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# PHONOLOGICAL FACTORS AFFECTING L1 PHONETIC REALIZATION OF PROFICIENT POLISH USERS OF ENGLISH

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## Abstract

Acoustic phonetic studies examine the L1 of Polish speakers with professional level proficiency in English. The studies include two tasks, a production task carried out entirely in Polish and a phonetic code-switching task in which speakers insert target Polish words or phrases into an English carrier. Additionally, two phonetic parameters are studied: the oft-investigated VOT, as well as glottalization vs. *sandhi* linking of word-initial vowels. In monolingual Polish mode, L2 interference was observed for the VOT parameter, but not for *sandhi* linking. It is suggested that this discrepancy may be related to the differing phonological status of the two phonetic parameters. In the code-switching tasks, VOTs were on the whole more English-like than in monolingual mode, but this appeared to be a matter of individual performance. An increase in the rate of *sandhi* linking in the code-switches, except for the case of one speaker, appeared to be a function of accelerated production of L1 target items.

**Key words:** Phonetic parameters, L2 phonetics, VOT, glottalization, *sandhi*

## 1. Introduction

In the area of second language (L2) speech research, the manifestation of L1>L2 phonological interference is undoubtedly the most commonly recurring theme. L2 pronunciation studies describe the degree to which learners master the phonetic norms of monolingual speech in the target language (e.g. Zampini, 2008). Perception studies investigate the degree to which learners' processing of L2 phonetics deviates from that of native speaker (see e.g. Strange & Shafer, 2008). Tests of accentedness, comprehensibility, and intelligibility investigate the consequences for listeners of L2

phonetic production (see e.g. Munro, 2008). The details of L2 speech, and the extent to which it is dependent on L1, are thus the focus of a majority of cross-language research. A commonly recurring theme is that starting L2 learning at an early age is the most reliable way of attaining native-like performance in the target language. Nevertheless, some models of L2 speech learning, while accounting for L1 interference and oft-invoked effects of age of acquisition, also allow for the possibility of bidirectional interaction between L1 and L2. Flege's (1995 et seq.) Speech Learning Model (SLM) is the most notable theory in this regard, having been developed in the wake of findings that bilinguals' production and perception of their first language may be affected by their second language.

One external factor that may come into play in the descriptions of cross-language phonological interaction is the background of the experimental participants. Some researchers have dealt with simultaneous or balanced bilinguals, usually the children or grandchildren of immigrants, who acquired their languages in a more or less naturalistic setting. Others have looked at first generation immigrants with a particular interest in the age at which L2 exposure and learning began. For these speakers, L1 is assumed to be dominant, yet their learning process is also naturalistic in the sense that they are immersed in L2 communities. Still other studies investigate those who actively study an L2 while residing in their L1 community. These speakers may best be described as 'learners' of a foreign language, who may or may not achieve proficiency approaching that of L1 users.

Another factor that is relevant for cross-language research is language context or language mode, the communicative situation from which empirical data are obtained. Grosjean (1998) proposed an activation continuum, by which the communicative setting determines the degree of interaction between bilinguals' two languages. In situations in which both languages are activated, language switching and cross-language interaction (CLI) are expected. These cases are described as bilingual mode. Sometimes, bilinguals find themselves in purely monolingual situations, in which one language or the other is deactivated. In those cases, bilingual speakers may be expected to maintain greater independence of their separate languages.

Returning to the issue of the effects of L2 on L1 phonology, questions of speaker background and language mode combine to create a number of possible research areas, many of which have been the focus of only a small number of studies. In particular, not many studies that found L2>L1 influence have controlled for language mode. For example, in the classic study of French-English bilinguals by Flege (1987), data are collected in only a single language context. However, a growing if not yet substantial body of research (Sancier & Fowler, 1997; Antoniou, Best, Tyler & Kroos, 2011; Olson, 2012) has shown that bilingual speakers' phonetic norms are dependent on the linguistic environment. With regard to speaker background, most of the work investigating the effects of language context on L1 phonology has dealt with balanced bilinguals, presumably under the intuitive assumption that only 'true' bilinguals may be expected to show L2 interference in their L1. This notion has been challenged by the findings of Chang (2012), who observed such effects in the speech of L1 English learners of Korean even in the early stages of their instruction. Thus, it is clear that L2 does not need to be learned naturalistically in order for it to have an influence on the phonology of L1. At the same time, however, Chang's study did not compare different language contexts. In

sum, we are left with a number of research gaps with regard to the effects of L2 on L1. To our knowledge, language mode studies have not examined consecutive bilinguals, while studies of L2 learners have not investigated the effects of language mode.

Beyond the issues of participant background and methodology with regard to language mode, research into phonetic performance in bilingual or multilingual speakers must identify the phonological parameters to be investigated. This is in fact a crucial and oft-neglected consideration in L2 speech research. The most influential current theoretical models use terms such as ‘phonetic similarity’ and ‘common phonological space’, yet these terms are not as straightforward as they may seem. In essence, the problem is that phonological theory has provided less than ideal foundations upon which the study of L2 speech must proceed. In particular, there is still uncertainty about the phonetic or phonological status of various types of features, which complicates predictions and interpretations of L2 speech research.

