Language Dominance and Performance Outcomes in Bilingual Pronunciation

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1. Introduction

A significant body of experimental and naturalistic studies has demonstrated that bilingual speakers of Romance language–English pairings are capable of creating separate phonetic categories for the production of voiceless stops, measured as voiced onset time (VOT), across their languages (Caramazza, Yeni-Komshian, Zurif and Carbone 1973, Flege and Eefting 1987, Major 1992, interalia). However, bilinguals equally tend to show altered, either converged or exaggerated, VOT values in one or both of their languages relative to the those of monolingual speakers. Sancier and Fowler's (1997) case study of a Portuguese-English bilingual suggests that a bilingual's VOT values are not fixed rather they tend to drift according to the ambient speech environment. They label the phenomenon observed in their study as "gestural drift" because the gradient changes to VOT are observed in both the speaker's L1 (Portuguese) and L2 (English). Gestural drift is consistent with Grosjean's (2001) notion of "language mode" and with Escudero and Boersma's (2002) "perceptual mode." Such research contends that bilinguals' language use is malleable in that they may behave differently according to which language they are producing or perceiving at a given time.

The focus of the present study is to examine the effect of language mode on VOT production in real time via the use of a linguistic code-switching task. As code-switching arguably requires bilinguals to activate both languages simultaneously, it is expected that speakers should manifest VOT values in code-switched tasks that differ significantly from their productions in monolingual modes. At issue is the extent to which each of a bilingual's component languages is affected by code-switching. Gestural drift implies that they should be equally vulnerable to inter-linguistic influence. But if phonetic categories are established early in childhood then we would expect that bilinguals' L1 categories should be resistant to incursions from the L2 but not vice-versa.

2. Switching Studies

A number of psycholinguistic laboratory studies have examined the effect of one language upon the other under the rubric of language "switching." In the domain of phonetics, switching studies generally aim to determine if requiring bilinguals to switch languages during perception or production tasks shifts the VOT cut-point in the component languages (Elman, Diehl and Buchwald 1977, Bürki-Cohen, Grosjean and Miller 1989, Grosjean and Miller 1994, Hazan and Boulakia 1994). Taken as a whole, these studies show conflicting results, but most researchers conclude that there is an effect of switching on production, at least in part. Only Grosjean and Miller (1994) claim that the phonetic switch from one language to another is seamless and cost-free. Their results are often cited as evidence that in "normal speech" (Green 1998:73) or "natural circumstances" (Thomas and Allport 2000:62), bilinguals may be able to inhibit one lexicon, and, presumably in this particular case, one phonetic system.

In our view, the methodology employed in "switching" studies does *not* reproduce the "normal speech" or "natural circumstances" of bilingual speech. The general design of a switching study draws on tokens whose initial consonant is manipulated to fall along a VOT continuum ranging from an

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unambiguously short lag to an unambiguously long lag value. The points in the middle of the continuum (around 0-20 milliseconds of voice lag) are usually deemed to be ambiguous between voiced/voiceless stops across languages. These tokens are then embedded into a carrier phrase that alternates in language. The carrier phrase is generally referred to as the "base language" or "precursor language" and the embedded token as the "guest language". Examples from the literature are in (1).

(1) Examples of "Precursor + Guest" Stimuli

Hazan and Boulakia (1994)		
Répète [bɛn]	vs.	*Repeat [bɛn]*
Elman et al. (1977)		
Escriba la palabra [pa]	vs.	*Write the word [pa]*
Bürki-Cohen et al. (1989)		
Il faut qu'on catégorise [de]	vs.	*We have to categorize [de]*
Grosjean and Miller (1994)		
Il faut qu'on copie PAUL constamment	vs.	*We have to copy PAUL constantly*

We maintain that underlying this methodology are implicit assumptions about bilingual speech that are inherently problematic. First, in each case, the guest language is represented by a single word or syllable that is more akin to lexical insertion that to bilingual code-switching. Bilinguals may interpret these single word insertions as borrowings and integrate them into the lexicon (and phonology) of the precursor language rather than switch languages. Second, there is a directionality assumption that the language that you start in affects the language that you switch into, i.e., that the "base" affects the "guest" language. Should language mode factor into bilingual performance then we would expect inter-linguistic transfer to occur regardless of direction. The rationale, then, for the present research arises from the recognition that we need studies that reflect natural code-switching performance, rather than lexical insertion. Further, we must question, rather than assume, the directionality assumption in order to tease apart the possible effect of a simple physiological carryover of laryngeal gestures from one language to the next from the possibly more pervasive influence of bilingual language mode.

