Research Article

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Production of voice onset time (VOT) by senior Polish learners of English

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Abstract: Although research on foreign language learning among seniors has recently accelerated, studies on L2 phonology in this age group remain scarce. Seniors may be at a great disadvantage when it comes to learning the sounds of a foreign language because age of onset has been shown to correlate negatively with ultimate attainment especially for phonology (Piske et al. 2001). However, this is all the more reason to attempt a better understanding of the mechanisms of senior. This paper offers an attempt at shedding light on how senior learners with an age of L2 onset above 60 produce voiced and voiceless L2 word-initial stops. Twenty L1 Polish senior learners of English were asked to read a list of words containing word-initial voiced and voiceless plosives in their L2 English at A2+/B1 level according to CEFR. The results show that the senior Polish learners of English produce an in-between category for the English stops (with VOT longer than for Polish, but shorter than native English). The senior learners also experienced L1 drift, but mostly in the voiceless L1 Polish stops.

Keywords: senior L2 learners, foreign language learning, L1 drift, L2 phonetics and phonology

1 Introduction

As societies age, seniors who retire have the means, health, vigour and need to stay active. Hence, the demand for classes targeted at senior learners is on the rise. That is why senior learners and lifelong learning have recently been brought into the limelight of foreign language learning research. One of the areas in senior foreign language learning that continues to be unexplored is research on L2 phonology. Assuming that age of onset correlates negatively with degree of accentedness in an L2 (e.g. Flege and Fletcher 1992; Flege et al. 1995; Moyer 1999; Piske et al. 2001), senior learners appear to be at a great disadvantage compared to children, but even younger adults when it comes to mastering the L2 sound system. Consequently, it is important to attempt a better understanding of the mechanisms of senior L2 phonology learning on the basis of which adequate learning programmes and materials can be designed.

This article is aimed at investigating whether and to what extent senior learners with age of onset at 60+ are able to produce L2 sounds. L1 Polish 60+ speakers were asked to read a list of words with word-initial voiced and voiceless plosives in their L2 English. Voice Onset Time (VOT) of the voiced and voiceless series was then measured and compared to the English baseline in the literature (Docherty 1992). The difference in the VOT parameter between Polish and English offers an opportunity for a measurable and reliable construct to analyse the possibility of seniors to produce an L2 sound characteristic that is different from their L1 counterpart. A further aim of the paper is to verify whether senior foreign language learners also experience the inherent part of foreign language learning, namely L1 drift.

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The paper is structured in the following way. The discussion begins with a description of how age of onset influences language learning with a particular focus on L2 sounds in Section 2. This is followed by a review of research on L1 drift and an elaboration on whether senior language learners of an L2 may also experience this phenomenon in Section 3. It then displays the research design in Section 4 and presents the results and discusses the findings with reference to literature on L2 phonology learning and L1 drift in Sections 5 and 6.

2 Senior learners of L2 phonology

There have been attempts to define senior citizens in terms of biological age (e.g. >65 by WHO and Eurostat, >60 by UN) or age of retirement in a given country. A more comprehensive classification is based on the way a person functions at a particular stage in their life. First age is reserved for education, second age for employment and third and fourth age for retirement (Moen 2011). The third age as opposed to the fourth age refers to those who no longer work but are still active and relatively healthy. "The golden age of adulthood" (Barnes 2011: 1) offers opportunities for development and activities which adults in the second stage simply may not have the time for. Many third age adults start learning a foreign language and in Poland, the foreign language of choice is typically English. These generations used to learn only Russian and/or German at school and had planned to start learning English as soon as they retired. Third age learners ≥60 are referred to as seniors or senior learners throughout this paper.

As for foreign language learning and the effects of the age of onset on pronunciation, we can find evidence suggesting that age of onset correlates negatively with the degree of accentedness in an L2 (e.g. Piske et al. 2001); also confirmed by studies on specific elements of pronunciation especially VOT durations and vowel quality (Flege 1991; Flege et al. 1997, 1999). In many such cases, age of onset coincides with age of arrival to the L2 country (e.g. Flege et al. 1999, 2003); thus it is agreed that an early start is beneficial in immersion settings. Already late learners defined as teenagers or late teenagers at learning onset tend to be at a disadvantage in terms of ultimate attainment when compared to early learners (Flege et al. 1999; Ioup 2008; Yeni-Komshian et al. 2000). There is some agreement that in lieu of a clear and replicable cut-off point at which a critical period for better results in language acquisition ends, "the degree of success in second-language acquisition steadily declines throughout the life span" (Hakuta et al. 2003: 37). It may also mean that a start in the sensitive period of early childhood is more likely to bring about positive effects, whereas a later start tends to have more variable results as far as attainment in the foreign language is concerned (Long 1990). When it comes to the sound system, some claim that if a critical period exists, then it may be reserved for phonology as it is the only language skill which requires "neuromotor involvement" (Scovel 1988: 101). Still, a gradual decrease in the ability to master an L2 is also supported by models for L2 phonological learning such as the Speech Learning Model (Flege 1995). Bearing in mind this general tendency coupled with a cognitive decline with age or even gradual loss of hearing, senior foreign language learners appear to have quite adverse circumstances for their language learning and probably for L2 phonology in particular (Green 2017).

On a more positive note, Pfenninger and Singleton (2019) stress that if late beginners may sometimes overcome their age-related disadvantages and reach native-like L2 proficiency even with respect to the sound system (e.g. Bongaerts et al. 1995, 1997; Muñoz and Singleton 2007), then this ability might as well be available for senior language learners. Second, many studies on learning in an L2 classroom setting do not confirm the negative correlation of age of onset with general accentedness or cross-linguistic influence in particular elements of phonetics observed in immersion settings (Fullana 2006; García Lecumberri and Gallardo 2003). As senior learners, at least those in Poland, mostly learn at foreign language courses or third age universities, they may be subject to tendencies observed across younger populations in classroom settings.