This paper will present L1 data from proficient Polish users of English, both in monolingual Polish contexts and performing insertional code-switching tasks. These speakers are L1 dominant bilinguals with professional-level proficiency in English. Our study has three primary goals. The first is to investigate whether L2>L1 interference may be observed independently of language mode effects. For this reason, we compare L1 data from proficient users of English produced in a monolingual Polish context with a group of ‘quasi-monolingual’ speakers. The next goal is to examine whether an English context with insertional code-switches into Polish may induce L2>L1 phonetic interference. Finally, we seek to provide perspective on the question of which phonetic features may be more susceptible to cross-language interaction. For this reason, we compare separate phonetic parameters with implications for different areas of phonology: Voice Onset Time (VOT) measures associated with the realization of laryngeal contrasts, and linking vs. glottalization of vowel-initial words associated with the strength of word boundaries. In both of these areas Polish and English show systematic differences, thus we seek to establish if they are subject to similar CLI effects.

The results of our studies suggest that the possibility of CLI is indeed dependent to a certain degree on the particular phonetic parameter under study. In particular, the VOT parameter showed CLI effects in the monolingual Polish task, while the code-switching task appeared to cause further phonetic drift. By contrast, the realization of vowel-initial words with respect to linking vs. glottalization was relatively consistent across speakers and tasks. The conclusion is that VOT appears to be inherently more susceptible to cross-language interference than the glottalized vs. linked realization of word-initial vowels.

The rest of this paper will be organized as follows. In Section 2, we consider the possible origins and explanations for bidirectional phonetic interaction. Then in Section 3 we provide phonetic and phonological background on the realization of vowel-initial words with regard to linking vs. glottalization. Section 4 presents the experimental phonetic studies. Finally, Section 5 offers general discussion with the goal of clarifying the relationship between the observed empirical patterns and the phonological considerations underlying the study of bilingual speech.

## 2. L2>L1 influence and the factors behind it

In the literature on L2 speech perception and production, one of the most influential and widely tested theories is Flege's (1995 et seq.) Speech Learning Model (SLM). The SLM was developed in response to findings that challenged the traditional claim of a 'critical period' for foreign language learning, after which a foreign accent was assumed to be inevitable. Instead of a critical period, the SLM postulates that the mechanisms involved in L1 phonological learning remain active over the lifespan, and may also apply to L2 learning. However, due to dominance in the amount of input, phonetic categories in long-term memory tend to reflect L1 norms, so the model predicts the observed age-based effects on the success of L2 learning. The SLM thus assumes that phonetic categories continue to evolve over the lifespan in accordance with a speaker's linguistic experience, and that crucially, L1 and L2 categories exist in a 'common phonological space'.

This final postulate, when taken to its logical conclusion, makes a strong prediction that bilingual speakers' phonological systems are subject to inevitable bidirectional interaction, and that bilinguals' phonetic performance may be expected to differ from that of monolinguals in both languages. Many of the findings of Flege and his colleagues lend support to this idea. For example, in a classic study, Flege (1987) found that the L1 VOT values of French-English and English-French bilinguals were concentrated between the norms of monolingual speakers. The interpretation behind this finding is that the /t/ in English and French was subject to equivalence classification despite the differences in phonetic realization with regard to VOT. Since they were contained within the same phonetic category in common phonological space, they were free to interact with each other. Similar findings of L2 influence on L1 VOT may be found in a number of works (e.g. Major, 1992; Sancier & Fowler, 1997; Harada, 2003). Among these papers, the Sancier and Fowler study is notable in that it looks at the linguistic environment of a bilingual speaker of Brazilian Portuguese, who after several months in Brazil produces more Portuguese-like VOTs and after several months in the United States produces more English-like VOTs. Meanwhile, there is evidence that L2 influence on L1 is not limited to bilinguals with advanced L2 fluency. Chang (2012) studied novice L1 English learners of Korean, and observed evidence of L1 phonetic drift, under the influence of L2, in the production of stop consonants (VOT and f<sub>0</sub> effects) as well as vowels.

However, not all cross-language studies have found evidence of bidirectional interaction. Notably, Antoniou et al. (2010, 2011) examined VOT production in L2-dominant Greek-English bilinguals in Australia, who produced stop consonants with VOTs that did not differ significantly from those of monolingual Greek and Australian English speakers. Such findings challenge the SLM's view of a common phonological space, in which CLI is all but inevitable. These authors invoke an alternative model, the L2 version of the Perceptual Assimilation Model (PAM-L2; Best & Tyler, 2007). A crucial difference between the SLM and the PAM-L2 models is that the latter incorporates an abstract phonological level at which L1 and L2 phones may be kept distinct in the minds of bilinguals. Thus, PAM-L2 does not predict that L2>L1 interference is inevitable. From this perspective, Antoniou et al. suggest that other studies' findings of L2 influence on L1 may have been due to the effects of bilingual

activation (cf. Grosjean, 1998) stemming from the communicative situation. Therefore, their studies control for this possible effect by comparing VOT production in a strictly monolingual context, as well as in a task designed to elicit phonetic code-switching. In the code-switching task, as in the monolingual mode, there was minimal L2>L1 interference, but some drift toward L1 norms.

