VOICE ONSET TIME IN SPANISH-ENGLISH SPONTANEOUS CODE-SWITCHING

Page E. Piccinini[1], Amalia Arvaniti[2]

[1]University of California, San Diego, [2]University of Kent
ppiccinini@ucsd.edu, a.arvaniti@kent.ac.uk

ABSTRACT

Research on the phonetics of code-switching has focused on voice onset time (VOT) and has yielded mixed results regarding cross-language interaction, possibly due to differences in data used (scripted vs. spontaneous speech) and populations examined (L1 vs. L2 dominant, early vs. late bilinguals). Here VOT was measured in a corpus of spontaneous code-switching speech elicited from a homogeneous group of early bilinguals in conversation with and without distraction (completion of jigsaw puzzles). The distraction meant to increase cognitive load, a manipulation that could affect phonetic realization. Both English and Spanish VOT were shorter at code-switching points than in comparable monolingual utterances. English VOT lengthened overall under increased cognitive load (but remained shorter in code-switching contexts). These results support previous findings of VOT shortening in code-switching for both English and Spanish, and confirm that the effect applies in the natural speech of early bilinguals.

Keywords: code-switching, bilingualism, voice onset time, Spanish, English

1. INTRODUCTION

In bilingual research, code-switching has been well studied in regards to grammatical structure [18], [20], [24], [21], [4], [16]. Fewer studies, however, have examined the phonetics of code-switching (but see [8], [6], [1], [13], [17], [3]). Yet, code-switching provides an interesting context in which to examine bilingual speech production as it offers a window into bilingual processing in a natural context.

Past studies on the phonetics of code-switching have produced mixed results. Some found no difference between phonetic productions in monolingual versus code-switching utterances [8, 13]. In others, differences were found for only one of the languages, generally the speakers' L2 [1], [3]. In yet a third set of studies, effects were found for both languages, but they were asymmetrical: only one language showed a shift of phonetic categories towards the other language, while the other language showed the opposite effect [6]. Olson [17] found that such asymmetries depend on language dominance: in his study the dominant language category (English or Spanish VOT) converged towards the non-dominant language, but not vice versa.

There are several possible reasons for this lack of agreement among studies. First, not all studies tested the same populations: [8], [6] and [17] tested late bilinguals, while [1] and [3] tested early bilinguals. In [1] and [17] speakers were L2 dominant, while in other studies they were L1 dominant (e.g. [6]), or dominance was unclear (e.g. [3]). In some studies the participant population was relatively uniform in age and other social characteristics, e.g. [8], [6], but in others participants varied significantly in this respect, e.g. [3]. In addition, studies used widely different tasks. Significantly, with the exception of [3] who examined spontaneous speech, studies relied mostly on scripted materials and tasks of uncertain ecological validity ([8], [6], [1]), a practice that is problematic in the study of a phenomenon that is primarily social and interactive in nature ([10], [16], [11]).

The current study addresses these concerns by examining the effects of code-switching on VOT (1) in spontaneous speech, and (2) with a homogeneous group of early Spanish-English bilinguals who are now English (L2) dominant. By using spontaneous speech it is possible to examine whether previously reported effects of code-switching on phonetic parameters are real or just task artifacts. By focusing on a homogeneous group of early bilinguals we can further test if effects are present in this specific bilingual population. Finally, by adding a distraction to one of the study's tasks it is possible to test whether doing so increases cognitive load substantially enough for it to have an effect on VOT in the same way code-switching does.

2. METHODS

2.1. Materials

Three conversational prompts were chosen with the help of a Mexican-American Spanish-English bilingual undergraduate researcher. The prompts were selected to be culturally appropriate so as to elicit natural conversations. Prompts, accompanied by pictures, asked participants to talk about their thoughts on and posed questions about their experiences with the following three topics: *Quinceañera*, a girl's 15th birthday party that marks an important milestone in Mexican-American culture; *Chavo del 8*, a popular Mexican TV show also shown in the United States on Spanish TV channels; *Día de los Muertos* or Day of the Dead, an important holiday in Mexican and Mexican-American culture to honor and celebrate the dead.

2.2. Speakers

Fourteen Spanish-English bilinguals from Southern California and of Mexican-American heritage participated in the experiment (the data of one female participant who turned out to be a speaker of Puerto Rican Spanish was discarded). The speakers' average age was 20.2 years and ranged from 18 to 24 years. Based on their answers to the Language Experience and Proficiency Questionnaire (LEAP-Q) [15], which participants filled out in English prior to taking part in the study, they all self-identified as fluent speakers of both languages. They were exposed to both Spanish and English before the age of six and continued to use them both in everyday life. Nine out of the thirteen speakers reported English as their dominant language, with only four choosing Spanish. None reported any history of speaking or hearing disorders.