There is abundant research on the perception (e.g. Ingvalson et al. 2017; Shen et al. 2016) and production of native language differences, especially of different fundamental frequency patterns between 70+

year olds and younger adults (Awan and Mueller 1992; Markó and Bóna 2010; Nishio and Niimi 2008; Russel et al. 1995). More and more literature is also appearing on senior language learners (Gabryś-Barker 2017; Murray 2011; Ramírez-Gómez 2016); however, studies on how seniors acquire the L2 sound system remain scarce. Some evidence can be found for a worse understanding of accented speech in senior learners when compared to younger adults (e.g. Burda et al. 2003). Nonetheless, to the best of my knowledge, there are no studies on VOT durations of word-initial stops in senior learners of a foreign language. This paper is an attempt at looking into how senior learners of a foreign language with age of onset at 60+ produce VOT durations of word-initial voiced and voiceless stops in the L2 which are different from their native language.

3 L1 drift in phonetics

It has been clear for some time now that certain changes that take place in L1 pronunciation are an inherent part of foreign language learning and usage because cross-linguistic influence is bi- or even multidirectional (Chang 2019; Sypiańska 2016). Chang (2019) distinguishes between L1 drift which he defines as short-term L1 changes due to recent experience with the L2 and phonetic attrition that is a result of long-term in late onset L2 learners that "are unlikely to be due to recent L2 experience only" (2019: 192). Attrition has mostly been used in the context of immigrants to the L2 country who experience diminished use of the L1 and are immersed in the L2 culture and language and thus have principally attracted the attention of researchers looking for changes to the L1 in healthy adults (Ahn et al. 2017; de Leeuw et al. 2018; Hopp and Schmid 2013; Major 1992; Mayr et al. 2012; Sypiańska 2017). Phonetic drift, contrary to L1 attrition, is also studied in the context of L*x* learning in formal education, but has received less consideration (Herd et al. 2015; Namjoshi et al. 2015; Schwartz et al. 2020; Sypiańska 2016; cf. Chang 2009; Dmitrieva 2019; Sancier and Fowler 1997; Ulbrich and Ordin 2017). It could be postulated that since formal settings allow for less L2 input, it results in a less significant L1 change. It remains to be verified whether changes to the L1 in formal settings tend to be less pronounced than in immersion contexts (shown by means of acoustic measurements but not necessarily foreign accent ratings which may require greater differences that are audible for the raters).

The theoretical basis for phonetic drift has been enabled already with the introduction of the definition for interference by Weinreich which he claimed to be "instances of deviation from the norms of *either* language which occur in the speech of bilinguals as a result of their familiarity with more than one language" (1953: I; my own emphasis). Also, the idea that the L1 and the L2 are, or at least can be, to some extent connected was allowed for the introduction of the notion of interlanguage (Selinker 1972). Later in the wholistic view of bilinguals, the coexistence of two languages in one mind was shown to produce a "unique and specific speaker-hearer" (Grosjean 1985: 471) rather than "the sum of two monolinguals" (Grosjean 1989: 6). On the grounds of L2 sounds, Flege (1995) talks of a shared phonetic space in which L1 and L2 sounds coexist making the bidirectional influence possible. Whereas Best and Tyler suggest that "a listener's perception of phonetic information *generally* behaves as a coherent dynamical system in which changes in any subregion may affect the lay of the remaining landscape" (2007: 18).

Phonetic drift can take place in at least two different scenarios resulting from some kind of adaptation of the articulators in response to what happens in the linguistic environment. First of all, drift can take place as a novelty phenomenon in learners who have just started learning the foreign language. Due to a recent exposure to L2 phonology, the transposition to new articulation and L2 phonological categories triggers changes in the L1 as well (Chang 2012, 2013; Kartushina et al. 2006; Lang and Davidson 2017). We still do not have enough data to know at which point this initial adaptation to L2 sounds seizes; however, Sancier and Fowler (1997) gave evidence of high adaptability of the L1 to language sounds in the immediate surroundings where the speaker had a series of periods in the L2 country and the L1 country, each of which triggered different changes in the L1. Second, the vast majority of studies on L1 phonetic drift show changes in the L1 in the most advanced learners of the foreign language and/or with the greatest amount of exposure to the L2. The outcome of a good command of the L2 and its phonology and/or significant exposure to the L2

sound system is mastery of the L2 articulatory routine, which is more likely to influence the articulatory routine for the L1. It can be hypothesised that, after an initial disturbance (= introduction of L2 sounds) in the phonological space, as the learner's command of L2 and its phonology increase, so does their ability to maintain control over their articulatory gestures and separate the gesture for the L1 and the L2 sounds. Whether drift is merely a matter of articulation and adaptation of gestures to surrounding language input is open for debate. One idea is that L2 input triggers changes in L1 articulatory routines, which at a later stage could influence L1 phonological categories restructuring both L1 production and L1 perception. These considerations, however, are not in the scope of the current paper. Nor is an in-depth discussion on how L1 drift differs from L1 attrition.

Finally, because L1 drift is an inherent but variable occurrence in the process of learning a foreign language, it is probably also conditioned by the learner's individual differences (Chang 2019), e.g. the highly variable cognitive control or especially inhibitory control that aids the suppression of the influence from one language on the other (Darcy et al. 2015, 2016). Seniors may have reduced cognitive skills (Zanto and Gazzaley 2017) that in turn promote greater influence not only from the L1 to the L2, but also from the L2 to the L1.

Although there is reason to claim that L1 drift takes place in either initial stages or in more advanced (or more experienced) learners, senior learners of a foreign language[1] may be the optimal candidate for L1 drift research. This is so because in a society that widely learns but also uses or at least is exposed to English almost on a daily basis via music, films, and the social media, senior learners, who are far less likely to experience this exposition, appear to be the only monolingual group from which a control group of age-matched seniors is actually possible to be obtained. Among younger adults and especially teenagers, the baseline to which researchers compare their data may frequently not be substantially different in their language use to show L1 drift. Also, the possibility that seniors may have a lower inhibitory control that most likely operates on cross-linguistic influence in both directions strengthens the assumption that senior learners of a foreign language should also experience L1 drift albeit for different reasons.

