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VOT across the Generations: A cross-linguistic study of contact-induced change

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Abstract

We investigate VOT of voiceless stops in conversational speech in a transitional bilingual context. We examine the speech of three generations of bilinguals whose Heritage Language (HL) is one of three European languages (Italian, Russian, or Ukrainian) and who also speak English. The data are extracted from recordings of sociolinguistic interviews conducted in Toronto that are contained in the Heritage Language Documentation Corpus (Nagy 2009). We examine word-initial /p, t, k/ in stressed syllables before /a/ and /o/ (~150 tokens per speaker), produced by 18 individuals representing three to five generations of speakers in each language. Unlike in English, voiceless stops in Italian, Russian, and Ukrainian are realized with a short lag VOT, defined as <30 ms. Comparison of the HL patterns to those of monolinguals illustrates contact-induced influence: across the generations, the VOT of these speakers drifts away from the monolingual short lag toward the long lag of English for Russian and Ukrainian. Puzzlingly, there is no cross-generational change for Italian. We discuss possible reasons for these different outcomes as well as contrasting them with the lack of cross-generational change found in analyses of pro-drop.

Introduction

The study presented here forms part of the Heritage Language Variation and Change in Toronto Project (HLVC).[*] This project compares the types of inter-speaker and cross-generational variation that occurs in different parts of the grammar of a range of heritage languages (HL) spoken in Toronto, a city where 44% (2.4 million people) count some

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language other than English as their mother tongue (Statistics Canada 2007). The project compares large languages like Italian and Cantonese (each claiming >3% of the population as mother tongue speakers) to smaller languages like Ukrainian and Faetar. The long-range goals of the project are to better understand what cross-linguistic generalizations are possible about the types of features (or structures or rules or constraints) that are borrowed earlier and more often, and to understand the roles of social factors, on the individual and community levels, in these contact-induced changes.

Previous research shows that bilinguals can produce voiceless stop categories differently in their first language (L1) and their second (L2). For example, simultaneous English-French bilinguals tend to realize English /p, t, k/ with a long lag voice onset time (VOT) and the corresponding French stops with a short lag, as expected for both languages (Flege 1987; Fowler *et al.* 2008). Yet, the L1 and L2 categories appear to be cognitively linked and continuously influence one another. As a result, the bilingual production of stops in both L1 and L2 is different from that of monolinguals: the same English-French bilinguals were found to produce English stops with a VOT shorter than that of English monolinguals, and French stops with a longer lag than that of French monolinguals (Fowler *et al.* 2008). We therefore expect to see that first generation speakers, whom we define as those that reached adulthood in the home country prior to immigrating to Toronto and have since spent at least 20 years in Toronto, will exhibit VOT patterns more similar to those of monolingual speakers, while second generation speakers (born in Toronto, or arriving before the age of six, with at least one first generation parent) and, to a greater extend, third generation speakers (children of second generation speakers) will have patterns more like monolingual English speakers.

Voice Onset Time (VOT) is defined as the duration (in seconds) of the interval between the release of a stop and the onset of vocal fold vibration. It is one of the cues that distinguishes voiced from voiceless (or lenis from fortis) obstruents in many languages (Lisker & Abramson 1964). Voiceless stops in Italian, Russian, and Ukrainian are realized with a short lag VOT, defined as < .03 sec. English, in contrast, has a long lag VOT, defined as > .03 sec. Long VOT is often referred to as 'aspiration'. This difference makes VOT an excellent domain in which to explore sociolinguistic variation induced by language contact and better understand the path of linguistic drift in a transitional bilingual context. Our results reveal variation both within and across the heritage languages and correlations with indices of language contact. Because we are using conversational data, we expect (and find) bigger differences than have been shown in reading task data, given the greater effect sizes seen in less monitored speech styles (Labov 1972, among others).

Our research questions are, therefore:

- Do consistent patterns of change in VOT exist across and/or within languages?
- Are these patterns related to length of time that the family, or the community, has been in Toronto?
- Are these patterns related to (any aspects of) ethnic orientation?

Methods

In order to accurately conduct this research, it is important to compare apples to apples – in the HLVC project the same methods are used to select participants, collect speech samples and analyze data across the languages and across linguistic variables. The languages examined in the project are summarized in Table 1—Italian, Russian and Ukrainian are examined in this paper. Note that they have all been present in Toronto for about a century, but that they differ greatly in the ratio of mother tongue (MT) speakers to

members of the ethnic population. Almost half the Italian population reports Italian as the MT, while about one quarter of the Ukrainian population does so. The Russian figures are not directly comparable, as many people who are not ethnically Russian have Russian as their mother tongue (having come from countries that were part of the Soviet Union). Necessarily, the Russian language will have a weaker link to ethnic orientation in Toronto than languages that are more tightly connected to a particular ethnic background.

Table 1: Sketch of the languages included in the HLVC project with demographic statistics for the Greater Toronto Area

Language	**# MT speakers**	**Ethnic population**		**Date est.[1]**	**Place of origin of HLVC participants**
Italian	186,000	<	466,000	1908	Calabria
Russian	65,000	≈	59,000	1916	St. Petersburg & Moscow
Ukrainian	27,000	<<	122,000	1913	Lviv
Cantonese	170,000	<	537,000	1972	Hong Kong
Korean	49,000	=	55,000	1967	Seoul
Faetar	~100	=	~150	1950	Faeto & Celle St. Vito

In contrast to most previous studies of bilingual VOT based on experimental elicitations (read words or sentences) and examining stable sociolinguistic contexts, we investigate VOT in conversational speech. Specifically, we examine the speech of bilinguals whose Heritage Language (HL) is a European language (Italian, Russian, or Ukrainian) and who also speak English. Because these speakers live in a transitional bilingual context, we focus on inter-speaker variation. The data are drawn from the Heritage Language Documentation

[1] We have determined the data of establishment of the community to be the date of establishment of the first church in Toronto operating in the relevant language. As this does not apply for Faetar, which lacks institutional support and is not mentioned in census data, we use the earliest reported date of immigration among HLVC participants. Further details are available in Nagy (*forthcoming*).