3. Code-switching and Phonetics: Unanswered Questions

In previous work, the first authors of the current study challenged Grosjean and Miller's (1994) claim that code-switching is phonetically immediate and complete (Toribio, Bullock, Botero and Davis 2005). We compared English–Spanish and Spanish–English bilinguals' monolingual VOT production values in each language versus those of their voiceless stops at code-switch junctures in sentences such as those in (2). The relevant phonemes are shown in bold.

(2) Example Stimuli from Toribio et al. (2005)

Los viajeros │**p**acked their bags.
"The travelers packed their bags."

The university │ **p**aga muy poco a los empleados.
"The university pays its employees very little."

Our findings indicated that participants did show statistically different VOTs in the code-switch and monolingual conditions within English and Spanish. However, in that study, we did not control for a participant's L1, nor did we examine whether other voiceless stops outside those that fall at the code-switch juncture showed any evidence of VOT convergence. Why should these factors matter?

It is possible that language dominance may be partially deterministic in code-switching. If phonetic categories are established early, then the L1 may be less permeable to phonetic influence than the L2. This would predict an asymmetric effect on production in which the L1 VOT values should remain constant while the L2 values drift toward those of the L1. On the other hand, if speakers adopt a bilingual production mode that is distinct from their monolingual mode, then VOT values throughout a code-switched utterance may be different from those in a monolingual one. That is, we might predict a global effect of language switching in which the direction of a code-switch (L1→L2 or L2→L1) is irrelevant, a possibility that has not been entertained in the extant literature on phonetics and switching.

3.1 Current Study Questions

The present study is designed to answer the following questions.

(3) Study Questions

a. Are there within-language differences between VOT production in monolingual versus code-switched natural speech?
b. Is one language affected more than the other?
c. Is the speaker's L1 less permeable to convergence than the L2?
d. Does the direction of the switch matter (from L1→L2 or from L2→L1)?
e. If an effect of code-switching occurs, how long does it persist into an utterance?

4. Experiment 1: Design and Methodology

This experiment tests the performance of L1 Spanish speakers in monolingual and code-switched production. The experimental stimuli included 288 sentences of which one third were test sentences and two thirds were fillers. The test sentences included 12 monolingual sentences in Spanish (e.g. ***Para qu***_ien es la_ ***t***_orta_ "For whom is the cake?") and 12 in English (e.g. *Who* ***t***_ook the_ ***c***_ap_ for *my* ***p***_en?_) in which words containing an initial voiceless stop were embedded. The bilingual stimuli comprised code-switched sentences that varied between subject–predicate and verb–object switch points. All the test sentences were grammatical code-switches, but one third of the filler stimuli contained ungrammatical code-switch junctures (i.e., between auxiliary–verb or determiner–noun) as distracters. Each sentence elicited a target phoneme in three different sites (Pre-switch, Switch, Post-Switch) as labeled in (4):

(4) Code-switch Stimuli

a. Spanish to English

Todos mis amigos	**t**alked Spanish as	**k**ids.
|	|	|
Pre-switch	Switch	Post-Switch

b. English to Spanish

The **t**yphoon damaged	**t**echos	y **p**arades.
|	|	|
Pre-switch	Switch	Post-Switch

All target words, in monolingual or code-switched sites, were counterbalanced across tokens of /p,t,k/. The total observation per participant was 72 monolingual phonemes (3 /p,t,k/ x 12 repetitions x 2 languages) and 216 phonemes produced in bilingual contexts (3 /p,t,k/ x 12 repetitions x 2 languages x 3 switch sites).