2.3. Procedures

Speakers participated in pairs. Partners knew each other, as a pilot study showed that speakers would not code-switch unless they were already familiar with their partner. Four pairs were female-female and three female-male (total 11 females, 3 males).

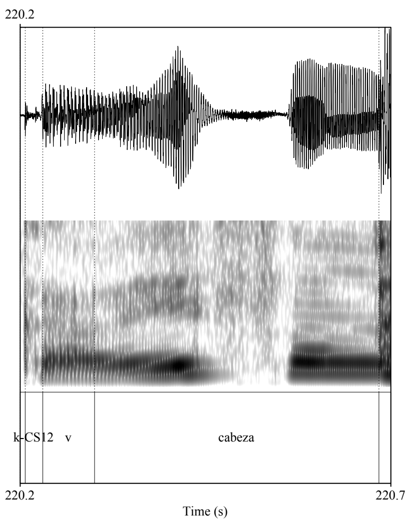
Speakers took part in two tasks the order of which was counterbalanced across pairs. In the Conversation Task they were given one of the three prompts with accompanying picture(s) and told to read the prompt and discuss it using the pictures. In the Conversation with Puzzle Task (henceforth "Puzzle Task") jigsaw puzzles were used as a form of distraction. There were four puzzles in total, each consisting of twelve 2 inch × 2 inch pieces. Each puzzle was of a different animal one would find at the zoo; all puzzles were designed for children ages three and up. The puzzles were deliberately selected to be easy, as the aim was to provide a mild distraction, not stifle conversation due to the demands of the puzzles.

The experimenter was not present for the conversations, which lasted about 15 minutes for the Conversation Task and 9 minutes for the Puzzle Task. Conversations were recorded in a sound-treated booth using Praat [5] and an A-to-D converter (at a sampling rate of 48 Hz with a quantization rate of 16-bit). The recordings were in stereo using two Earthworks SR77 microphones.

2.4. Annotation and Measurements

VOT was measured for word-initial voiceless stops /p/, /t/, and /k/. Measurements were taken from the onset of the burst to the onset of the following vowel (/t/s judged to have been flapped were not measured). See Figure 1 for an example. The duration of the word (VOT plus remainder of word) was also measured and divided by the number of its phonemes to provide an average phoneme duration; this was subsequently used as a measure of speaking rate.

Figure 1: Example of segmentation for the Spanish word "*cabeza*" ("head").



Tokens were coded according to whether the stop occurred in a code-switching utterance or a monolingual utterance. Utterances were coded as monolingual if only Spanish or English was used (though clearly both languages are activated to some extent in any conversation in which speakers switch between their two languages). Due to a lack of clearly defined norms for code-switching, for the purposes of this study a "code-switching utterance" was operationally defined as an utterance that included both languages, had a pause of less than 300 ms between languages at switch points, and included no false starts. Code-switching tokens were thus taken from words both before a code-switch and after a code-switch point as long as they were within a "code-switching utterance". The total number of stops measured by language and context (monolingual or code-switching) is reported in Table 1. For additional information see [19].

Table 1: Total number of monolingual (ML) and code-switching (CS) tokens across and within tasks (C = Conversation, P = Puzzle) by language.

	English		**Spanish**		
	ML	*CS*	*ML*	*CS*	**Total**
C Task	373	91	746	191	1401
P Task	147	30	318	126	621
Total	520	121	1064	317	2022

3. RESULTS

3.1. The corpus

The corpus included 159.6 minutes of speech, 104.3 minutes from the Conversation Task and 55.4 minutes from the Puzzle Task (for one pair of speakers the recording of the Puzzle Task was lost due to experimenter error). The corpus included a total of 2022 instances of word-initial voiceless stops. As can be seen in Table 1, there were fewer tokens in the Puzzle Task than the Conversation Task. This is likely due to the shorter duration of the conversations in the former. Nevertheless, the percentage of code-switches is similar across tasks: 20% in the Conversation Task and 25% in the Puzzle Task. (Note that these numbers do not reflect the number of times code-switching occurred, only the number of times a word beginning with a voiceless stop occurred in each context.)