Harada (2003) describes how the VOT durations of voiceless plosives L1 Japanese/L2 English speakers increased because of the influence of the longer VOT in English. The language pairing of the senior learners in the current paper (L1 Polish/L2 English) gives an opportunity to study the same type of difference in VOT as in Harada (2003). Although senior learners may be less successful in learning an L2, it is assumed that at least some of them will produce the L2 English stops with a longer VOT than expected for Polish. That is to say, they will not use their Polish VOT for the L2 English stops, but will show signs of having learnt the English VOT even if it falls short of native speaker values. Then, as a result of L1 drift, these senior learners should prolong their shorter VOT durations in initial voiceless plosives in L1 Polish because of the influence of the longer VOT in matching L2 sounds. In the voiced series of plosives, L1 drift should bring about shorter prevoicing.

4 Research design

4.1 Aim and hypotheses

The first aim of the paper is to analyse the way senior learners of an L2 produce the L2 phonetic element that is different from the L1 counterpart. For this purpose, L1 Polish/L2 English senior learners of English were asked to read a list of English words with word-initial voiced and voiceless plosives. Polish is a true voicing language, so voiceless plosives /p/, /t/, /k/ have short VOT and the voiced stop series /b/, /d/, /g/ is

1 The senior learners described in this paper are neither at an initial stage of learning nor are they advanced learners with much experience in the L2.

prevoiced (Keating et al. 1981). English, on the other hand, is an aspirating language which means that it contrasts long VOT for fortis stops with short VOT for lenis stops (Lisker and Abramson 1964). Studies on younger L1 Polish learners of L2 English report that the VOT values in L2 English as produced by Polish speakers may not reach native speaker levels (Waniek-Klimczak 2005) but it is a learnable parameter (Moyer 2013). Once the extent to which senior Polish learners of English are able to produce English VOT is established, the second aim of the paper is to decide whether they also experience L1 drift.

Based on the literature review, it is hypothesised that senior learners will not be able to reach native-like values in the L2 VOT parameter, but will produce an in-between category of VOT (longer than native Polish, but shorter than native English). The hypothesis is that the L1 Polish prevoiced and short-lag stops will be influenced by the L2 English short-lag and long-lag stops by, respectively, shortening the prevoicing and increasing VOT. Those senior learners who produce longer VOT for L2 English than they do for L1 Polish are hypothesised to experience L1 drift in the form of an increase in VOT values in L1 Polish in the voiceless stop series and a shortening of prevoicing in the voiced stop series compared to the Polish control.

4.2 Participants

There were two groups of participants: a research group and a control group. The former included L2 English senior speakers (n = 20, mean age = 68.8, only females) residing in Poland who were compared to the control group consisting of age-matched speakers (n = 19, mean age = 60+, only females) with no contact with English (or contact limited to school education in late teens). All participants in the research group reported an age of onset of L2 English learning at 60+. Mean length of English instruction of the bilingual group at the third age university was three and a half years. All participants reported learning other foreign languages in school, mostly Russian or German, with no language contact or use of the languages following graduation from high school. The level of proficiency in English was assessed by means of a standardised placement test at A2+/B1 according to the Common European Framework of Reference. The participants were taught with the use of materials in British English based on the communicative method (4 h per week with no extracurricular exposure). The teacher also provided input in British English. Although the teacher reported that she instructs the students on details of pronunciation and corrects their speech, no phonetic training or instruction was given on the differences between Polish and English stops. The participants did not report any hearing disorders or medical conditions that may cause difficulties in concentration or attention. Detailed information about the participants is available in Appendix 1.

4.3 Stimuli

The stimuli included one syllable words with initial voiceless plosives /p/, /t/, /k/ and voiced plosives /b/, /d/, /g/ followed by the front mid-vowel in Polish and English, eighteen words per language altogether 36 words (Appendix 2). The vowel was chosen because of its similarity in Polish and English, allowing for comparisons between the languages. Both English and Polish words were recorded. The participants were asked to first read the Polish and, following a short break, the English words as they appeared on slides. The set of words also included fillers at a 50%:50% ratio. The recording was made with the use of a RØDE N1 condenser microphone connected to a computer by means of a Focusrite Scarlett 2i2 2Gen audio interface in a quiet room at the Słupsk Third Age University associated with Akademia Pomorska in Słupsk. Some tokens had to be discarded due to mispronunciations of either the stop or the following vowel. All in all, there were 346 tokens L2 English, 378 L1 Polish, and 342 Polish Control tokens (Table 1). The VOT was measured in PRAAT from the onset of the stop burst until the first regular pulse of the voicing in the following vowel.

Table 1: Number of tokens

Sound	Polish control	L1 Polish	L2 English
/p/	57	63	60
/b/	57	63	60
/t/	57	63	59
/d/	57	63	59
/k/	57	63	57
/g/	57	63	51
Total	342	378	346

5 Results

The first step in the analysis of the results was to investigate how senior foreign learners of L2 English with Polish as a native language produced L2 voiced and voiceless stops. The mean results for L2 English showed greater VOT for the voiceless series (Table 2; apart from the slightly lower VOT for the velar stop), and on average, 26 ms shorter prevoicing in the voiced series when compared to the participants' L1 Polish productions. The results for L2 English did not reach native English VOT values (Docherty 1992).

A three-way ANOVA was run to investigate the statistical significance of these differences with Language (Polish; English), Place of articulation (POA: labial, coronal, velar) and Voicelessness (voiced; voiceless) as main factors and Language*POA and Language*Voicelessness as interaction effects. The statistically significant main effect of Language ($F = 31.81016$, $p = 0.000$) and particularly the interaction effect of Language*Voicelessness ($F = 11.01956$; $p = 0.000$) showed that the group used different VOT for their two languages. The bilingual speakers produced their Polish word-initial voiceless stops with VOT greater than the Control group on average by 4.1 ms for the voiceless stops and 10.3 ms for the voiced stops. VOT for all the voiced stops and the voiceless labial and coronal stops were significantly different in L2 English than in L1 Polish (Figure 1; statistical significance marked with an asterisk).

