# L2-INDUCED PHONETIC DRIFT IN L1 POLISH VOWEL PRODUCTIONS

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## ABSTRACT

An acoustic study sought to investigate the effects of intensive phonetic instruction in L2 English on L1 Polish productions of vowels /ɛ/ and /a/ in order to attest possible effects of L2-induced phonetic drift. The data from first year students of the English programme who took part in a longitudinal experiment were compared with comparison groups from second and third years as well as a group of monolinguals.

The results showed some lowering of both /ɛ/ and /a/ as training progressed, peaking in the productions of second year students. Some fronting was found in /ɛ/ but no effects on the advancement of /a/ were observed. Overall, the Polish vowels appeared to move towards more peripheral positions, possibly to accommodate the new L2 categories being acquired in the common phonological space.

**Keywords**: phonetic drift, Polish, vowels, Speech Learning Model, speech production

## 1. INTRODUCTION

The effects that one's native language (L1) can exert on the pronunciation in one's second language (L2) have been studied quite thoroughly. The opposite, however, that is the influence that L2 may have on the native productions has only been brought to the forefront of attention in the last decade or so, beginning with a series of studies authored by Charles B. Chang [1]. He coined the term *phonetic drift* to refer to short-term changes in the acoustics of L1 resulting from recent exposure to L2. Ever since then, more and more language pairs have been investigated, with the purpose of learning which acoustic parameters, and to what extent, are subject to drift.

As a result, L2-induced drift in L1 has been attested in both production and perception. Production experiments on consonantal drift have focused on parameters such as VOT (e.g., [2], [3]), pitch at vowel onset [2], and F1 and F2 values of vowel segments [4]. In turn, perception studies looked mostly at perceptual shifts (e.g., [5], [6]), and reaction times [7].

Furthermore, studies have shown that phonetic drift can be expected in both L2-immersion (e.g., [8], [9]) and L1-dominant (e.g., [10], [11]) settings, and in both novice [2] and proficient [12] learners.

In general, the effects of learning L2 on L1 Polish productions remain understudied. The few existing studies have investigated the effects of multilingualism, rather than bilingualism, on L1 [13], [14]. To date, only two studies ensured that no possibly confounding effects of Ln were present in their data [15], [16], and those focused on stop consonant productions. The present experiment sought to fill the research gap with regards to the effects on learning L2 English on L1 Polish vowels – to establish whether they would be attested in this language pair.

## 2. PREVIOUS STUDIES ON VOCALIC DRIFT IN L1

The overview of selected previous studies on vocalic drift can be divided into two parts, depending on the context of L2 acquisition.

Beginning with L2-immersion environment, [2] investigated the productions of 19 American English speakers enrolled in a language course in South Korea (i.e. novice learners of Korean). While the differences were subtle, English vowels were found to drift to approximate Korean norms, with respect to vowel height and but not advancement. Moreover, the drift effects were observed to be systemic, thus targeting the entire vocalic inventory rather than individual segments. [13] studied the vowel productions of 32 Japanese-English bilinguals (16 adults and 16 children) living in Texas, USA for a year and compared them with a control group of monolingual English speakers from the same area. By means of a picture naming task the authors obtained acoustic data which showed that while no changes over time were detected in the adult learners' production of Japanese vowels, Japanese children showed drift effects for the vowels /i/ and /a/. Importantly, it was the group of the children that improved most in their L2 productions, while no changes in the adults' productions of English vowels between the two testing times were found. This suggests that the broader the experience in the L2, the more salient its influence on the L1.

In L1-dominant settings, [17] studied the productions of Catalan-Spanish bilinguals and the extent to which extensive exposure to L2 Spanish (in particular its one vowel /e/) influences the correct realisation of the Catalan /e/-/ɛ/ contrast. The authors observed that the group of speakers with high weekly usage of Catalan produced the difference between this particular vowel pair more robustly (in minimal pairs, cognates, and non-cognates alike) than the speakers with higher degree of exposure to Spanish and lower weekly usage of Catalan. Therefore, greater experience in Spanish contributed to more noticeable changes in L1 Catalan production. [18] compared early, mid, and late Quichua-Spanish bilinguals and the effects of Spanish vowels on their L1 Quichua /i, a, u/. The results of a delayed repetition task revealed that the speakers who successfully acquired L2 vowels showed more noticeable drift effects in vowel height. [19] additionally looked at whether articulatory training in L2 has any effects on L1 vowel production. In order to do so, 20 monolingual L1 French speakers were trained on two non-native vowels: Danish /ɔ/ and Russian /ɨ/. Even brief phonetic training on novice learners triggered the occurrence of phonetic drift in L1 vowel formants.