The experiment was conducted over two days of testing, separated by one week. The first day was conducted entirely in Spanish by Spanish-speaking researchers. The first day included three tasks: reading aloud of the Spanish monolingual stimuli, the completion of a Spanish proficiency exam (*DELE*), and of a Working Memory Test in the participant's native language. The second day of experimentation was bilingual; participants first read aloud the code-switched sentences. Then, they took a non-linguistic Simon task on the computer to test their inhibitory control, and they completed a written attitude questionnaire in English, and a language history questionnaire administered orally in English. Finally, participants read aloud the English monolingual sentences. Each participant was paid at the conclusion of the session.

The experimental stimuli to be read aloud were presented in randomized blocks (Spanish monolingual, Code-switching, and English monolingual) using e-Prime presentation software. The subjects were instructed to read aloud the sentence that appeared on the screen at a normal speaking rate and then to push a button on the keyboard to continue with the next sentence. They continued until a message appeared in Spanish or in English thanking them for their participation. Their productions were recorded using a head-mounted Shure A10 microphone onto a Marantz PDM 660 at 44kHz–16bit quantization. VOT was measured from the consonant release burst to the onset of periodicity, using Praat (Boersma and Weenink 2006). One author measured all of the monolingual productions and a second all of the bilingual productions to insure consistency.

4.1 Experiment 1: Participants

The participants for this study were fifteen Spanish L2 speakers of English, recruited via email or by snowball sampling. Their average age of acquisition of English was 12 years of age, average years of residency in an English-speaking country was four and average age was 30.5. Their language attitude questionnaires revealed that they all self-rated their Spanish speaking ability as a perfect 7/7 but English as 4.5/7. All were either Spanish teachers or college students.

4.2 Experiment 1: Results

The results of the VOT measures were submitted to a 2-way repeated measures ANOVA with a 2 (language) x 4 (site) factorial design with a posthoc contrast analysis due to the prediction that the VOT across sites would differ (we collapsed the /p,t,k/ measures together as participants showed no difference between phoneme production across sites).[1] The results are shown in Figure 1 where VOT measures are displayed across the y-axis. Spanish language productions appear as the four left columns, in light gray; English language productions are in dark gray. Along the x-axis, "SP" and "Eng" represent monolingual Spanish and English productions, respectively. All other labels reference Spanish (SP) or English (Eng) VOTs at the various sites in code-switched speech.