The corpus was also analyzed for pauses and disfluencies in order to ensure that the Puzzle Task had not resulted in desultory or disfluent conversation between long pauses during which participants worked on the puzzles. Any period of silence of more than 300 ms was considered a pause. A paired t-test showed no significant difference between tasks in the percentage of time filled by pauses [$t(5) = -1.21$, *n.s.*], and no speaker-specific differences were found for the duration of within-speaker pauses between the two tasks [$t(11) = -1.04$, *n.s.*]. Similarly, a paired t-test for disfluencies per minute for each speaker – where disfluency was defined as any instance where a speaker stopped producing a word before completing it – showed no differences between tasks [$t(11) = 0.17$, *n.s.*]. Based on the above, we conclude that the solving of jigsaw puzzles did not affect the participants' speech to the point of stopping them from conversing, nor did it lead to an increase of disfluencies or pausing. For more information about the corpus see [19].

3.2. Monolingual versus code-switching VOT

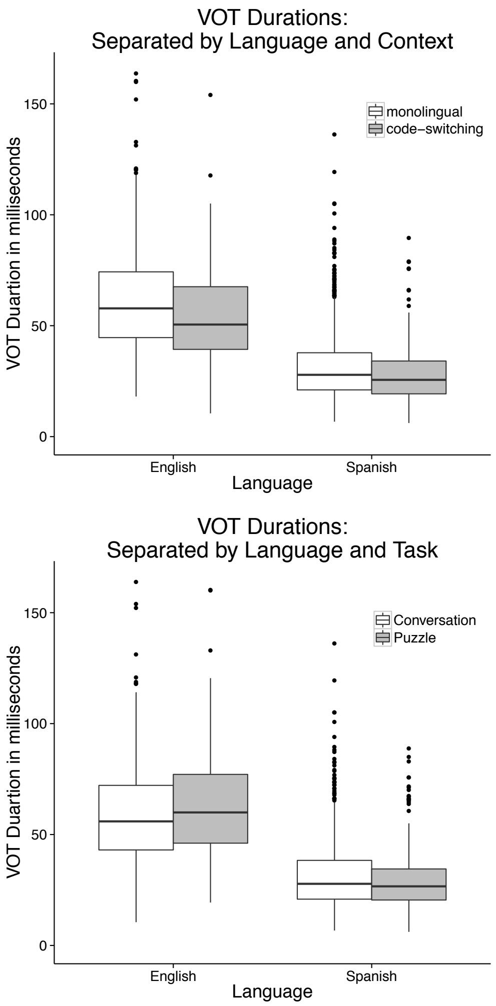
To test for significant effects, linear mixed effects models were run in R [22]. The dependent variable was VOT in ms log-transformed. The fixed effects were language (English, Spanish), context (monolingual, code-switch), task (Conversation Task, Puzzle Task), and place of articulation (bilabial, alveolar, velar). In order to take possible speaking rate effects on VOT duration into account, the (log-transformed) average phoneme duration in the words from which VOT was extracted was included in the model as a covariate. Language, context, and task were included as interactions. All categorical variables were coded using contrast coding; as such, place of articulation was included as two fixed effects, bilabial versus lingual (alveolar and velar), and alveolar versus velar. A random slope for speaker by language, task, and context was included, allowing us to factor out individual differences. A random slope for dyad of speakers by language, task, and context was also included, allowing us to factor out any effects due to individuals being paired with other specific individuals. This was the maximal, uncorrelated random-effects structure that converged. There were no interactions in the random effects structure, only random slopes for each main effect included. Significance of fixed effects was assessed using model comparison. Significance was set at $p < 0.05$.

There was a significant effect of language, such that Spanish tokens had shorter VOTs than English tokens [$\beta = -0.31$, $SE = 0.02$; $\chi^2(1) = 24.93$, $p < 0.001$]. There was also a significant effect of context, with code-switching tokens having shorter VOTs than monolingual tokens [$\beta = -0.04$, $SE = 0.01$; $\chi^2(1) = 6.97$, $p < 0.01$]. Three other fixed effects were also significant. First, as expected, bilabial voiceless stops had shorter VOT than lingual voiceless stops [$\beta = 0.13$, $SE = 0.01$; $\chi^2(1) = 116.97$, $p < 0.001$], and alveolar voiceless stops had shorter VOT than velar voiceless stops [$\beta = -0.06$, $SE = 0.01$; $\chi^2(1) = 43.50$, $p < 0.001$]. Average phoneme duration also showed a positive correlation with VOT [$\beta = 0.24$, $SE = 0.02$; $\chi^2(1) = 164.28$, $p < 0.001$]. Finally, there was a significant interaction of language and task [$\beta = -0.06$, $SE = 0.02$; $\chi^2(1) = 5.76$, $p < 0.05$]. Follow up regressions run separately by language found that, VOT was longer in the Puzzle Task for English [$r = 0.09$, $p < 0.05$], but the effect was not present for Spanish [$r = 0.03$, *n.s*]. No other interactions were significant: in particular, there was no interaction between language and context (monolingual, code-switch). See Figure 2 for data pooled across place of articulation.