Corpus (Nagy 2009), consisting of sociolinguistic interviews conducted in Toronto with speakers in several generations of six heritage languages, stratified by age and sex. The interviews were conducted in the HL and produced about an hour of conversational speech from each participant, covering topics ranging from speaker's upbringing and interests to their attitudes toward ethnic communities in Toronto. This approach allows us to describe naturalistic speech and requires us to carefully examine contextual effects. The data were collected 2009-2011.

Speakers are recruited from the personal networks (where possible, and otherwise from extensions of these networks) of research team members who are themselves heritage language speakers who have grown up in Toronto. Participants are selected to participate if they self-define as "fluent enough to participate in an hour-long conversation in the heritage language." When complete, the corpus will contain samples of 40 such speakers from heritage languages, distributed across three generation, balanced for age and sex, and exhibiting a range of histories of language exposure and linguistic and cultural orientations. The 34 speakers analyzed here are listed in Table 2, represented by speaker codes which indicate their language, generation, sex, and age. The final character disambiguates among speakers who would otherwise be coded the same. It was not possible to avoid interactions between age and generation, due to limitations of available data, so age is not examined in this study.

Table 2: Speaker sample

Generation	**Russian (N=11)**	**Ukrainian (N=12)**	**Italian (N=11)**
First	R1F55B, R1M47A, R1M56A, R1M62D	U1F85A, U1M46A, U1M85A	I1F71A, I1F73A, I1M62A, I1M75A
Second	R2F17A, R2F20A,	U2F54A, U2F60A,	I2F44A, I2F53A,

	R2F50A, R2M56B	U2M56A, U2M57A	I2F57A, I2M53A
Third	R3F25A, R3F37A, R3M56A	U3F26A, U3F65A, U3M24A, U3M47A	I3F21A, I3F23A, I3M22B
Fifth	--	U5F163A	--

Speakers participate in three tasks beginning with a sociolinguistic interview (Labov 1984), a relaxed conversation conducted in the heritage language and digitally recorded. The goal of this task is to collect naturalistic in-group conversational speech. All interviews are conducted by heritage language speakers whose background is from the same place of origin as the participant (e.g., Calabria, for Italian participants, see Table 1). After this interview, an Ethnic Orientation Questionnaire (EOQ) is orally administered in the HL. Our questionnaire, adapted from Keefe & Padilla's (1987) study of Chicano ethnicity in the US, can be found online at http://projects.chass.utoronto.ca/ngn/pdf/HLVC/short_questionnaire_English.pdf. Participants are asked a range of questions about language use (their own and that of their family and friends), language attitude and cultural orientation. These responses are recorded and later coded and scored to produce numerical EOQ scores for each participant. A picture description task is also conducted, but that is not relevant to this study.

The interview data is transcribed orthographically in ELAN (Wittenburg *et al*. 2006) by native speakers of each HL. This method creates time-stamped transcriptions which are linked to the .wav file of the interview recording, making it possible to conduct visual examination of the audio file in Praat (Boersma & Weenink 2011) from within ELAN. In the transcription file, the first 25 instances of each segment of interest are marked, beginning at a time point 15 minutes

after the beginning of the conversations, to decrease the possibility of examining unnatural speech as the participant gets used to the presence of the recorder and the interview situation. Using the transcription, plus audio and visual cues from Praat, the tokens are segmented to mark the beginning and end of the preceding segment (S), the closure (C) and the release (R) of the voiceless stop, and the following vowel (V). VOT was defined as the duration from the onset of the stop burst to the first zero-crossing of the first periodic wave of the following vowel. The following vowel's duration was measured as a means of controlling for speech rate differences among speakers. Figure 1 illustrates the mark-up for a Ukrainian token of word-initial /p/, in the word *pan* 'gentleman.