## 3. METHOD

### 3.1. Materials

Polish is a language with a relatively small vocalic inventory: /a, ɛ, i, ɨ, ɔ, u/, in contrast to a relatively rich vowel system in English. The Polish word list consisted of 121 words in total, out of which 54 were included in the analysis with the rest of them being fillers. The /b, d, g/ and /p, t, k/ items were mono- and di-syllabic words, followed by vowels [a, ɛ, ɔ]. The dataset included 17 labial, 19 coronal, and 18 velar onsets. 29 of them were voiceless while 25 of them voiced. With a total of 65 speakers (out of whom 20 were recorded three times), a database of 5670 Polish recorded items was comprised. In this paper we focus on the words where the voiced and voiceless plosives were followed by the unrounded vowels /ɛ/ and /a/.

### 3.2. Participants

The participants that have taken part in the present study can be divided into two major groups: the main group of students taking part in the longitudinal study (henceforth 1BA[1]; N=20) and the comparison group, comprising three smaller subgroups: second year students (=2BA, N=15), third year students (=3BA, N=15), as well as Polish “quasi-monolinguals” (N=15). The choice of the population of Polish English majors is by no means accidental. Their motivation to acquire native-like proficiency in English is assumed to be high – they are studying to use English professionally at work, be it teaching, translation, or other endeavours.

The group of students were subject to intensive phonetic training over the course of their studies. 1BA students were taking part in practical phonetics classes (3hrs per week; mostly drilling exercises devised to master all segments of British/American English, taught by trained in phonetics Polish teachers) and theoretical courses in English phonetics and phonology (2hrs per week). Prior to their enrolment in the English programme, they had never had any experience with pronunciation training.

2BA students, having undergone 1BA courses, were enrolled in practical phonetics classes in their second year (1.5hrs per week), where they were trained on phonostylistics and intonation.

3BA students have attended all 1BA and 2BA phonetics courses, but while still taking courses in English in their third year, they were no longer being actively trained in pronunciation.

Polish “quasi-monolinguals” comprised speakers who do have a history of learning foreign languages in school, but they claim not to be fluent in any of them, at least as far as production is concerned. They could, then, be described as “functional monolinguals” [20].

Proficiency in any other language was ruled out on the basis of a language background questionnaire administered in all of the groups.

### 3.3. Procedure, acoustic measures, and statistical analysis

1BA students were the only that have participated in the longitudinal experiment. They were tested three times during the first year of their university education. The sessions were held in October (henceforth T1), February (=T2), and June (=T3). The first batch of recordings was made within the first two weeks of October. Therefore, it can be assumed that the session was held early enough for the effects of phonetic training not to have affected the students’ productions yet. The second session was held in February, during the winter exam session, while the third took place in the last two weeks of June, right before the summer exam session, therefore towards the end of the first, second, and third year of studies for 1BA, 2BA, and 3BA, respectively.

The recordings were made in a sound-attenuated booth at a Polish university, directly onto laptop, using a condenser microphone and a USB interface. The words were shown to the participants on a

[1] “BA” refers to the programme in which the students were enrolled as they studied to obtain their Bachelor of Arts degree.

monitor via PowerPoint slides in a pseudo-randomised order (the same for each participant), with the pace controlled by the researcher sitting in another room.

In the case of the monolingual group, the recordings were made in a quiet classroom in the private language school which they were attending. They were recorded directly onto laptop, using a head-mounted microphone and a USB interface.

As far as the acoustic measurements go, the vowel was measured in Praat [21] from the onset of voicing associated with vowel production (thus, excluding burst and release noise) until the point in which F2 and F3 were no longer visible. Using a Praat script, the mean values of F1 (difference between F1- $f_0$; Bark normalised) and F2 (difference between F3-F2; Bark normalised) from the middle 20% of the vowel were taken to be included in the analysis.

The Bark difference measures used in the Syrdal and Gopal [22] normalisation method have been found to better reflect the auditory properties of phonological categories associated with vowels, such as height and backness, than raw values of single formants [23], [24]. While Syrdal and Gopal's normalisation has been observed to be slightly less successful than vowel-extrinsic methods in classification studies dealing with sociolinguistic variation, the present study does not focus on speech categorisation. For the purposes of the current experiment, the Bark-difference normalisation method allows us to control for speaker-dependent differences, while yielding a single-measure suitable for cross-speaker comparison.

The statistical analysis was run in SPSS [25]. Two Generalised Linear Mixed Models were built, one with F1 (F1- $f_0$) and the other with F2 (F3-F2) as the dependent variables. In both models, the main interaction of interest was Vowel*[Recording]Session. Speaker and Item were included as random factors. The results below show pairwise comparisons provided by the model.

### 3.4. Results

In total, 4179 tokens were analysed, out of which /ɛ/ comprised 990 items and /a/ – 3189 items. In what follows, we will discuss each vowel individually.