4. DISCUSSION

The present study examined spontaneous code-switching as produced by a homogeneous group of largely L2 dominant bilinguals. The results showed that although speakers did maintain distinct VOT categories in English and Spanish, their code-switching tokens were different from monolingual tokens. This is prima facie evidence that code-switching does affect the phonetic production of bilinguals even when they are in what can be seen as a generally bilingual mode – i.e. a mode in which both languages are in use – as in the present study. Thus the results confirm that, at least among early bilinguals, code-switching effects reported in earlier studies are not an experimental artifact but apply in spontaneous speech as well.

Figure 2: Boxplots of VOT durations by language and context (top) and language and task (bottom).



For English, the effects of code-switching were compatible with those of [1], [3], [6], [17], all studies reporting effects of the non-dominant on the dominant language's VOT (here, an effect of Spanish on English), but not vice versa. In English this effect applied also in the Puzzle Task, though without the cumulative effect we had anticipated due to the higher cognitive load introduced by puzzle solving (cf. Figure 2).

The Spanish VOT results were also similar to those reported in some other studies, e.g. [6], showing somewhat shorter VOT in code-switching. It is possible that sociolinguistic or cognitive factors affected the results, as suggested, e.g. in [6] about their data. It is worth noting, however, that the Spanish VOT shortening reported here was very small. This likely reflects the fact that short-lag VOT is not easily amenable to durational changes, as documented by studies with both monolinguals, [9], [2], and bilinguals, [23], [14], in a variety of languages. This characteristic of short-lag VOT may well be the reason why effects on Spanish VOT have been inconsistent across studies; cf. [6], [17], [3]. Whether this explanation holds can only be determined by testing bilinguals speaking languages with similar VOT categories but different distributions, such as English [7] and Navajo [12] both of which have long-lag VOT but with Navajo values being substantially longer.

Finally, we note that the present study examined a group of early bilinguals who are now dominant in their L2 and form a homogeneous sample in that they were raised in the same area and were of similar age. The fact that our results are not identical to those of previous studies – such as [6, 1, 17, 3] inter alia – indicates that both age of acquisition and current language dominance play a part in code-switching speech production: both languages in the present study were affected by code-switching, but with phonetic productions moving towards the L1's categories, not the dominant language's categories. Future work should thus consider not only age and order of acquisition but current dominance as well to ensure homogeneity in groups of bilinguals studied. Doing so will allow us to better compare results across studies, and understand how different factors affect bilingual speech production.

5. CONCLUSION

The present study examined VOT in spontaneous code-switching speech elicited from a homogeneous group of English-Spanish early bilinguals. The results show that speakers had shorter VOT in code-switching contexts in both English and Spanish, though the effects were more pronounced for English, confirming the greater effect of the non-dominant on the dominant language. The shortening of short-lag VOT found in Spanish code-switching contexts (instead of the expected lengthening) indicates that general phonetic factors may also play a part in determining phonetic parameters in bilingual speech. Nevertheless, the results overall confirm that code-switching does affect the production of early bilinguals in spontaneous speech and is not the result of artificial experimental tasks.

6. ACKNOWLEDGEMENTS

Thank you to Rosa Quezada for help with stimuli development. Thank you to Criccely Grijalva, Mireya Pinell-Cruz, and Rosalia Schultze-Kraft for help with the Spanish transcriptions. Finally, thank you to the members of the UCSD Phonetics Lab and the Phon Company for advice and comments.

7. REFERENCES

[1] Antoniou, M., Best, C. T., Tyler, M. D., Kroos, C. 2011. Inter-language interference in VOT production by L2-dominant bilinguals: Asymmetries in phonetic code-switching. *Journal of Phonetics* 39(4), 558–570.

[2] Arvaniti, A. 1999. Effects of speaking rate on the timing of single and geminate sonorants. *Proceedings of the XIVth International Congress of Phonetic Sciences*, Berkeley, CA., 599–602.