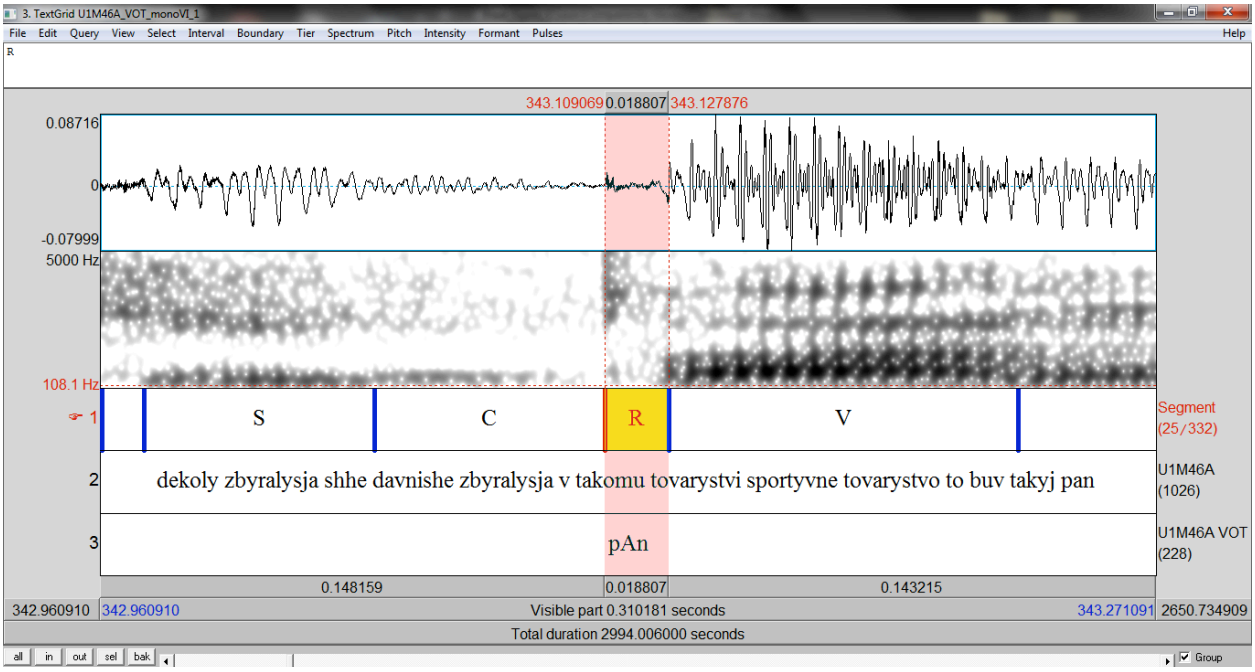

Figure 1: Intervals labeled in Praat for a Ukrainian token of word-initial /p/ by speaker U1M46A (.018 sec. release highlighted)

Only tokens that were clearly audible and free of speech errors and background noise were selected. A Praat script was run to extract the durations of each of these segments. We then conducted repeated measures ANOVAs to check for significant differences among consonants,

between following vowels, and across generations, within each language. Correlations between mean VOT and EOQ scores among individuals were calculated.

Because of the possibility of great variation according to context, we restrict our examination to word-initial /p, t, k/ in stressed syllables before /a/ and /o/. Speech from 34 individuals representing three to five generations of speakers in each of the three HL languages is analyzed. We examined approximately 75 tokens per speaker, three per consonant, for a total of 2,515 tokens.

Analysis

To ascertain the degree of contact-induced influence, we compare the HL patterns to those of monolinguals. We report first on the patterns within each language, and then make cross-linguistic comparisons. Finally, we will look at the connections between VOT and EOQ scores.

The Russian VOT data, summarized in Figure 2, generally illustrate the cross-generational trend that we expect. There is a significant difference between the mean measurements for the third generation vs. the second, although the difference between the first and second generations is not significant. The third generation's VOTs approach those reported for monolingual English speakers (in Montreal) by Fowler *et al*. (2008): /p/ 0.057 sec., /t/ 0.074 sec., /k/ 0.078 sec. The first and second generation VOTs, in contrast, are both within the range reported for Russian monolinguals in St. Petersburg by Ringen & Kulikov (2010): /p/ 0.018 sec., /t/ 0.020 sec., /k/ 0.038 sec.

The durations for /k/ are significantly longer than for /p/ and /t/, as expected for velar articulations. By the third generation, another interesting trend emerges: the VOT duration

for /t/ increases less than the /p/ and /k/ VOTs. This suggests that (some) speakers may be developing two distinct categories: an alveolar English /t/ and a dental Russian /t/. In such a case, Flege's (1987) Equivalence Classification Principle would suggest that the Russian /t/ would be less influenced by English /t/ than would phonemes such as /p/ and/k/ which are more similarly articulated in the two languages (and stored as one category). This "dip" for /t/ is observable in the third generation columns of Figure 2.