Aside from Antoniou et al.'s work, there is a very small amount of literature on the phonetics of code-switching, Grosjean and Miller (1994) found no difference in VOT between switched and non-switched items in the speech of French-English bilinguals, while Bullock and Toribio (2009) did observe CLI in code-switched items in the speech of Spanish-English bilinguals. Olson (2012) points out that the two studies differed in the type of code-switches analyzed, with the earlier study looking at insertional code-switches and the latter looking at alternational code-switches. It is suggested that insertional code-switches, in which there is a clearly dominant base language, are less conducive to phonetic interference. Olson's own work adds to the inventory of phonetic parameters of phonetic code-switching studies by looking at suprasegmentals, in particular duration and pitch, finding evidence that insertional code-switches in the speech of Spanish-English bilinguals may be subject to hyper-articulation, which in principle is a phenomenon that is independent of phonetic interference.

In sum, there remains a great deal of uncertainty with regard to the conditions in which we may observe L2 influence on L1 phonetic production. In addition to a general need for more empirical evidence from new language pairings, a number of areas have, to our knowledge, not been addressed at all. One gap in this research is L1-dominant consecutive bilinguals in different language contexts; studies into phonetic code-switching have dealt with simultaneous bilinguals. Additionally, it is important to increase the inventory of phonetic parameters examined in the study of phonetic CLI. While VOT has been ubiquitous in this research, *sandhi* linking vs. glottalization in vowel-initial words has not received significant attention. In what follows, we shall offer some discussion to motivate the inclusion of this additional phonetic feature.

### 3. Vowel glottalization vs. linking in Polish and English

Although the realization of initial vowels in terms of glottal attack or linking is not a contrastive phonemic property, it appears as if the phonologies of individual languages encode it in a systematic way. For example, in French vowel-initial items are systematically joined with preceding words by the *sandhi* processes of *enchaînement* and *liaison*. In the former,<sup>1</sup> word-final consonants are joined with the following word-initial vowel, altering the syllabic affiliation of the consonant. For example in the phrase *elle aime* 'she likes', the final /l/ of *elle*, which is produced as a coda when the word is pronounced in isolation, is linked with the following vowel and resyllabified as an onset: [ɛ.ləm]. The French patterns contrast starkly with what is observed in German, which is characterized by *harter Einsatz*, hard attack, that is realized by means of glottalization or full glottal stops. In standard German, vowel-initial word-stems are reported to begin

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<sup>1</sup> In *liaison*, final consonants that are not pronounced when the word is produced in isolation appear as onsets before word-initial vowels.

with a glottal stop. The absence of [ʔ] in rapid or casual speech may be considered a deletion (Wiese, 1996).

With regard to linking vs. glottalization at word boundaries, English and Polish appear to show a similar opposition. English pronunciation textbooks (e.g. Cook, 2000; Cruttenden, 2001) describe linking processes that join word-initial vowels to the preceding word. Glottalization may be used for emphasis, and to mark phrase boundaries, but it is not the default realization of initial vowels in English (Cruttenden, 2001). By contrast, in Polish, word-initial syllables have been observed to be characterized by phonetic prominence that preserves the prosodic integrity of lexical items (Dogil, 1999; Newlin-Łukowicz, 2012), which for vowel-initial words is typically realized as glottalization (Schwartz, 2013); *sandhi* linking processes are largely absent. Unlike languages such as French or English, word-final consonants are not resyllabified to be pronounced as onsets when followed by word-initial vowels. Glottalization may be therefore be said to preserve a boundary that is already present. By contrast, glottalization in English is usually interpreted as an ‘inserted’ boundary marker that is most likely to appear phrase-initially (Dilley, Shattuck-Hufnagel & Ostendorf, 1996; Garellek, 2012), and before stressed word-initial vowels (Davidson & Erker, 2014).

As with any phonetic feature, contrastive or non-contrastive, vowel glottalization is subject to gradient effects of a large number of internal and external factors. Glottalization has been observed to be more likely at higher-level prosodic boundaries (Dilley et al, 1996; Garellek, 2012), in faster speech (Davidson & Erker, 2014), in less frequent words (Kraska-Szlenk & Żygis, 2012), in low vowels (Brunner & Żygis, 2011), and when following a vowel (Umeda, 1978). Despite these effects, whether or not a language allows linking appears to be a phonological issue that represents a rich and understudied area for investigations into cross-language phonetic interaction. For the acquisition of English by Polish learners, this involves the suppression of vowel glottalization that is common in L1 to produce linked vowel-initial words. The question that is raised in this study is whether high proficiency in a language with like English with *sandhi* linking processes has any effects on an L1 in which the glottalization of initial is the norm.

Our study also seeks to juxtapose the realization of two separate phonetic parameters: the oft-investigated VOT and the linking vs. glottalization of initial vowels. There are phonetic reasons to expect that these parameters may behave differently. Glottalization, despite variation and gradience in its realization, is an inherently privative property. That is, although the strength and robustness of its realization is variable, in each case glottal marking is either present or absent, quantifiable in binary terms. VOT, on the other hand, is quantified on a numerical scale. While boundaries for the phonological categories voiced and voiceless may be identified on this scale, the measurements themselves are not categorical.