#### *3.4.1. Vowel height*

Let us begin with the higher of the two vowels, that is /ɛ/. Out of the 990 obtained productions, Group 1 provided 584 items (194 at T1: *M*=4.5 Bark, *SD*=.55; 196 at T2: *M*=4.57 Bark, *SD*=.62; and 194 at T3: *M*=4.74 Bark, *SD*=.62), Group 2 – 147 items: *M*=4.85, *SD*=.59; Group 3 – 144: *M*=4.70 Bark, *SD*=.48; while Group 4 – 115: *M*=4.47 Bark, *SD*=.64.

The changes in the height of the vowel /ɛ/ are visualised in the line graph in Fig. 1. The *y* axis has been reversed for the differences with respect to height to be clearer.

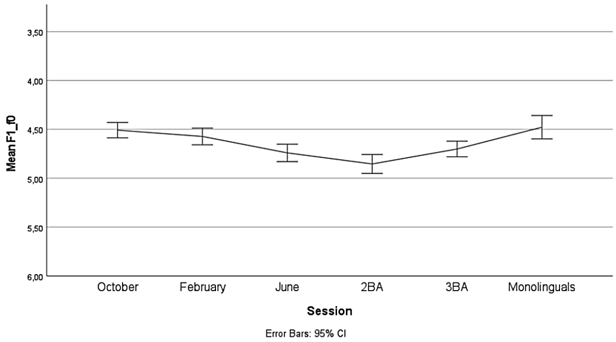


**Figure 1**: Mean F1 (F1-$f_0$; Bark normalised) values of the vowel /ɛ/ sorted for Group/Session.

While the differences are very small, we can observe some lowering taking place, with the F1-$f_0$ difference getting bigger, over the course of the phonetic instruction in L2. The analysis revealed that there was a significant difference in 1BA students between T1 and T3 (*B*=-.223; *t*=-4.487; *p*<.001) and T2 and T3 (*B*=-.164; *t*=-3.325; *p*=.001). T1 was also different from 2BA (*B*=-.324; *t*=-2.212; *p*=.027), while 2BA students differed from the monolingual controls (*B*=.368; *t*=2.323; *p*=.02). No other contrasts turned out to be significant. Therefore, the most visible effects of phonetic drift on the height of /ɛ/ were present in after eight months and two years of pronunciation instruction.

Now let us turn to the vowel /a/. Out of the 3189 obtained productions, Group 1 provided 1854 items (618 at T1: *M*=5.58 Bark, *SD*=.64; 612 at T2: *M*=5.75 Bark, *SD*=.65; and 624 at T3: *M*=5.88, *SD*=.57), Group 2 – 467 items: *M*=5.91 Bark, *SD*=.57; Group 3 – 468: *M*=5.58 Bark, *SD*=.61; while Group 4 – 400: *M*=5.36 Bark, *SD*=.75. Fig. 2. traces the changes in the mean height values of the vowel /a/ over time and compares them to the monolingual norms. Once again, the *y* axis has been inverted for ease of interpretation.

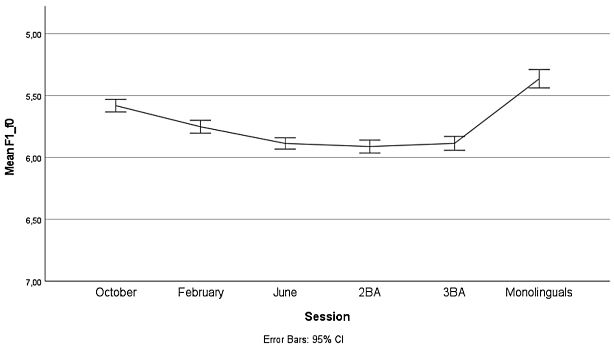


**Figure 2**: Mean F1 (F1-$f_0$; Bark normalised) values of the vowel /a/ sorted for Group/Session.

Again, as we can see the vowel appears to get progressively lower (with the F1-$f_0$ difference getting bigger) over the course of training.

In the case of first year students, the progressive lowering of /a/ turned out to be significant across all testing times: T1 vs. T2 (*B*=-.169; *t*=-6.051; *p*<.001), T2 vs. T3 (*B*=-.131; *t*=-4.707; *p*<.001), as well as T1 and T3 (*B*=-.299; *t*=-10.798; *p*=.000). 1BA students at T1 differed also from 2BA (*B*=-.3.22; *t*=-2.306; *p*=.021) and Group 3 (*B*=-.292; *t*=-2.084; *p*=.037). Additionally, aside from 1BA students at T1 (*B*=.232; *t*=1.654; *p*=.098), all groups were significantly different from the monolingual controls.