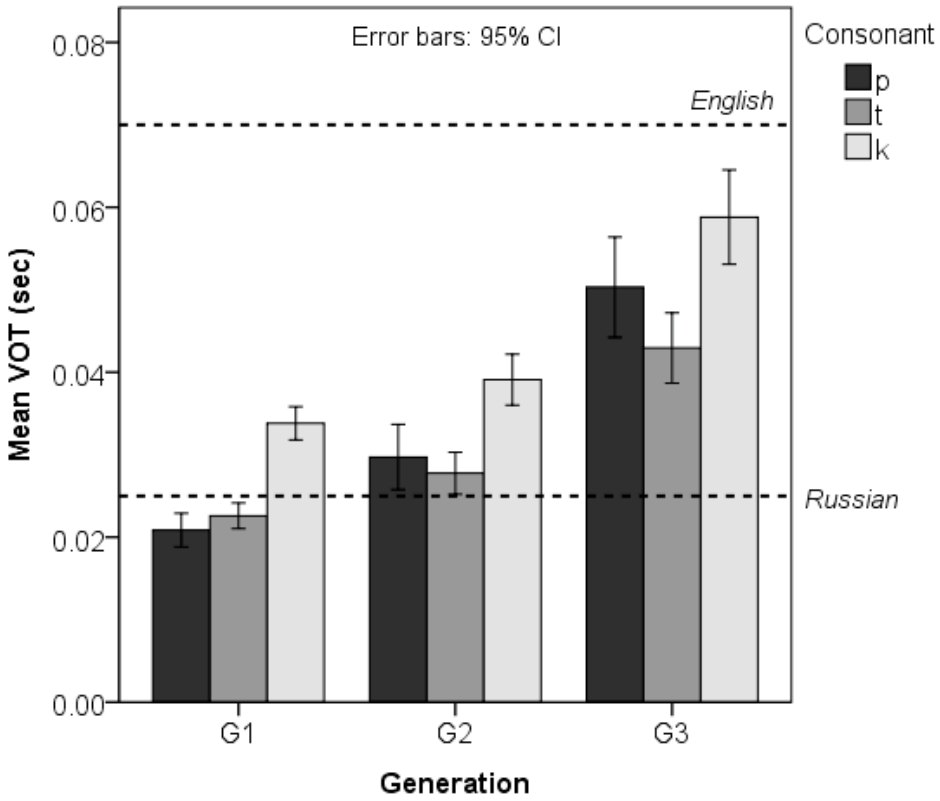

Figure 2: Russian VOT means for stops /p, t, k/ by generation (G1, G2, G3), compared to the Canadian English and homeland standards (based on the literature)

The Ukrainian data (Figure 3) also shows the expected cross-generational changes, although in this case there is a significant increase from first to second generation, but no significant difference from second to third. The same "dip" for the /t/ emerges in the third generation Ukrainian data that was evident in the third generation Russian data. We lack a homeland comparison data sample but believe that VOT in Ukrainian should be much like

Russian. We also were fortunate to record one fluent fifth generation Ukrainian speaker, who is included for comparison. She shows VOT measurements in the range expected for monolingual English speakers.

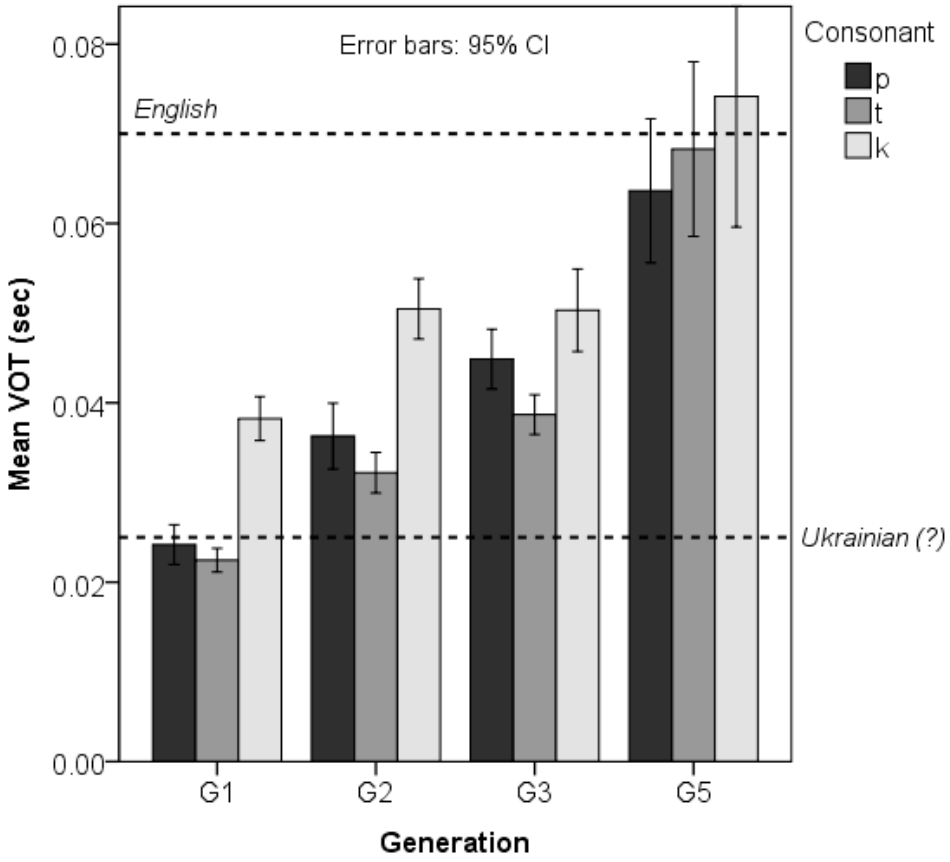

Figure 3: Ukrainian VOT means for stops /p, t, k/ by generation (G1, G2, G3, G5), compared to the Canadian English and homeland standards (based on the literature)

We turn next to the Italian speakers (Figure 4), who behave quite differently from the speakers of the two Slavic languages examined. For one thing, there is no cross-generational increase in VOT. In fact, there is a slight but significant decrease in VOT means from the first to the second generation. All generations show VOTs that are slightly longer than the means reported in Sorianello's (1996:134) study of homeland Calabrese Italian speech, summarized in Table 3. These means are for pre-tonic (not necessarily word-initial), intervocalic, non-phrase-final words produced by three speakers in a sentence

reading task. Further, in Figure 4 we see no evidence of the "dip" for /t/ that the other two languages exhibit, though the similarity of values for /p/ and /t/ in Generation 3 (compared to Generations 1 and 2) suggests that it is almost established.