#### 4. Experimental studies

This section describes two experimental phonetic studies dealing with the L1 production of Polish speakers with professional level proficiency in English. The first

study deals with voice onset time. The second looks at the realization of word-initial vowels with respect to linking vs. glottalization.

#### 4.1 Experiment 1 – L1 VOT production

This section describes an experiment in which proficient L1 Polish users of English produce word-initial stops in a carrier phrase context. Previous studies (Waniek-Klimczak, 2011; Sypiańska, 2013) have found evidence that the VOT measurements of L1 Polish may be subject to L2 influence. In particular, the aspirated realizations of /p t k/ in English appear to lead to increased VOT in Polish bilinguals' productions of voiceless stops. This study seeks to enhance the findings of those studies with an additional variable associated with a phonetic code-switching task.

##### 4.1.1 Method

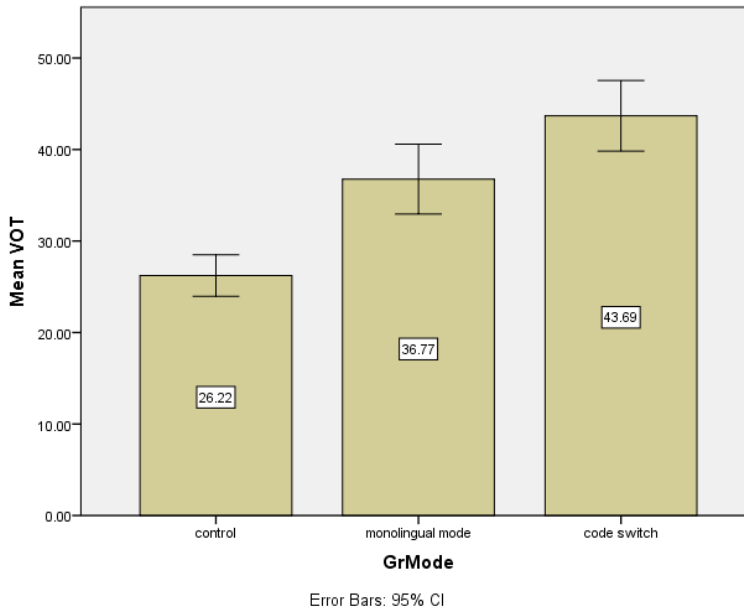
Five L1 Polish speakers served as the experimental group in the VOT study. The speakers were all highly proficient speakers of English (C2 level), employees at the faculty of English at Adam Mickiewicz University in Poznań. That is, the speakers were all English language specialists. In addition, 5 'quasi-monolingual' Polish speakers with elementary (A2 level) proficiency in English served as controls.

A list of 9 monosyllabic Polish words produced utterance-initially comprised the data set for the study. Each of the 9 target words started with a voiceless stop (p, t, or k). The word-list was counterbalanced for place of articulation (3 \* labial, coronal, dorsal) and following vowel quality (3 \* /a/, /e/, /u/) to control for universal effects of vowel context and consonant place on VOT (e.g. Maddieson, 1997).

Three basic conditions were set for data collection. In the first, the control group produced the tokens (2 repetitions in a randomized order) in the Polish phrase *X to nie jest trudne słowo* 'X is not a difficult word'. In the second, the experimental group produced the tokens in the same phrase. In the third, approximately one month after the first recording session, the experimental group produced the tokens in the English phrase *X is an easy Polish word*. In the first two conditions, all instructions were given to participants in Polish. In the third, a native speaker of English ran the recording session and gave instructions in English. The target items were presented to the participants on PowerPoint slides inside a soundproof recording booth at the Faculty of English at UAM. Recordings were made directly onto a laptop computer through an Edirol UA-25 USB audio interface. A total of 270 tokens were collected for analysis: (9 target words \* 2 repetitions \* 5 control group speakers = 90 control tokens + 9 target words \* 2 repetitions \* 5 experimental group speakers \* 2 language contexts = 180 experimental tokens). VOT was measured in Praat according to the standard criteria.