In order to investigate L1 drift among the participants, L1 Polish mean VOT durations were compared with the Polish Control group's VOT (Table 3; L2 English and native English from Docherty (1992) added for a better understanding of the L1 drift effect and its origins in L2 English). The tendency was for the participants to produce L2 English stops with longer VOT in the voiceless series and shorter prevoicing in the voiced series. A Generalised Linear Model was run with Group (Research; Control), Place of articulation (POA: labial, coronal, velar) and Voicelessness (voiced; voiceless) as main factors and Group*POA and Group*Voicelessness as interaction effects. The Bonferroni correction was used to avoid false positives with multiple comparisons. The statistically significant main effect of Group ($F = 6.12141$, $p = 0.000$) but non-significant interaction effects of Group*Voicelessness ($F = 3.37753$; $p = 0.065$) and Group*POA ($F = 0.64825$; $p = 0.523$) show that L1 drift was not associated with the voiced or voiceless series only or with a given place of articulation. The differences between L1 Polish VOT and the Polish Control reached statistical significance for /t/, /k/ and /b/, /d/ (Figure 2; statistical significance marked with an asterisk).

Table 2: Mean results of VOT in ms for L1 Polish and L2 English in the research group

Sound	L1 Polish	L2 English	Native English (Docherty 1992)
/p/	24.3	27.2	42
/b/	−110.6	−83.6	15
/t/	29.5	39.5	64
/d/	−112.3	−100.1	21
/k/	52.3	49.4	62
/g/	−110.3	−70	27

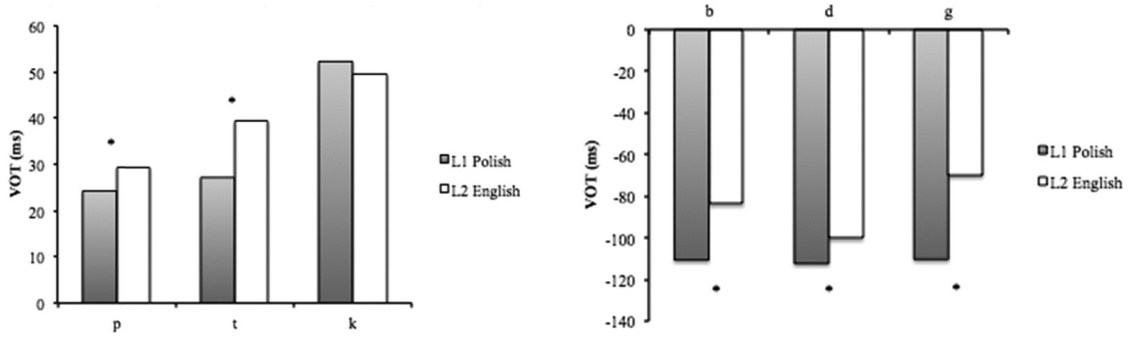

Figure 1: L1 Polish stops compared to L2 English stops (left – voiceless stops; right – voiced stops).

Table 3: Mean results of VOT in ms for L1 Polish compared to Polish control

Sound	Polish control	L1 Polish	L2 English	Native English (Docherty 1992)
/p/	21.2	24.3	27.2	42
/t/	25.5	29.5	39.5	64
/k/	46.9	52.3	49.4	62
/b/	–129.3	–110.6	–83.6	15
/d/	–119.9	–112.3	–100.1	21
/g/	–115	–110.3	–70	27

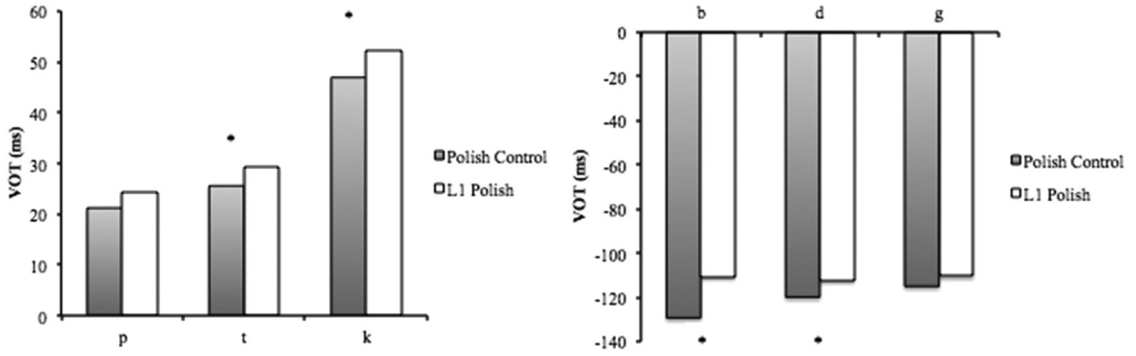

Figure 2: L1 Polish stops compared to the Polish control (left – voiceless stops; right – voiced stops).

However, mean results do not show the extent to which senior foreign language learners were able to produce aspirated voiceless and short-lag voiced stops in their L2 English. For this purpose, voiceless stops were divided by POA and instances of stops with VOT greater than 30 ms for /p/, greater than 35 ms for /t/ and greater than 55 ms for /k/ were counted (Table 4). The threshold for /p/ was chosen because the English voiceless series [b̥, d̥, g̊] is defined as having VOT below 30 ms and the voiceless /p/ above 30 ms (Ladefoged

Table 4: Instances of voiceless stops with aspiration

	/p/ with VOT > 30 ms (%)	/t/ with VOT > 35 ms (%)	/k/ with VOT > 55 ms (%)
Polish control	4	4	4
L1 Polish	19	3	35
L2 English	30	27	39

and Cho 2000; Wood 1976). The thresholds for the coronals and velars were much more problematic to establish. On the one hand, all thresholds should exceed the various VOT measurements for Polish available in the literature (Keating et al. 1981; Kopczyński 1977). On the other hand, they also have to take into consideration the perceptual border between the lenis and fortis stops in English that is 35 ms for /t/ and 42 ms for /k/ (Kuhl and Miller 1978). Senior foreign learners of L2 English were able to produce aspiration correctly in approximately 30% of the instances with the least success for the coronal stop and the greatest percentage for the velar stop. Accordingly, the greatest amount of L1 drift was visible for the velar stop, 35% of which was produced with aspiration. On the other hand, 19% of the labial tokens were produced with aspiration. Finally, only 3% of coronal tokens were produced with aspiration in L1 Polish even if the percentages for /t/ with aspiration in L2 English matched the other two voiceless stops.