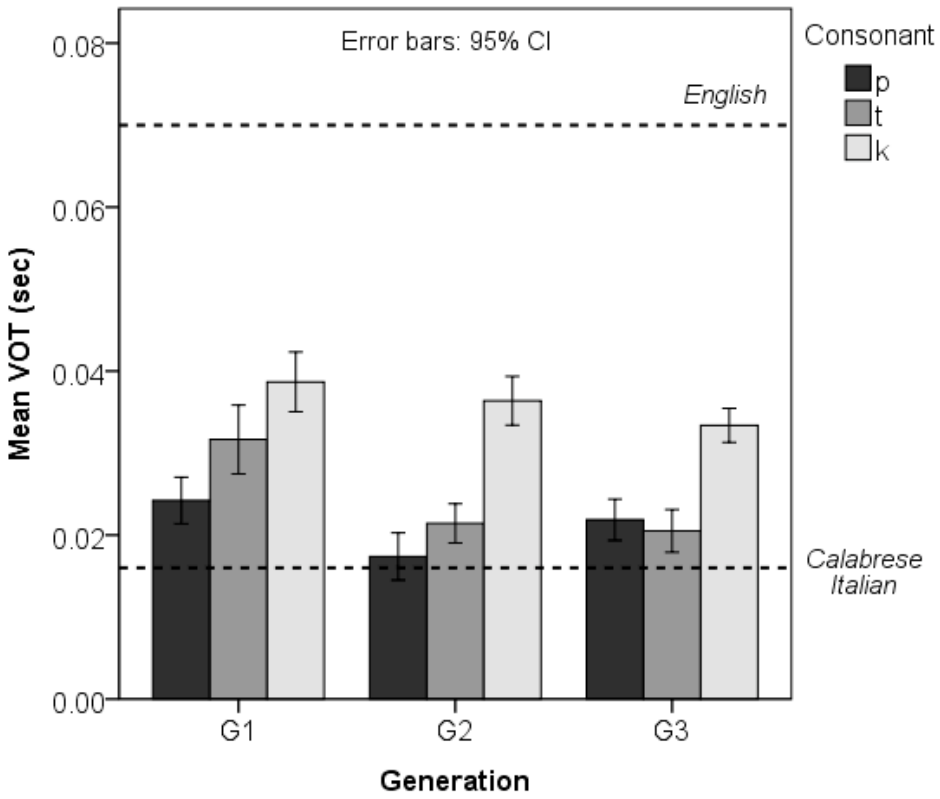

Figure 4: Italian VOT means for stops /p, t, k/ by generation (G1, G2, G3), compared to the Canadian English and homeland standards (based on the literature)

Table 3: Mean VOT values (in sec) in homeland Italian and Calabrese (adapted from Sorianello 1996:134)

	Cosenza dialect		Regional Italian	
	mean	standard deviation	mean	standard deviation
/p/	.017	.03	.014	.07
/t/	.016	.04	.070	.04
/k/	.024	.06	.029	.06

Figure 5 allows for comparison across the three languages, showing quite similar means for the first generation of all three languages, but different cross-generational trends of change in each: a significant change only between second and third generations in Russian but between first and second in Ukrainian, and a significant *decrease* from first to second generation for Italian. For comparison, we indicate English (from Fowler *et al.* 2008) and an averaged homeland value (from Ringen & Kulikov 2010 for Russian, Sorianello 1996 for Calabrian Italian). Note that these measurements come from sentence reading data, while the HL data is from conversational speech.

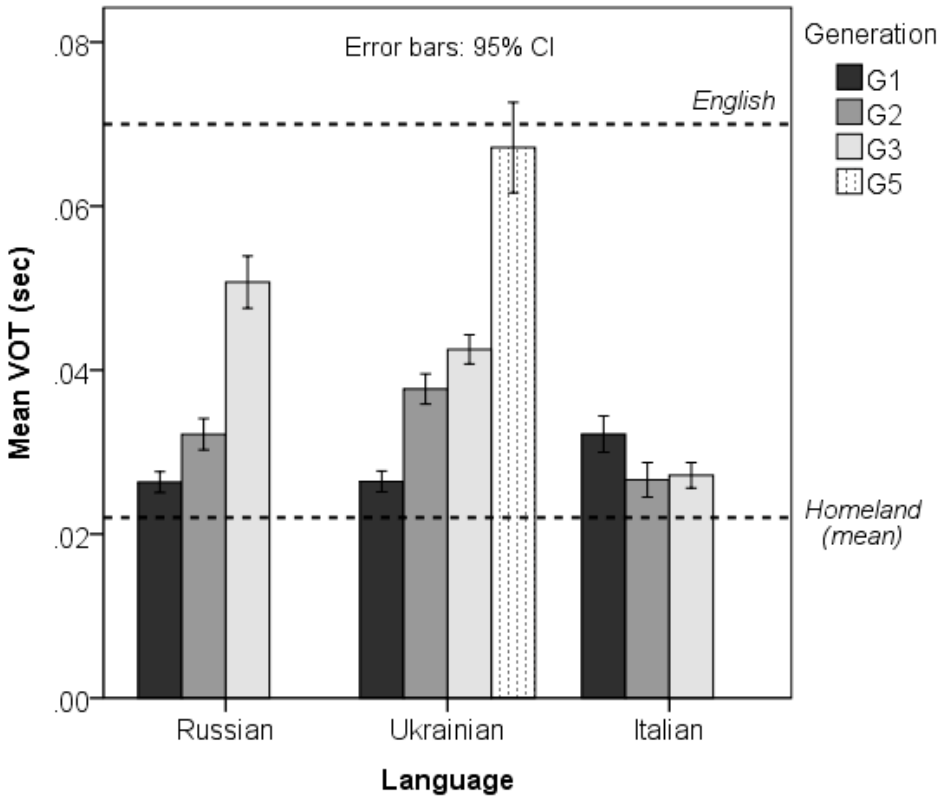

Figure 5: Cross-generation and cross-linguistic comparison of VOT means (from Hrycyna et al. 2011)