#### 4.1.2 Results

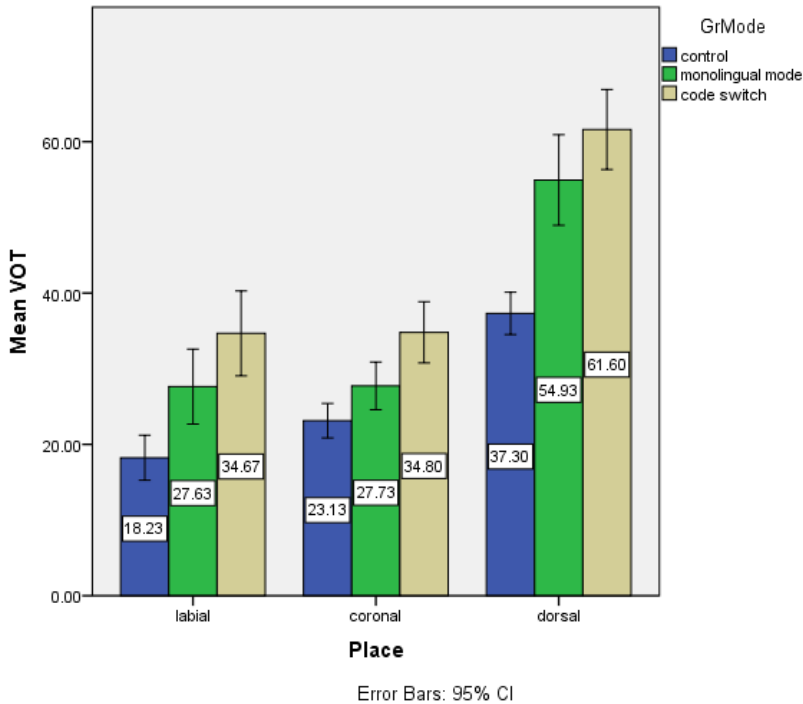
The results of the VOT study are summarized graphically in Figure 1. A one-way ANOVA revealed a significant main effect of condition on VOT,  $F[2,267]=26.5$ ,  $p<.001$ . Post-hoc Bonferroni tests revealed that each of the pairwise comparisons was significant. The bilinguals in monolingual mode produced longer VOT than the quasi-monolinguals,  $p<.001$ . The code-switched items showed longer VOT than those of the experimental group in monolingual mode,  $p=.013$ .



**Figure 1.** Mean VOT values according to group/mode condition.

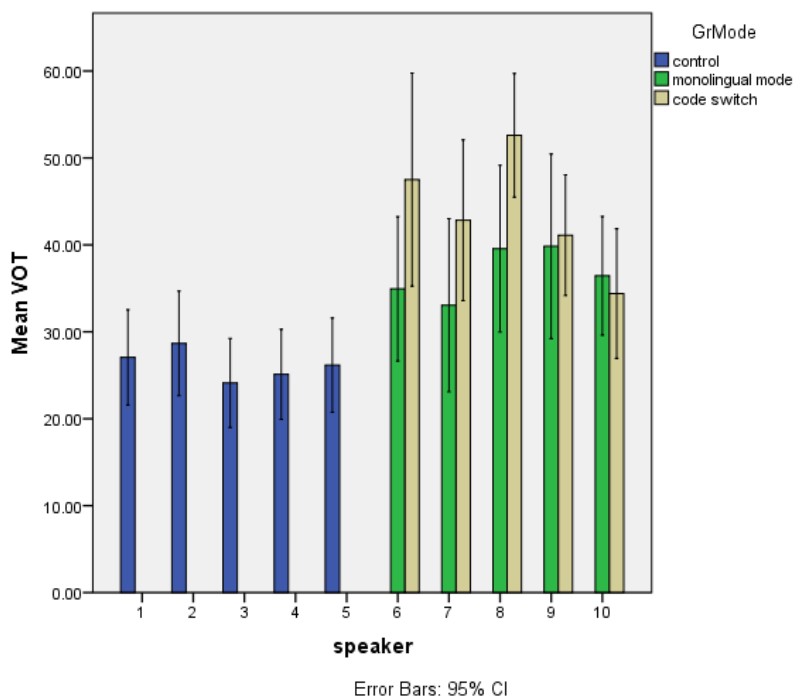
In Figure 2, we see the results sorted for individual places of articulation. The expected effects of place of articulation on VOT were observed,  $F[2,267]=88.5$ ,  $p<.001$ , with dorsals showing longer VOT than the other places,  $p<.001$ . The analysis also revealed a significant condition-place interaction ( $p=.015$ ), by which the increase in VOT in the experimental group was greater in the case of dorsals than for coronals or labials.





**Figure 2.** Mean VOT values by condition sorted for place of articulation.

The results for each of the individual participants are shown in Figure 3. In the figure we can see the general pattern of longer VOT from the bilingual group. With regard to the code-switches, the basic tendency for longer VOTs was less robust than in the group data. T-tests revealed a significant difference between monolingual mode and code switches only in the case of one of the five speakers 9 ( $p=.027$  for speaker 8 in the figure), with two other speakers showing differences that approached significance ( $p=.08$  for speaker 6;  $p=.13$  for speaker 7).



**Figure 3.** Mean VOT values by individual speaker/mode.

#### 4.1.3 Discussion

The results of the VOT study may be summarized as follows. Phonetic drift seems to have occurred in the realization of initial voiceless stops in the Polish produced in a monolingual mode, as evidenced by the difference between the control group and the experimental group. The phonetic drift was especially robust in the case of the dorsal consonants. The effects of the code-switching task, however, seem to be more modest. While the group data showed significantly longer VOTs for the code-switched items, this was only marginally observable in the individual data.

With regard to the research question posed earlier, it appears that phonetic drift may indeed be observed independently of language mode effects in the case of these participants. For L1 Polish speakers who are proficient users of English, this finding is compatible with the findings of Waniek-Klimczak (2011). The effect on the dorsals is also interesting in that it suggests that more robust phonetic realizations are better candidates for phonetic drift. In other words, since dorsals have longer VOT than labials or coronals, they may be more susceptible to CLI effects on VOT.