For voiced stops, instances with VOT equal or more than 0 were counted. Voiced stops were not divided into POA as any token without prevoicing was considered target English pronunciation regardless of POA. Table 5 shows that 22% of all the tokens of voiced stops in L2 English were produced correctly without prevoicing. As far as L1 drift is concerned, only 4% of voiced tokens in L1 Polish were produced without prevoicing which could be considered as evidence of a small amount of L1 drift.

6 Discussion

The first aim of the paper was to analyse the production of L2 English stops by senior Polish learners. Having no instruction on how to produce the L2 English stops and in what ways they are different from their L1 counterparts either during their language course or as part of the study, on the basis of input alone, they still managed to differentiate L1 and L2 stops with the use of VOT. The seniors produced greater mean VOT for L2 English voiceless plosives than they did for L1 Polish plosives (apart from the velar stop). They also shortened their mean prevoicing for the L2 English voiced stops. As hypothesised, senior L1 Polish learners of L2 English produced in-between categories for the stops which did not reach native speaker values based on Docherty (1992) for British English. However, they were significantly different from their L1 Polish values. As far as the velar stop is concerned, lack of a statistically significant difference between the L1 and the L2 in this case may be explained by the so-called velar lengthening. The Polish VOT for the velar stop is already quite long because of the mechanical lengthening of VOT as a result of the velar stricture being further down the articulatory tract in comparison to the labial or coronal stop. The participants may have perceived the English velar stop to be similar to the Polish one with no need to establish a new category for the L2 sound. In accordance with Flege's SLM model (1995), the result is a diaphone for the L1 and L2 sounds.

Finally, the results provided in the form of means do not show a favourable outcome of the learning process for the senior learners. However, a slightly different understanding of the learnability of the VOT parameter in an L2 by senior learners is provided by the analysis of the voiced and voiceless stop series. Approximately 30% of all voiceless tokens is actually pronounced correctly with aspiration and approximately 20% of voiced tokens without prevoicing. The suppression of prevoicing has been shown to be more difficult to master than an increase in VOT values to produce the effect of aspiration (e.g. Schwartz et al. 2020), and this asymmetry is also reflected in the current data. Although the senior learners did not reach native speaker levels with their production of L2 English stops, some of the stops were produced with correct VOT length for voiceless English stops and a suppression of prevoicing for the voiced English stops.

Table 5: Instances of voiced stops without prevoicing

	Voiced stops with VOT > 0 (%)
Polish control	0
L1 Polish	4
L2 English	22

The data also provide evidence of L1 drift as an effect of L2 learning. In the voiceless series, the labial and velar stops 19% and 39%, respectively, are produced with VOT that is high enough to be categorised as aspiration. L1 drift is most clearly observed for the velar stop which is compatible with previous findings on L1 Polish/L2 English speakers, though with an advanced level in the foreign language (Waniek-Klimczak 2011; Schwartz et al. 2015). In the voiced series, only 4% of all stops are produced without prevoicing which suggests much less L1 drift in the voiced series than in the voiceless series of L1 Polish stops, which could be a reflection of the fact that suppressing prevoicing is more difficult to learn and thus less likely to cause L1 drift. The data provide further evidence that greater mastery of a language or a given element of the L2 may lead to greater L1 drift.

7 Conclusion

All in all, the study shows evidence that senior Polish learners of L2 English with an onset of L2 learning above 60 years of age, with no instruction on how to produce the L2 English stops, are to some extent able to produce target English stops. Although they typically produce an in-between category for their L2 stops, in 30% of the cases they are able to aspirate the voiceless English stops. Slightly lower correctness is observed for voiced stops that have been shown to be more problematic to learn.

Also, senior L1 Polish learners of L2 English show signs of L1 drift particularly in the voiceless stop series. The learners prolong the VOT when producing L1 Polish voiceless stops to match the longer VOT for the L2 English stops. Even if they do not always aspirate their L2 English stops, they tend to make a distinction between the L1 Polish and the L2 English stops. If mastery of the L2 articulatory routine is likely to influence the articulatory routine for the L1, then L1 drift may be considered an effect of acquiring the L2 sound. This study shows that L1 drift also occurs in senior learners of an L2 which may be treated as a form of evidence of (some degree) of success in their L2 learning.

The limitations of the current study include differences in the L2 language proficiency of the research group, no English control group and no measurement of cognitive control, especially inhibitory control among the senior learners. However, it opens up potential lines of further research in which different cognitive, and particularly inhibitory, control levels may have effect on the acquisition of L2 sounds and the manifestation of L1 drift in senior L2 learners.

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References

Ahn, S., C. B. Chang, R. DeKeyser, and S. Lee-Ellis. 2017 September. “Age effects in first language attrition: Speech perception by Korean-English Bilinguals.” *Language Learning* 67(3): 694–733.

Awan S. N. and P. B. Mueller. 1992. “Speaking fundamental frequency characteristics of centenarian females.” *Clinical Linguistics and Phonetics* 6: 249–54.

Barnes, S. 2011. *Third age. Golden years of adulthood*. San Diego, California: San Diego State University Interwork Institute. http://calbooming.sdsu.edu/documents/TheThirdAge.pdf (accessed 29.05.2020).

Best, C. T. and M. D. Tyler. 2007. “Nonnative and second-language speech perception: Commonalities and complementarities.” In: *Language experience in second language speech learning: In honor of James Emil Flege*, ed. Murray J. Munro, p. 13–34. Ocke-Schwen Bohn: John Benjamins.

Bongaerts, T., B. Planken, and E. Schils. 1995. "Can late starters attain a native accent in a foreign language? A test of the critical period hypothesis?" In: *The age factor in second language acquisition*, eds. D. Singleton and Z. Lengyel, p. 30–50. Clevedon: Multilingual Matters.

Bongaerts, T., C. Summeren, B. Planken, and E. Schils. 1997. "Age and ultimate attainment in the pronunciation of a foreign language." *Studies in Second Language Acquisition* 19: 447–65.