We were concerned that differences in speech rate, likely slower speech in (some) third generation speakers than in (some) first generation speakers, might account for some

apparent differences in VOT. That is, slower speech from the less fluent third generation speakers might result in longer VOT duration measurements for that group. To control for that, we calculated the duration of the following vowel (which would also be longer in slower speech). Figure 6 shows these measurements for the three heritage languages. Note that for Italian speakers, the later generations have longer vowels, suggesting slower speech, as expected. Therefore, a cross-generational decrease in speech rate cannot account for the anomalous VOT results for Italian. If anything, the pattern illustrated in Figure 4 is an attenuation of the actual pattern: second and third generation VOTs would be even shorter if normalized according to the vowel durations which stand in for speech rate measures. Russian patterns similarly to Italian. For Ukrainian, the fifth generation speaker has longer mean vowel duration than the other speakers, possibly indicating slower speech and a partial account for her much longer VOT measurements. However, the third generation shows a (non-significantly) lower mean vowel duration than the first and second generations, so there is no reason to question the VOT trend shown in Figure 3.

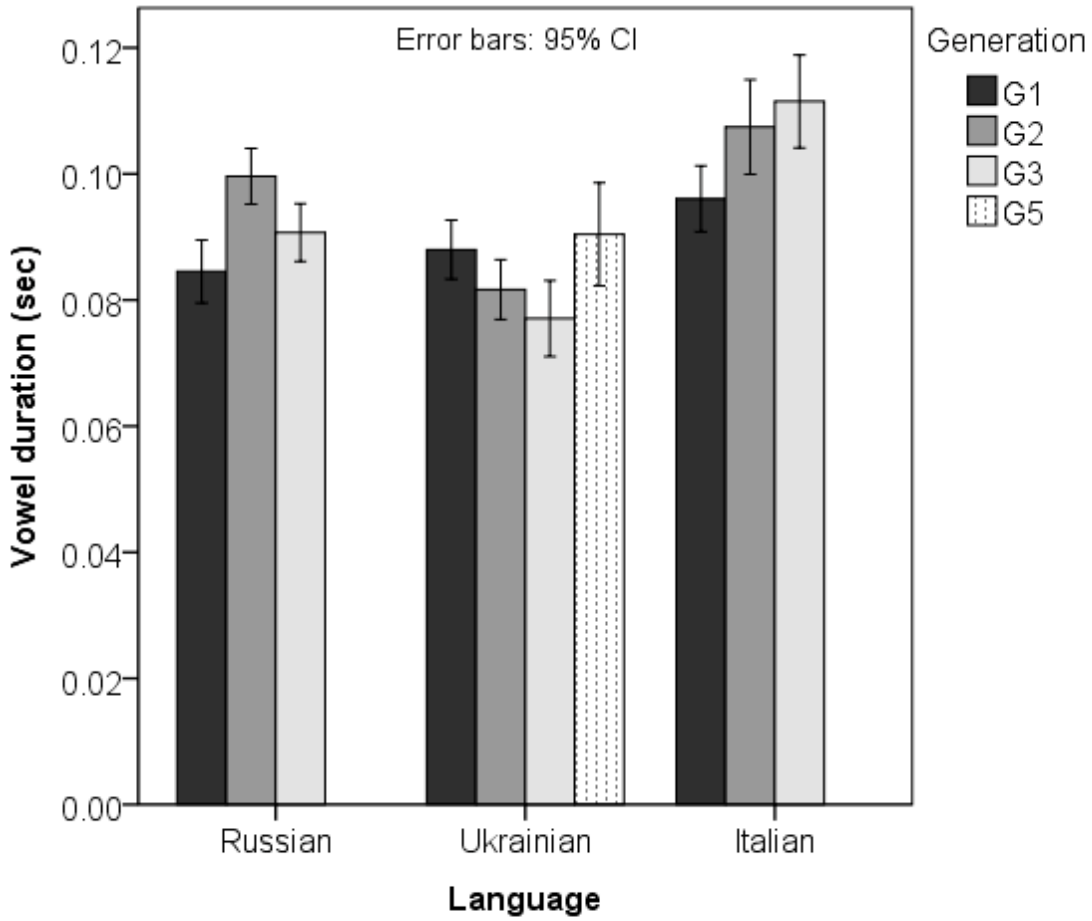

Figure 6: Italian mean duration of /a/ and /o/ vowels following the consonants examined for VOT, by generation.

The VOT differences are confirmed statistically by repeated measures ANOVAs conducted within each language. We find a main effect for Generation in Russian ($F(2,7)=6.10$, $p<.05$) and Ukrainian ($F(2,7)=12.01$, $p<.01$), but not Italian ($F(2,7)=1.299$, $p=.33$). Bonferroni post-hoc tests show VOT to be significantly higher for G3 compared to G1 in Russian ($p<.05$; adjusted for multiple comparisons), higher for G5 compared to the other generations in Ukrainian ($p<.01$-$.05$), and no generational effect for Italian. All languages have a significant effect for Consonant, with /k/ significantly longer than other consonants, with p values ranging from 0.001 to 0.05.

We turn next to the effect of Ethnic Orientation on VOT. It is important to note first that EOQ scores are highly related to generation: first generation speakers in all languages have higher overall EOQ scores than second generation, which, in turn are higher than third generation. This trend is evident in the vertical dimension of Figure 7. (There is one exception: Italian Generation 2 and 3 EOQ mean values are similar, but their ranks are switched.) The overall scores are necessarily related to generation, to a certain extent. For example, there is a question about where the participant and her parents were born, and this is fully dictated by our definition of generation. Therefore, we turn to a more fine-grained analysis of subparts of the EO questionnaire.