The language mode results suggest that phonetic performance in code-switching contexts is to a certain degree idiosyncratic of individual speakers. It appears then that the general pattern of longer VOT for the code-switches may be attributable to hyper-articulation on the part of some speakers (cf. Olson, 2012), rather than a systematic

effect of phonetic CLI. In this connection, it must be noted that this study dealt with insertional, rather than alternational code-switches, which may be less conducive to CLI effects. In both Grosjean and Miller's as well as Antoniou et al.'s studies, insertional code-switches were examined, with minimal effects on L1 VOT.

## 4.2 Experiment 2 – linked vs. glottalized vowel hiatus

The next study we will describe deals with glottalization vs. linking of V#V sequences. In English, linking of vowel-initial words is quite common, while Polish has a tendency to show glottalization, which maintains the prosodic integrity of the word-initial vowel. Thus, our study investigates the degree to which L1 Polish speakers with professional level proficiency in English produce linked vowel-initial words under the influence of the L2.

### 4.2.1 Method

Seven L1 Polish speakers served as the experimental group for our study. The speakers were all highly proficient speakers of English (C2 level), employees at the Faculty of English at Adam Mickiewicz University in Poznan. In addition, 20 'quasi-monolingual' speakers with elementary (A2 level) proficiency in English served as controls.<sup>2</sup> The linguistic materials were comprised of 20 Polish phrases which contained vowel hiatus spanning a word boundary (V#V). The data set was counterbalanced for both V1 and V2 quality, which has been found to affect the likelihood of glottalization. Half of the V2 tokens were /e/ and half were /a/. The first vowel was either /i/ or /a/. All of the word-initial vowels were unstressed, which is generally an environment conducive to linking.

The stimuli were presented to the participants on Power Point slides on a monitor installed in a soundproof recording booth. Speakers were instructed to try to read quickly. The experimental group was recorded in both monolingual Polish mode and in an insertional code switching task. In monolingual mode, the target two-word sequences were contained in short phrases (2-5 words). In the code switching task, the target phrases were inserted into an English carrier phrase: *In English the Polish phrase [target] means [translation of target phrase given]*. There was an interval of 2-4 weeks between the recording sessions. Vowel-initial items were coded as linked or glottalized, while the duration of the target phrases was measured in order to calculate speech rate in syllables/second, since speech rate has been shown elsewhere to influence the likelihood of glottal marking. Tokens which were produced more than 1 standard deviation (0.647 syllables/sec) faster or slower than the mean speech rate (6.07 syll/sec) were excluded from the analysis.

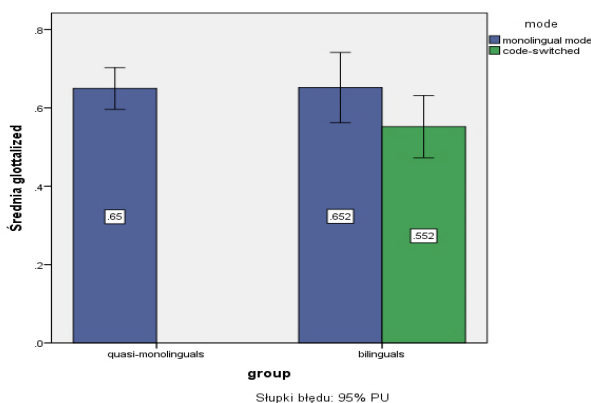
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<sup>2</sup> The discrepancy in the size of the control groups of the two studies stems from the fact that the vowel-initial linking study was carried out in the context of a larger project on glottalization in L1 Polish and Polish-accented English. As a result, a larger corpus of L1 Polish speech was available to us.

#### 4.2.2 Results

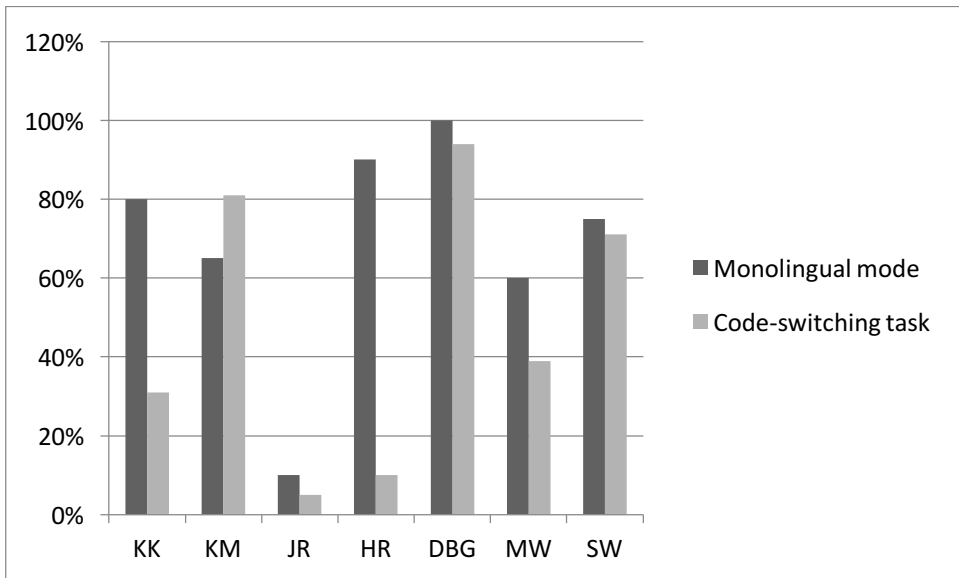
The first set of results to be presented concerns speech rate as a function of language mode and as a function of linking vs. glottalization. Linked phrases ( $M=6.27$ ,  $SD=.630$ ) were produced more quickly than glottalized ones ( $M=5.96$ ,  $SD=.629$ ),  $F[1,575]=33.2$ ,  $p<.001$ . The phrases produced in the code switching task ( $M=6.32$ ,  $SD=.672$ ) were produced more quickly than those in monolingual Polish mode ( $M=5.98$ ,  $SD=.615$ ),  $F[1,575]$ ,  $p<.001$ . A binary logistic regression analysis revealed that rate was a significant predictor of glottalization,  $B=-.771$ ,  $p<.001$ . Lexical frequency was a significant predictor of glottalization, more frequent words (checked against an on-line corpus of spoken Polish: <http://www.nkjp.uni.lodz.pl/spoken.jsp>) were less likely to be glottalized,  $B=-.004$ ,  $p=.026$ ).