Burda, A. N., J. Scherz, C. Hageman, and H. T. Edwards. 2003. "Age and understanding speakers with Spanish or Taiwanese accents." *Perceptual and Motor Skills* 97(1): 11–20.

Chang, C. B. 2009. "Short-term phonetic drift in an L2 immersion environment." In: *Current issues in linguistic interfaces*, eds. Y.-S. Kang, S.-W. Tang, C. Kim, J.-Y. Yoon, Y.-S. Kang, K.-A. Kim, H. Yoo, Y. Jang, and H.-K. Kang, vol. 2, p. 31–46. Seoul, South Korea: Linguistic Society of Korea.

Chang, C. B. 2012. "Rapid and multifaceted effects of second-language learning on first-language speech production." *Journal of Phonetics* 40(2): 249–68.

Chang, C. B. 2013. "A novelty effect in phonetic drift of the native language." *Journal of Phonetics* 41(6): 491–504.

Chang, C. B. 2019. "Phonetic drift." In: *The Oxford handbook of language attrition*, eds. M. S. Schmid and B. Köpke, p. 191–203. Oxford: Oxford University Press.

Darcy, I., J. C. Mora, and D. Daidone. 2016. "The role of inhibitory control in second language phonological processing." *Language Learning* 66(4): 741–73.

Darcy, I., H. Park, and C. L. Yang. 2015. "Individual differences in L2 acquisition of English phonology: The relation between cognitive abilities and phonological processing." *Learning and Individual Differences* 40: 63–72.

de Leeuw, E., A. Tuscha, and M. S. Schmid. 2018. "Individual phonological attrition in Albanian–English late bilinguals." *Bilingualism: Language and Cognition* 21(2): 278–95.

Dmitrieva, O. 2019. "Transferring perceptual cue-weighting from second language into first language: Cues to voicing in Russian speakers of English." *Journal of Phonetics* 73: 128–43.

Docherty, G. J. 1992. *The timing of voicing in British English obstruents*. Berlin: Foris.

Flege, J. E. 1991. "Age of learning affects the authenticity of voice-onset time (VOT) in stop consonants produced in a second language." *Journal of the Acoustical Society of America* 89(1): 395–411.

Flege, J. E. 1995. "Second language speech learning theory, findings, and problems." In: *Speech perception and linguistic experience: Issues in cross-language research*, ed. Winifred Strange, p. 233–77. Timonium, MD: York Press.

Flege, J. E., O. S. Bohn, and S. Jang 1997. "Effects of experience on non-native speakers' production and perception of English vowels." *Journal of Phonetics* 25: 437–70.

Flege, J. E. and K. L. Fletcher. 1992. "Talker and listener effects on degree of perceived foreign accent." *Journal of the Acoustical Society of America* 91: 370–89.

Flege, J. E., I. R. A. MacKay, and D. Meador. 1999. "Native Italian speakers' perception and production of English vowels." *Journal of the Acoustical Society of America* 106(5): 2973–87.

Flege, J. E., M. J. Munro, and I. R. A. MacKay. 1995. "Factors affecting strength of perceived foreign accent in a second language." *Journal of the Acoustical Society of America* 97: 3125–34.

Flege, J. E., C. Schirru, and I. R. A. MacKay. 2003. "Interaction between the native and second language phonetic subsystems." *Speech Communication* 40: 467–91.

Flege, J. E., G. H. Yeni-Komshian, and S. Liu. 1999. "Age constraints on second-language acquisition." *Journal of Memory and Language* 41: 78–104.

Fullana, N. 2006. "The development of English (FL) perception and production skills: starting age and exposure effects." In: *Age and the rate of foreign language learning*, ed. C. Muñoz, p. 41–64. Bristol: Multilingual Matters.

Gabryś-Barker, D. (Ed.). 2017. *Third age learners of foreign languages*. Bristol: Multilingual Matters.

García Lecumberri, M. L. and F. Gallardo. 2003. "English FL sounds in school learners of different ages." In: *Age and the acquisition of English as a foreign language*, eds. M. P. García Mayo and M. L. García Lecumberri, p. 115–35. Bristol: Multilingual Matters.

Green, D. 2017. "The interactional challenge: L2 learning and use in the third age." In: *Third age learners of foreign languages*, ed. D. Gabryś-Barker, p. 31–47. Bristol: Multilingual Matters.

Grosjean, F. 1989. "Neurolinguists beware! The bilingual is not the sum of two monolinguals." *Brain and Language* 36(1): 3–15.

Grosjean, F. 1985. "The bilingual as a competent but specific speaker-hearer." *Journal of Multilingual and Multicultural Development* 6(6): 467–77.

Hakuta, K., E. Bialystok, and E. Wiley. 2003. "Critical evidence. A test of the critical-period hypothesis for second-language acquisition." *American Psychological Society* 14(1): 31–8.

Harada, T. 2003. "L2 influence on L1 speech in the production of VOT." In: *Proceedings of the 15th International Congress of Phonetic Sciences*, eds. M. J. Sole, D. Recasens, and J. Romero, p. 1085–8. Barcelona: Causal Productions.

Herd, W. J., R. L. Walden, W. L. Knight, and S. N. Alexander. 2015. "Phonetic drift in a first language dominant environment." *Proceedings of Meetings on Acoustics* 23(1): 060005.

Hopp, H. and M. S. Schmid. 2013. "Perceived foreign accent in first language attrition and second language acquisition: The impact of age of acquisition and bilingualism." *Applied Psycholinguistics* 34: 361–94.

Ingvalson, E. M., C. Nowicki, A. Zong, and P. C. M. Wong. 2017. "Non-native speech learning in older adults." *Frontiers in Psychology* 8: 148.

Ioup, G. 2008. "Exploring the role of age in the acquisition of a second language phonology." In: *Phonology and second language learning*. [Studies in Bilingualism, 36], eds. J. G. Hansen Edwards and M. L. Zampini, p. 41–62. Amsterdam: John Benjamins Publishing Company.

Kartushina, N., A. Hervais-Adelman, U. H. Frauenfelder, and N. Golestani. 2006. "Mutual influences between native and non-native vowels in production: Evidence from short-term visual articulatory feedback training." *Journal of Phonetics* 57(2016): 21–39.