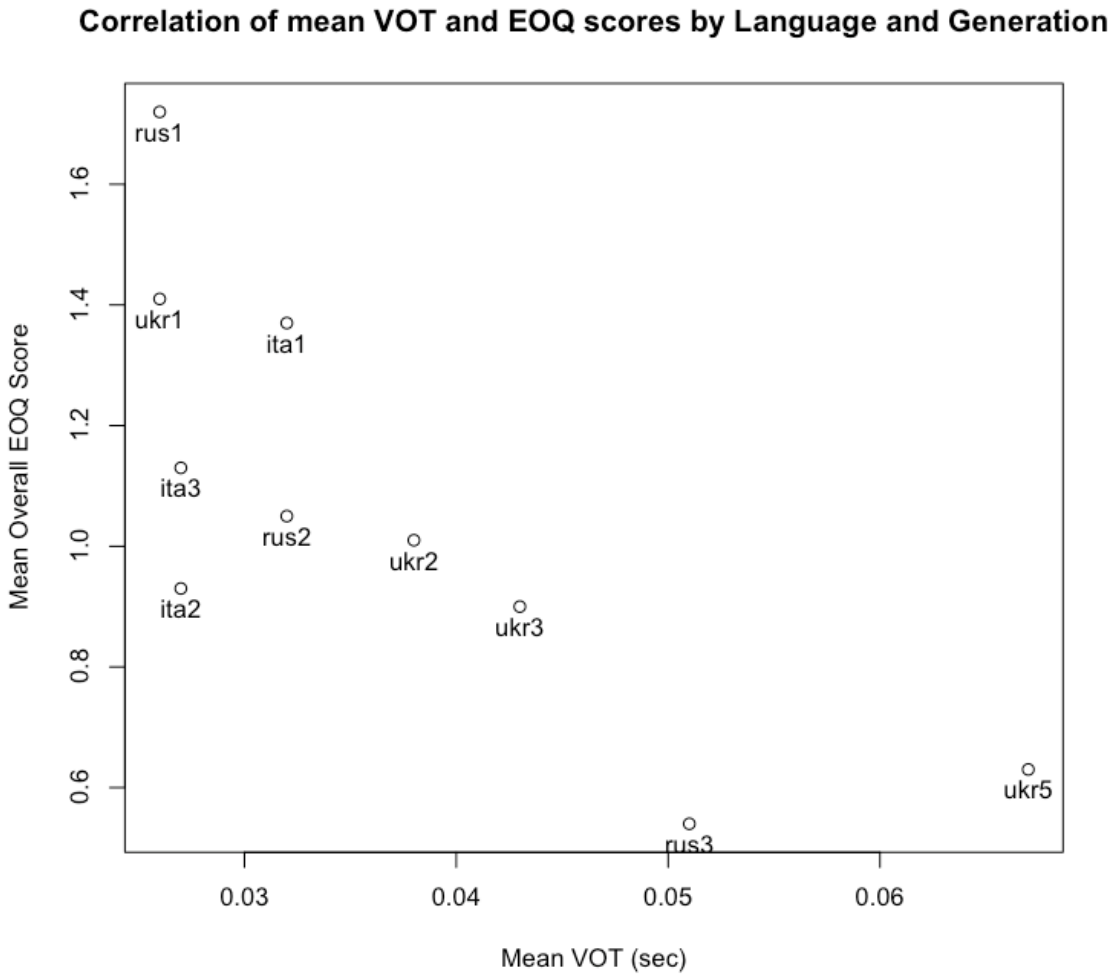

Figure 7: Average VOT on x-axis (higher values are more English-like) and average EOQ score on y-axis (lower values are more English-oriented) for each generation, each language.

We look first at relationships within the EOQ scores for the corpus as a whole. EOQ scores from 35 questions were divided into six indices of different aspects of the participants' linguistic and cultural behavior and attitudes. Table 4 illustrates the lack of correlation among these different subsets of EOQ responses, for 114 Italian, Russian and Ukrainian speakers. Of all the pairs, only one is highly correlated ($r > .5$, *cf*. Cohen, 1988:83) and significant ($p < 0.05$): the correlation between cultural environment and language choice. This correlation holds across the languages as well as within each language. Given that these subsets are, therefore, with the one noted exception, independent measures, we might expect at least some of them to correlate to a linguistic pattern. That is, we might expect some correlation between attitude toward the HL and its speakers and how a participant speaks the HL.

Table 4: (Lack of) correlation across EOQ indices: Pearson's product-moment correlations

	Language choices	**Cultural envir.**	**Language use**	**Cultural choices**	**Discrim-ination**
Ethnic ID	0.23	0.10	0.30	0.29	0.01
Language choices		**0.81**	0.21	0.20	-0.11
Cultural envir.			0.25	0.12	-0.17
Language use				0.10	-0.02
Cultural choices					0.09
Discrim.					

