish and L3 English multilinguals. L1 Polish as a language with no systemic spirantization of intervocalic stops was predicted to be influenced by L2 Spanish spirantization. The influence was expected in the relative intensity of the consonant and the following vowel including Cmin, Vmax, IntDiff and IntRatio. Only influence from the L2 was foreseen, as the L3 has been shown to be a negligible source of impact on the L1 in previous studies. A final aim was to investigate whether the extent of the influence on the native language is attributable to the degree of mastery of spirantization in the L2.

The results indicate that L1 Polish is under the influence of L2 Spanish in L1 Polish, L2 Spanish and L3 English multilinguals. Mean values of intensity including Cmin and Vmax amplified, suggesting a smaller degree of occlusion for the bilabial, dental and velar stops in L1 Polish in the research group. IntDiff and IntRatio remained mostly unaffected as their components, Cmin and Vmax, increased proportionately, thus maintaining the same difference and similar ratio.

As predicted, L3 did not constitute a significant source of influence on the L1. Both Cmin and Vmax in L1 Polish increased, making it more similar to the values from L2 Spanish, rather than L3 English. Even if IntDiff and IntRatio did not reach statistical significance for all sounds, they did decrease towards the values for Spanish, rather than increase towards the values for English.

The measurements employed in the study were not equally effective in capturing CLI from the L2 on the L1. The basic measurements of Vmax and Cmin significantly differentiated between the research group and the control group. However, contrary to predictions, the derivative measurements of IntDiff and IntRatio did not.

Although the research group did not reach the degree of spirantization in L2 Spanish observed for Spanish native speakers in the control group, they still produced a much smaller degree of occlusion in their L2 than the L1. This is why it was possible to investigate whether there is a relationship between the extent of spirantization in the L2 and the extent of the influence of the L2 on the degree of intervocalic occlusion in the L1. The final conclusion is that the better the speakers were at producing intervocalic spirants in L2 Spanish, the less occlusion was produced in intervocalic stops in L1 Polish.

The results of the study inform cross-linguistic research in multilinguals, as they show a particular instance of influence on the L1 that stems from a second language which is more frequently used and at a higher level of proficiency than the L3. It also informs L1 drift research by demonstrating the relationship between the mastery of an L2 element and the amount of influence on the L1.

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Appendix 1

Stimuli

Spanish	Polish	English
/β/: *haba*, *taba*	/b/: *żaba*, *baba*	/b/: rubber, cupboard
/ð/: *hada*, *cada*	/d/: *rada*, *lada*	/d/: ladder, sadder
/ɣ/: *haga*, *paga*	/g/: *waga*, *zgaga*	/g/: dagger, bugger

Appendix 2

Participant biodata

No.	Age	Group	Sex	L2 LoP	L3 LoP	L2AoA	L3AoA
1	20	1	f	C1	B1	15	4
2	20	1	f	C1	B1	13	4
3	22	2	m	C1	B1	10	18
4	19	1	f	C1	B1	13	7
5	21	1	f	C1	B1	12	7
6	20	1	m	C1	B1	16	7
7	20	1	f	C1	B1	16	7
8	20	2	m	C1	B1	8	20
9	24	2	f	C1	B1	13	20
10	23	1	f	C1	B1	19	15
11	22	1	f	C1	B1	16	8
12	23	1	f	C1	B1	16	7
13	23	2	f	C1	B1	6	16
14	21	2	f	C1	B1	6	18
15	23	2	f	C1	B1	7	19
16	24	1	m	C1	B1	10	18
17	23	1	m	C1	B1	14	10
18	22	1	f	C1	B1	3	3
19	21	1	f	C1	B1	16	10
20	25	2	f	C1	B1	10	16
21	22	1	f	C1	B1	15	9
22	23	1	f	C1	B1	20	11
23	23	2	f	C1	B1	9	16
24	24	2	f	C1	B1	6	16
25	24	1	f	C1	B1	16	7