The glottalization rates of the individual lexical items ranged from 46.7% to 84.4%. The rates of glottalization of vowel-initial items as a function of speaker group and language mode are summarized in Figure 4. In monolingual mode, the quasi-monolingual group produced glottalization in 64.9% of the vowel-initial tokens, while the experimental group produced glottalization in 65.2% of the cases. Meanwhile, in the code-switched items, glottalization was produced in 55.2% of the word initial vowels. Neither Group (in monolingual mode,  $B=.01$ ,  $p=.96$ ) nor Language Mode (in the bilingual group,  $B=-.42$ ,  $p=.102$ ) was a significant predictor of glottalization in the group data, although the figure suggests that the odds of linking tended to increase in the code-switching.



**Figure 4.** Glottalization rates across group and task.

Results for each of the individuals in the experimental group are shown in Figure 5. Six out of the seven participants produced more linking and less glottalization in the code-switching task. Of these six, however, all but one produced the target items more quickly when code-switched. Thus, on the whole, it cannot be stated that the code-switching task necessarily induced CLI with regard to linking of word-boundary vowel effects; the lower glottalization rates in the code switches may have been the result of faster productions.



**Figure 5.** Individual glottalization rates by task.

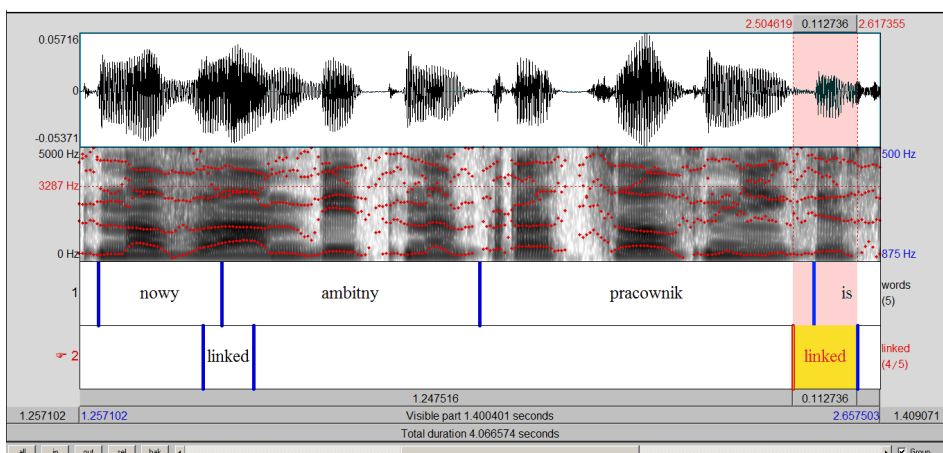
#### 4.2.3 Discussion

As with the VOT study, the goal of the boundary hiatus experiment was to attempt to observe language mode effects independently from possible L2>L1 interference. The results of the study found minimal evidence for the two phenomena. The proficient users of English and the ‘quasi-monolinguals’ produced similar rates of linking/glottalization in the monolingual task. For the group of proficient users of English, the greater prevalence of linking in the code-switching task was mitigated by the effects of speech rate. In what follows, we will discuss possible implications of the negative results of our study.

In the vowel hiatus experiment, code-switched items were produced more quickly than the items produced in the monolingual Polish task. This is in contrast to Olson’s (2012) study in which code-switched items were prosodically prominent and produced more slowly. The present study differs from that of Olson in that the participants were not balanced bilinguals but L1 dominant users who were code-switching into their L1. Thus, it may be suggested that the target items were native and the context was foreign, and switching ‘back’ into one’s L1 may be conducive to increases in speech rate in comparison to L2. An interesting area for future research would be to compare the phonetic performance of different categories of bilinguals performing code-switching tasks.