We turn now to look at correlations of these different measures of Ethnic Orientation and VOT scores, using data from the 22 speakers for whom we have both VOT data and most of the responses to the EOQ. Table 5 provides Pearson's r values for each pairwise correlation. There are two strong correlations in the data for all three languages combined. The less a speaker uses their HL, the more their VOTs resemble English VOT values. And the lower the overall HL, the more English-like the VOT. These two correlations are also found when correlations are calculated just within the Russian and Ukrainian data sets. No strong correlation between VOT and any EOQ score exists for Italian. We must be careful in considering the many strong correlations in the Russian column, given that they are based on responses from only four speakers. However, where there is socially-demarcated variation (by generation) in a language's VOT scores, we find that these values correlate to EOQ, and where there is no such social-marking, we find no correlation to EOQ (note the extremely low r-values for Italian).

Table 5: *Correlation between EOQ indices and VOT: Pearson's product-moment correlations*

EOQ topic	**Italian** (n=7)	**Russian** (n=4)	**Ukrainian** (n=10)	**3 languages combined** (N=21)
All questions	0.01	**-0.97**	**-0.74**	**-0.66**
Ethnic Orientation	0.08	**-0.71**	-0.37	-0.31
Language Choices	0.32	**-0.96**	-0.24	-0.29
Cultural Environment	0.01	**-0.89**	0.01	-0.16
Language Use	0.14	**-0.71**	**-0.60**	**-0.57**
Cultural Choices	0.39	-0.34	**-0.51**	-0.29
Perceived Discrimination	-0.34	**-0.95**	-0.20	-0.43

Summary and Discussion

To answer our research questions:

- Do consistent patterns of change in VOT exist across and/or within languages?

  No. We see the expected pattern of drift toward English VOT across generations for two of the three languages, but not for Italian. We see evidence of the development of separate phonemic categories for English and the HL in the same two languages, but again not for Italian.

- Are these patterns related to length of time that the family, or the community, has been in Toronto?

  For two of the three languages, we see an effect of the length of time that the family has been in Toronto (reflected by cross-generational differences). The three language communities examined here have all been present in Toronto for just over a century, so we cannot consider this factor at the community level to be important. Although the beginning of immigration from the three countries is at about the same timepoint, the Italians immigrated at a much higher rate during the earlier periods of settlement, while most Russians and Ukrainians came more recently, and in a series of discontiguous waves. The long-time presence of a large Italian-speaking community may play a role in inhibiting English influence, but this remains to be seen once other variables are examined.

- Are these patterns related to (any aspects of) ethnic orientation?

  Yes, we see correlations between VOT of individuals and their scores on the EOQ as a whole and in the subsection related to language use, again with the caveat that

Italians are an exception. No other subsets of the questionnaire play a consistent role.

While it is true that in no case are English patterns entirely adapted in the HL spoken by later generation speakers in Toronto, we see a range of linguistic behaviors across these three languages. At this point, we can only speculate about reasons for the different behaviors. As noted at the outset, the goal of the HLVC Project is to gather sufficient data, using controlled methodology, to move beyond such speculation. As we are not there yet, here are some speculations that will become testable hypotheses in later stages of the project, once more linguistic variables are analyzed:

- Because there is such a large, long-time Italian community in Toronto (10% of the city is ethnically Italian, and prior to 1991, it was by far the biggest source of immigrants to Toronto, Statistics Canada 2009), there is likely a great range of linguistic abilities. It may be that only the most fluent speakers come forward to volunteer for research projects like this one, and so we only see the very "best" speakers – those who maintain Italian as a quite different system from English. There is also a lot of institutional support for Italian in Toronto, meaning that many third generation speakers may get a great deal of input from the classroom, not just their family. This could account for the maintenance of homeland-like standards (Vanessa Bertone, p.c.). Additionally, Italians report discrimination against their group early in their history of migration to Toronto. This may have induced pressure early on to assimilate to English norms, possibly reducing the number of earlier immigrants who passed along their HL to future generations. This would

decrease the pool of "not so careful" speakers from which we draw our Italian sample.

- Ukrainian was an oppressed language in its homeland, outlawed from time to time under Russian or Polish hegemony. One of the goals of immigrants to Canada from Ukraine was to find a place where their culture and language could be practiced. As a result, there is a strong network of institutional support for Ukrainian, resulting in a variety of contexts beyond the family in which Ukrainian is spoken in Toronto (Melania Hrycyna, p.c.). 20% of people whose mother tongue is Ukrainian report that it is the language that they use most often at work (Statistics Canada 2010). This means that people born in Toronto may speak Ukrainian with a wide range of people outside the home, possibly accounting for shared norms between second and third generation speakers.
- In contrast, Russian was never an oppressed language in its homeland. Russian immigrants may therefore not feel as strong a cultural pull to maintain their HL, (Natalia Lapinskaya, p.c.). However, 24% of Russian mother tongue speakers report that Russian is the language they used most often at work (Statistics Canada 2010). Given the similarity in rates of usage of the HL at work, it is not obvious why, for Russians, the shift toward a more English-like VOT comes between the second and third generations, while for Ukrainian, it is between the first and second.

To highlight the importance of testing such hypotheses with a range of linguistic variables before drawing conclusions, we conclude by contrasting the VOT findings reported here to the patterns established for a morphosyntactic variable, pro-drop, or the variable surface

presence of subject pronouns. Also using conversational data from the HLVC corpus, in some cases from the same speakers, Nagy et al. (2011) reported no significant differences between generations in either the rate of pronoun use or the factors conditioning pronoun presence in three HLs: Russian, Cantonese, and Italian. Although the three languages have different rates of usage (and represent partial, radical and canonical pro-drop languages, respectively), they do not exhibit cross-generational differences. Considering the divergent outcomes of these two studies, it is evident that statements regarding the types of contact-induced change in a certain context must be specific regarding both linguistic and social factors.

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