Keating, P., M. J. Mikoś, and M. F. Ganong. 1981. "A cross-language study of range of voice onset time in the perception of initial stop voicing." *The Journal of the Acoustical Society of America* 70(5): 1261–71.

Kopczyński, A. 1977. *Polish and American English consonant phonemes: A contrastive study*. Warszawa: Państwowe Wydawnictwo Naukowe.

Kuhl, P. K. and Miller, J. D. 1978. "Speech perception by the chinchilla: Identification functions for synthetic VOT stimuli." *Journal of the Acoustical Society of America* 63: 905–17.

Ladefoged, P. and T. Cho. 2000. "Linking linguistic contrasts to reality: The case of VOT." *UCLA Working Papers on Phonetics* 98: 1–9.

Lang, B. and L. Davidson. 2017. "Effects of exposure and vowel space distribution on phonetic drift: evidence from American English learners of French." *Language and Speech* 62(1): 30–60.

Lisker, L. and A. S. Abramson. 1964. "A cross-language study of voicing in initial stops: Acoustical measurements." *Word* 20: 384–422.

Long, M. 1990. "The least a second language acquisition theory needs to explain." *TESOL Quarterly* 24: 649–66.

Major, R. C. 1992. "Losing English as a first language." *The Modern Language Journal* 76: 190–208.

Mayr, R., S. Price, and I. Mennen. 2012. "First language attrition in the speech of Dutch–English bilinguals: The case of monozygotic twin sisters." *Bilingualism: Language and Cognition* 15: 687–700.

Markó, A. and J. Bóna. 2010. "Fundamental frequency patterns: The factors of age and speech type." *Proceedings of the Workshop "Sociophonetics, at the crossroads of speech variation, processing and communication" Pisa, December 14th–15th, 2010*.

Moen, P. 2011. "A life-course approach to the Third Age." In: *Gerontology in the era of the Third Age. Implications and next steps*, eds. D. C. Carr and K. Komp, p. 13–32. New York: Springer.

Moyer, A. 1999. "Ultimate attainment in L2 phonology." *Studies in Second Language Acquisition* 21: 81–108.

Moyer, A. 2013. *Foreign accent: the phenomenon of non-native speech*. Cambridge: Cambridge University Press.

Muñoz, C. and D. Singleton. 2007. "Foreign accent in advanced learners: Two successful profiles." *EUROSLA Yearbook* 7: 171–90.

Murray, G. 2011. "Older language learners, social learning spaces, and community." In: *Beyond the language classroom*, eds. P. Benson and, H. Reinders, p. 132–45. Basingstoke: Palgrave Macmillan.

Namjoshi, J., A. Tremblay, E. Spinelli, M. Broersma, M. T. Martínez-García, K. Connell, T. Cho, and S. Kim. 2015. "Speech segmentation is adaptive even in adulthood: Role of the linguistic environment." In: *Proceedings of the 18th International Congress of Phonetic Sciences* (paper number 0676), ed. The Scottish Consortium for ICPhS 2015. Glasgow, UK: University of Glasgow.

Nishio M. and S. Niimi 2008. "Changes in speaking fundamental frequency characteristics with aging." *Folia Phoniatrica et Logopaedica* 60: 120–7.

Pfenninger, S. and D. Singleton. 2019. "A review of research relating to the learning, use and effects of additional and multiple languages in later life." *Language Teaching* 52(4): 419–49.

Piske, T., I. R. A. MacKay, and J. E. Flege. 2001. "Factors affecting degree of foreign accent in an L2: a review." *Journal of Phonetics* 29: 191–215.

Ramírez-Gómez, D. 2016. *Language teaching and the older adult: The significance of experience*. Bristol: Multilingual Matters.

Russel A., L. Penny, and C. Pemberton. 1995. "Speaking fundamental frequency changes over time in women: A longitudinal study." *Journal of Speech and Hearing Research* 38: 101–9.

Sancier, M. L. and C. A. Fowler. 1997. "Gestural drift in a bilingual speaker of Brazilian Portuguese and English." *Journal of Phonetics* 25(4): 421–36.

Scovel, T. 1988. *A time to speak: a psycholinguistic inquiry into the critical period for human speech*. Rowley, MA: Newbury House.

Selinker, L. 1972. "Interlanguage." *International Review of Applied Linguistics* 10: 209–31.

Shen, J., R. Wright, and P. E. Souza. 2016. "On older listeners' ability to perceive dynamic pitch." *Journal of Speech, Language, and Hearing Research* 59: 572–82.

Schwartz, G., A. Balas, and A. Rojczyk. 2015. "Phonological factors affecting L1 phonetic realisation of proficient Polish users of English." *Research in Language* 13(2): 181–98.

Schwartz, G., J. Dzierla, and E. Wojtkowiak. 2020. "Laryngeal phonology and asymmetrical cross-language phonetic influence." In: *Approaches to the study of sounds structure and speech: Interdisciplinary Work in Honour of Katarzyna Dziubalska-Kołaczyk*, eds. M. Wrembel, A. Kiełkiewicz-Janowiak, and P. Gąsiorowski. New York: Routledge.

Sypiańska, J. 2016. "L1 vowels of multilinguals: The applicability of SLM in multilingualism." *Research in Language* 14(1): 79–94.
Sypiańska, J. 2017. *Cross-linguistic influence in bilinguals and multilinguals*. Wydawnictwo Naukowe UAM: Poznań.
Ulbrich, C. and M. Ordin. 2017. "Can L2-English influence L1-German? The case of post-vocalic/r/." *Journal of Phonetics* 45(1): 26–42.
Waniek-Klimczak, E. 2005. *Temporal parameters in second language speech: applied phonetics approach*. Łódź: Wydawnictwo Uniwersytetu Łódzkiego.
Waniek-Klimczak, E. 2011. "Aspiration and style: a sociophonetic study of VOT in Polish learners of English." In: *Achievements and perspectives in the SLA of speech: New sounds 2010*, eds. K. Dziubalska-Kołaczyk, M. Wrembel, M. Kul, vol. 1, p. 303–16. Frankfurt am Main: Peter Lang.
Weinreich, U. 1953. *Languages in contact, findings and problems*. New York: Linguistic Circle of New York.
Wood, C. C. 1976. "Discriminability, response bias, and phoneme categories in discrimination of voice onset time." *Journal of the Acoustical Society of America* 60(6): 1381–9.
Yeni-Komshian, G. H., J. E. Flege, and S. Liu. 2000. "Pronunciation proficiency in the first and second languages of Korean-English bilinguals." *Bilingualism: Language and Cognition* 3: 131–49.
Zanto, T. P. and A. Gazzaley. 2017. "Cognitive control and the ageing brain." In: *The Wiley handbook of cognitive control*, ed. T. Egner, p. 476–90. New York: John Wiley & Sons, Inc.