### 3.4.2. Vowel advancement

The mean values of vowel advancement for /ɛ/ presented themselves as follows. In 1BA productions, at T1: *M*=2.74 Bark, *SD*=.60; T2: *M*=2.61 Bark, *SD*=.63; T3=2.69 Bark, *SD*=.59. In 2BA: *M*=2.59 Bark, *SD*=.51, while in 3BA: *M*=2.41 Bark, *SD*=.69. The monolingual controls average was 3.00 Bark, *SD*=.60.

A visual representation of the changes with respect to the advancement of /ɛ/ is shown in Fig. 3 The *x* and *y* axes have been swapped for the reader to clearly see the changes in fronting across the groups.

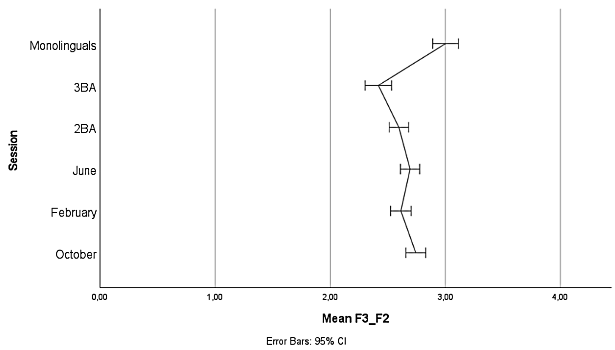


**Figure 3**: Mean F2 (F3-F2; Bark normalised) values of the vowel /ɛ/, sorted for Group/Session.

As can be observed, /ɛ/ appears to move towards more front realisations as the phonetic instruction progresses, peaking in the productions of 3BA.

The statistical analysis revealed that 1BA at T1 differed significantly from both 1BA at T2 (*B*=.126; *t*=2.042; *p*=.041) and 3BA (*B*=.331; *t*=1.981; *p*=.048). In turn the productions of the monolingual group were significantly less front than 1BA at T2 (*B*=-.384; *t*=-2.271; *p*=.023), and both 2BA (*B*=-.402; *t*=-2.228; *p*=.026) and 3BA (*B*=-.589; *t*=-3.261; *p*=.001). No other contrasts turned out to be significant.

Decidedly less variation was present in the central vowel /a/ (1BA T1: *M*=3.77 Bark, *SD*=.75; T2: *M*=3.80 Bark, *SD*=.82; T3: *M*=3.79 Bark, *SD*=.84; 2BA: *M*=3.81 Bark, *SD*=.81; Monolinguals: *M*=3.75, *SD*=.73). As can be seen, the differences in F3-F2 distance are very small in magnitude, indicating very little change in the advancement of /a/. This is illustrated also in Fig. 4. Once again, the *x* and *y* axes have been swapped to better illustrate the changes in fronting.

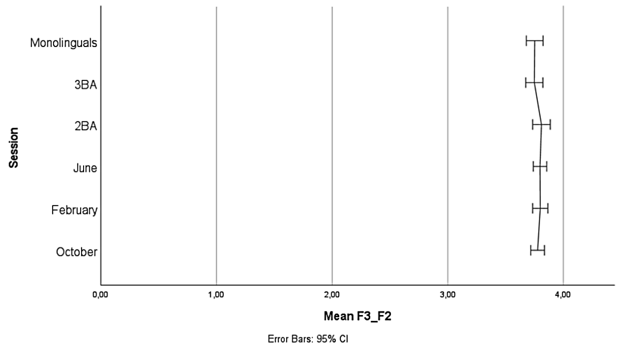


**Figure 4**: Mean F2 (F3-F2; Bark normalised) values of the vowel /a/, sorted for Group/Session.

The statistical analysis revealed no significant differences across groups for the advancement of /a/.

## 4. DISCUSSION

The present study sought to attest possible phonetic drift effects in the acoustics of vowels (namely vowel height and vowel advancement). Two non-high unrounded vowels were considered, that is /a/ and /ɛ/. While the differences were overall rather small, the results indicate that the quality of proficient Polish vowels was affected by phonetic training in L2 English, despite the fact that they were living in an L1-dominant environment. The effects were most striking productions of the students who were finishing their second year of phonetic instruction.

Both Polish vowels investigated here appeared to move towards more peripheral positions, which goes in line with the postulate of common phonological space, known from the Speech Learning Model (SLM) [26]. It claims that all L1 and L2 sounds co-exist, therefore the vowel space needs to be progressively expanded so that the new L2 categories being acquired can be accommodated. In Polish, this seems to be done by means of /ɛ/ fronting and the lowering of both vowels.

The results of the current experiment yield empirical support also to the SLM's assumption of the bi-directional interaction between the languages and the remark found in the revised version of the SLM [27] about how L1 categories are malleable across the lifespan of the user.

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