[3] Balukas, C., Koops, C. OnlineFirst: 2014; Forthcoming in print. Spanish-English bilingual VOT in spontaneous code-switching. *International Journal of Bilingualism*. In: Travis, C. E., Torres Cacoullos. R. (eds), Special issue: Gauging convergence on the ground: code-switching in the community.

[4] Belazi, H. M., Rubin, E. J., Toribio, A. J., Rubin, J., Jacqueline, A. 1994. Code switching and X-Bar Theory: The functional head constraint. *Linguistic Inquiry* 25(2), 221–237.

[5] Boersma, P., Weenink, D. 2009. Praat: doing phonetics by computer.

[6] Bullock, B. E., Toribio, A. J., González, V., Dalola, A. 2006. Language dominance and performance outcomes in bilingual pronunciation. In: O'Brien, M. G., Shea, C., Archibald, J. (eds), *Proceedings of the 8th Generative Approaches to Second Language Acquisition Conference* (GASLA 2006), Somerville, MA. Cascadilla Proceedings Project, 9–16.

[7] Cho, T., Ladefoged, P. 1999. Variation and universals in VOT: Evidence from 18 languages. *Journal of Phonetics* 27(2), 207–229.

[8] Grosjean, F., Miller, J. L. 1994. Going in and out of languages: An example of bilingual flexibility. *Psychological Science* 5(4), 201–206.

[9] Kessinger, R. H., Blumstein, S. E. 1997. Effects of speaking rate on voice-onset time in Thai, French, and English. *Journal of Phonetics* 25(2), 143–168.

[10] Khattab, G. 2002. VOT production in English and Arabic bilingual and monolingual children. In: Parkinson, D., Benmanoun, E. (eds), Perspectives on Arabic Linguistics XIII-XIV. *Papers from the Thirteenth and Fourteenth Annual Symposia on Arabic Linguistics*, volume 8. Amsterdam, Philadelphia. John Benjamins Publishing Co., 1–38.

[11] Khattab, G. 2009. Phonetic accommodation in children's code-switching. In: Bullock, B. E., Toribio, A. J. (eds), *Cambridge Handbook of Linguistic Code-Switching*. Cambridge: Cambridge University Press, 142–160.

[12] Lisker, L., Abramson, A. S. 1964. A Cross-Language Study of Voicing in Initial Stops: Acoustical Measurements. *Word* 20(3), 384–422.

[13] López, V. G. 2012. Spanish and English word initial voiceless stop production in code-switched vs. monolingual structures. *Second Language Research* 28(2), 243–263.

[14] Magloire, J., Green, K. P. 1999. A cross-language comparison of speaking rate effects on the production of voice onset time in English and Spanish. *Phonetica* 56, 158–185.

[15] Marian, V., Blumenfeld, H. K., Kaushanskaya, M. 2007. The Language Experience and Proficiency Questionnaire (LEAP-Q): Assessing Language Profiles in Bilinguals and Multilinguals. *Journal of Speech, Language, and Hearing Research* 50(4), 940–967.

[16] Myers-Scotton, C. 2008. Language contact: Why outsider system morphemes resist transfer. *Journal of Language Contact - TEMA* 2(1), 21–41.

[17] Olson, D. J. 2013. Bilingual language switching and selection at the phonetic level: Asymmetrical transfer in VOT production. *Journal of Phonetics* 41(6), 407–420.

[18] Pfaff, C. W. 1979. Constraints on language mixing: Intrasentential code-switching and borrowing in Spanish/English. *Language* 55(2), 291–318.

[19] Piccinini, P., Arvaniti, A. under review. Voice onset time of word initial voiceless stops in Spanish-English code-switching. *Journal of Phonetics*.

[20] Poplack, S. 1980. Sometimes I'll start a sentence in Spanish Y TERMINO EN ESPAÑOL: Toward a typology of code-switching. *Linguistics* 18(7-8), 581–618.

[21] Poplack, S. 1987. Contrasting patterns of codeswitching in two communities. In: Wande, E., Anward, J., Nordberg, B., Steensland, L., Thelander, M. (eds), *Aspects of Multilingualism*. Borgstroms, Motala, Uppsala, 51–77.

[22] R Development Core Team, 2013. R: A language and environment for statistical computing. Vienna, Austria.

[23] Schmidt, A. M., Flege, J. E. 1996. Speaking rate effects on stops produced by Spanish and English monolinguals and Spanish/English bilinguals. *Phonetica* 53(3), 162–179.

[24] Woolford, E. 1983. Bilingual code-switching and syntactic theory. *Linguistic Inquiry* 14(3), 520– 536.