As with the VOT study, the results of the hiatus experiment suggest that the likelihood of language mixing in phonetic production is an idiosyncratic property of individual speakers. Of the individual participants in the vowel hiatus study, one speaker (HR in Figure 5) produced less glottalization (10%) in the code switching task (as

opposed to 90% in monolingual Polish mode) while producing the code-switched items more slowly (5.9 syll/sec vs. 6.3 syll/sec,  $p=.019$ ). Since this speaker did not show any rate effects on glottalization, it may be concluded that language mixing in the code-switching task induced the observed linking patterns. Informal examination of speaker HR revealed an additional interesting phenomenon. She produced linking not only in the target items, but also at the edges of the target sequences. That is, she often linked the final segment of the *Polish* target with the initial segment of the *English* carrier. An example is illustrated in Figure 6, which shows a spectrogram and waveform display of the Polish target *nowy ambitny pracownik* ‘new ambitious employee’ as well as the word *is* from the English carrier. In the figure we see linking of both the target hiatus sequence in the Polish phrase, and between the final /k/ of *pracownik* and the initial vowel of *is*.



In the group data, the non-significant effects of both speaker group and language mode as a predictor of linking vs. glottalization suggest that this particular feature, unlike VOT, is somehow resistant to cross-language interference. In what follows we will consider the implications of this finding for describing the interplay between phonological theory and current models of L2 speech acquisition.

## 5. General discussion

A question that we consider in this paper is that if the variables of speaker background and task are held constant, why should two different phonetic features behave differently with regard to cross-language interaction? In our studies, VOT showed signs of CLI in monolingual mode while the realization of initial vowels did not. In the code-switching tasks, VOT increased significantly in the overall group data while the likelihood of linking did not.

It appears that the first of these results reflects a systematic aspect of the linguistic competence of the bilingual speakers. In both experiments the bilingual group was compared with a control group producing the same stimuli in a monolingual Polish mode. Thus, the drift that was observed in the VOT may be attributable to the

interference of English. This did not manifest itself in terms of *sandhi* linking, despite the fact that the target items were all phrase-medial unstressed vowels, which are typically linked in English.

By contrast, the results of the code-switching tasks may have been a relic of the carrier phrases in the experimental stimuli, rather than a systematic effect of CLI. While both experiments involved insertional code-switches of L1 Polish items into an L2 English context, the VOT target items were produced at the beginning of the English carrier phrase, so they would be more likely to be characterized by a stronger articulation that could have explained the increase in VOT. While the Polish carrier also put the target items in initial position, Olson (2012) has shown that insertional code-switches may be subject to additional hyper-articulation. At the same time, the longer target items and carrier of the linking-glottalization experiment might be expected to mitigate any tendency for hyper-articulated code-switches. In other words, since the English carrier was longer in the initial vowel experiment, speakers may have had a tendency to 'skip over' the target items, resulting in the observed speech rate effects by which the code-switches were produced more quickly. In future work, it will be necessary to lessen the discrepancy between the carrier phrases. This task, however, may be complicated by the fact that VOT is an inherently 'initial' phenomenon while linking is an inherent 'medial' one.

Returning to the data from the monolingual mode tasks, we may consider implications for theoretical models of L2 phonology. In Flege's SLM, bidirectional CLI is attributable to 'equivalence classification'. When L2 learners classify two sounds as the same across languages, they do not acquire a new phonetic category. In such instances, intense use of the L2 is predicted to lead to a 'compromise' realization of the phone. It appears as if the speakers in our study attributed the voiceless stops in the two languages to the same phonetic category, and that this resulted in more English-like VOTs in L1 Polish. With regard to the realization of initial vowels, one might have expected equivalence classification between glottalized and linked realizations to lead to CLI. This did not occur.

We suggest that the difference in the findings for the two parameters may be explained in terms of the phonological status of the features involved. VOT is a parameter traditionally associated with the phonetic realization of voice contrasts. Under one view, language specific VOT patterns reflect differences in the phonetic implementation of phonological specifications that are equivalent across languages. In other words, a voiceless stop such as /k/ is [-voice], and is phonologically the same object regardless of whether it is realized with aspiration and long VOT. In another view, aspirated stops are specified with a feature [spread glottis], and are phonologically distinct from plain voiceless stops which lack laryngeal specification. If we accept the SLM postulate of equivalence classification, then the VOT patterns observed here support a view in which voiceless stops in both Polish and English are phonologically linked. Consequently, VOT must be an issue of phonetic implementation.

The fact that CLI was not observed in the initial vowel experiment suggests that there is no equivalence classification between glottalized and non-glottalized realizations of initial vowels. In other words, we must conclude that glottalized and linked initial vowels are phonologically distinct in the two languages. At first glance, this may seem surprising, given the fact that vowel glottalization is not a contrastive property in either

English or Polish; neither language has phonemic glottal stops. However, from the perspective of prosodic structure, glottalization vs. linking is far more significant than VOT in that it affects the phonological integrity of individual lexical items. Whether or not a language allows this appears to be a phonological decision. Although the phonological status of boundary realization may be obscured by external factors such as lexical frequency and speech rate, the same is true of phonemic contrasts as well.

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