Appendix 1 Participants' biodata

Participant	Group	Age	Sex	Length of instruction (years)	Other foreign languages	Stay in English speaking country	Placement test result	L2 proficiency
1	Research	73	F	1.5	Russian	no	25	A2+
2	Research	75	F	3.5	Russian	no	24	A2+
3	Research	74	F	3	Russian, Latin	no	26	A2+
4	Research	72	F	2.5	—	no	25	A2+
5	Research	72	F	1.5	Russian, Latin	no	25	A2+
6	Research	73	F	3	German	no	27	A2+
7	Research	69	F	2	German	no	27	A2+
8	Research	67	F	3.5	Russian	no	20	A2+
9	Research	66	F	4	German	no	25	A2+
10	Research	66	F	3	French, Russian	no	21	A2+
11	Research	71	F	1.4	Russian	no	22	A2+
12	Research	69	F	6	German	no	25	A2+
13	Research	67	F	3	German, Russian	no	19	A2
14	Research	73	F	4	German, Russian	no	25	A2+
15	Research	63	F	2.5	French, Russian	no	28	A2+
16	Research	60	F	2	German, Russian	no	31	B1
17	Research	63	F	2.5	French, Russian	no	34	B1
18	Research	65	F	3	Russian	no	26	A2+
19	Research	71	F	4.5	Russian	no	33	B1
20	Research	67	F	6	French, German	no	34	B1

Participant	Group	Age	Sex	Previous contact with English	Plans to learn English	Other foreign languages studied	Stay abroad
1	Control	60+	F	No	No		
2	Control	75	F	Yes	No		
3	Control	60+	F	No	No		
4	Control	60+	F	No	No		
5	Control	65	F	Yes (school, studies)	No		
6	Control	73	F	No	No		
7	Control	73	F	Yes (school, studies)	No	French	
8	Control	66	F	Yes (course)	Yes		
9	Control	77	F	Yes (school)	No		
10	Control	67	F	No	Yes		
11	Control	67	F	Yes	Yes		

12	Control	68	F	yes (school)	No	Russian	
13	Control	67	F	No	No	German, Russian	
14	Control	61	F	Yes	No	Russian	
15	Control	60+	F	Yes (school)	Yes		
16	Control	63	F	No	No	French, Russian, German	A stay in France
17	Control	66	F	No	Yes	Russian, German	
18	Control	75	F	No	No	Russian	
19	Control	73	F	No	No	German	

Appendix 2 The stimulus

Targeted sound	Language	POA	Voicing	Word	Transcription	English translation
/p/	Polish	Labial	v-less	perz	/pɛʂ/	Couch grass
/p/	Polish	Labial	v-less	pech	/pɛx/	Bad luck
/p/	Polish	Labial	v-less	perć	/pɛrt͡ɕ/	A small mountain trail
/b/	Polish	Labial	Voiced	bek	/bɛk/	Bleat
/b/	Polish	Labial	Voiced	beż	/bɛʂ/	Beige
/b/	Polish	Labial	Voiced	bez	/bɛs/	Without
/t/	Polish	Coronal	v-less	teść	/tɛɕt͡ɕ/	Father-in-law
/t/	Polish	Coronal	v-less	też	/tɛʂ/	Also
/t/	Polish	Coronal	v-less	tek	/tɛk/	Suitcase (plural, augmentative, genitive)
/d/	Polish	Coronal	Voiced	deszcz	/dɛʂt͡ʂ/	Rain
/d/	Polish	Coronal	Voiced	dech	/dɛx/	Breath
/d/	Polish	Coronal	Voiced	dek	/dɛk/	Deck
/k/	Polish	Velar	v-less	kecz	/kɛt͡ʂ/	Ketch
/k/	Polish	Velar	v-less	keks	/kɛks/	Fruitcake
/k/	Polish	Velar	v-less	keg	/kɛk/	Keg
/g/	Polish	Velar	Voiced	gest	/gɛst/	Gesture
/g/	Polish	Velar	Voiced	gej	/gɛj/	Gay
/g/	Polish	Velar	Voiced	gen	/gɛn/	Gene

Targeted sound	Language	POA	Voicing	Word	Transcription
/p/	English	Labial	v-less	peck	/pɛk/
/p/	English	Labial	v-less	peg	/pɛg/
/p/	English	Labial	v-less	pen	/pɛn/
/b/	English	Labial	Voiced	bench	/bɛnt͡ʃ/
/b/	English	Labial	Voiced	bet	/bɛt/
/b/	English	Labial	Voiced	beg	/bɛg/
/t/	English	Coronal	v-less	tell	/tɛl/
/t/	English	Coronal	v-less	tent	/tɛnt/
/t/	English	Coronal	v-less	ten	/tɛn/
/d/	English	Coronal	Voiced	deck	/dɛk/
/d/	English	Coronal	Voiced	debt	/dɛt/

/d/	English	Coronal	Voiced	desk	/dɛsk/
/k/	English	Velar	v-less	Ken	/kɛn/
/k/	English	Velar	v-less	kept	/kɛpt/
/k/	English	Velar	v-less	Kent	/kɛnt/
/g/	English	Velar	Voiced	guest	/gɛst/
/g/	English	Velar	Voiced	guess	/gɛs/
/g/	English	Velar	Voiced	get	/gɛt/