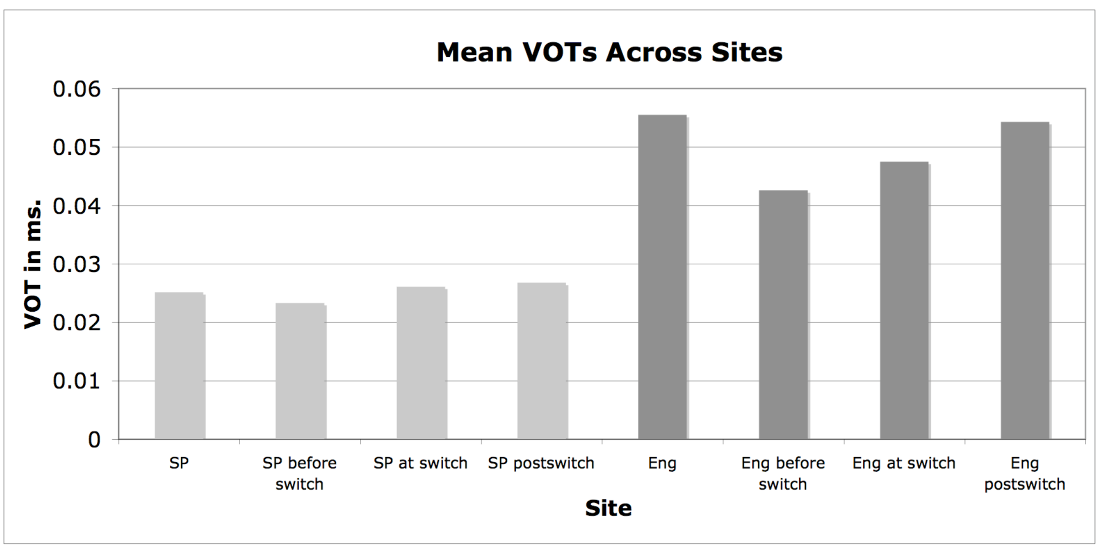

Figure 1: Results for L1 Spanish Speakers

Results of the statistical analysis reveal clearly that the speakers produce separate phonetic categories for Spanish versus English. The mean VOT values produced in monolingual utterances for these participants were 25 ms. for Spanish /p,t,k/ and 55 ms. for English. Within the Spanish language productions, there were no significant differences between monolingual Spanish and any of the bilingual contexts. Within English, there were significant differences between the monolingual condition and before the switch (*p=.001) and between the monolingual and the switch site (*p=.030). Each of these sites in the code-switching context were, in turn, significantly different from the post-switch condition (before the switch < post-switch (*p=.000) and at the switch < post-switch (*p=.025). The VOT values in the post-switch condition were not significantly different from those of the participants' monolingual English.

4.3 Discussion of Experiment 1

The results indicate that these L1 speakers of Spanish show distinct signs of VOT convergence, but only in their L2 English, not in their Spanish. While their Spanish VOT values remain stable, their English values drop toward more Spanish-like VOTs in anticipation of and directly after a code-switch with Spanish. However, this effect is temporary and the speakers quickly recover their own monolingual-like VOT values within their L2 English at the post-switch site. These results suggest that code-switching does indeed promote a convergence in VOT, but the effect is asymmetric; it only seems to affect the L2, not the L1. Notably, there is no observed effect of the "precursor language" since convergence occurs regardless of the direction of the code-switch. The lowest VOT values in these speakers' English language productions occurred *in anticipation* of a switch into Spanish; in fact, the pre-switch condition was significantly lower than the VOT values produced at a switch juncture from Spanish into English (before the switch < at the switch (*p=.008)). This implies that the order of the putative "precursor" and "guest" languages is irrelevant in bilingual speech.

The results of Experiment 1 raise the question of whether the asymmetry observed in these bilinguals' behavior is due to dominant L1 phonetic categories, leading to stability in the L1, or whether there are other factors that come to bear on how code-switching affects phonetic production. In an attempt to resolve this question, we conducted a similar experiment with L1 English speakers of Spanish, described below.

5. Experiment 2: Design and Participants

If the L1 is phonetically more resistant to influence than the L2, then L1 English speakers of Spanish should manifest production patterns opposite to those of the L1 Spanish bilinguals. That is, their L2 Spanish language VOTs should raise toward their dominant language, English, but those of their L1 should remain intact. Experiment 2 employed the same design, materials, procedures and analysis as Experiment 1. The participants were 10 L1 late-learners of Spanish. Their average age of acquisition of Spanish was 13.9 and their average length of residence in a Spanish-speaking country was 1 year. They were comparable in average age to our Spanish L1 participants, 27 years old. They self-rated their Spanish speaking ability as 5.725/7, higher than our Spanish participants rated their own English ability, and English as a perfect 7/7. All of the L1 English-speaking participants were Spanish teachers, so their professional experience likely compensated for their lack of immersion experience and enhanced their phonetic knowledge.

5.1 Experiment 2: Results

The results of Experiment 2 are visually depicted in Figure 2. As with our L1 Spanish speakers, these participants also maintain categorically distinct voiceless stops in Spanish versus English. The mean monolingual VOT values for these participants were 31 ms. for Spanish /p,t,k/ and 61 ms. for English, exactly 5 ms. longer, on average, than the same stops produced by our L1 Spanish speakers. Within the Spanish language productions, there was a significant difference between monolingual Spanish and the Spanish produced in the pre-switch condition (i.e. *before* a code-switch into English). Here the mean VOT value for the pre-switch site was *lower* than that of the participants' monolingual Spanish productions (*p=.016). There was no significant difference between the participants' monolingual Spanish VOT and the VOT produced at the switch site but, because the standard deviation at this particular juncture was excessive (13 ms.), this result is unreliable. Within English, there were significant differences between the monolingual condition and the site before the switch into Spanish (*p=.005) and between the monolingual and the switch site (*p=.049), in the expected direction, converging toward Spanish-like VOTs. As with our Spanish L1 speakers, the post-switch site was significantly higher on average than either the pre-switch (*p=.001) or the switch positions (*=.023), but it was identical to the monolingual VOT.

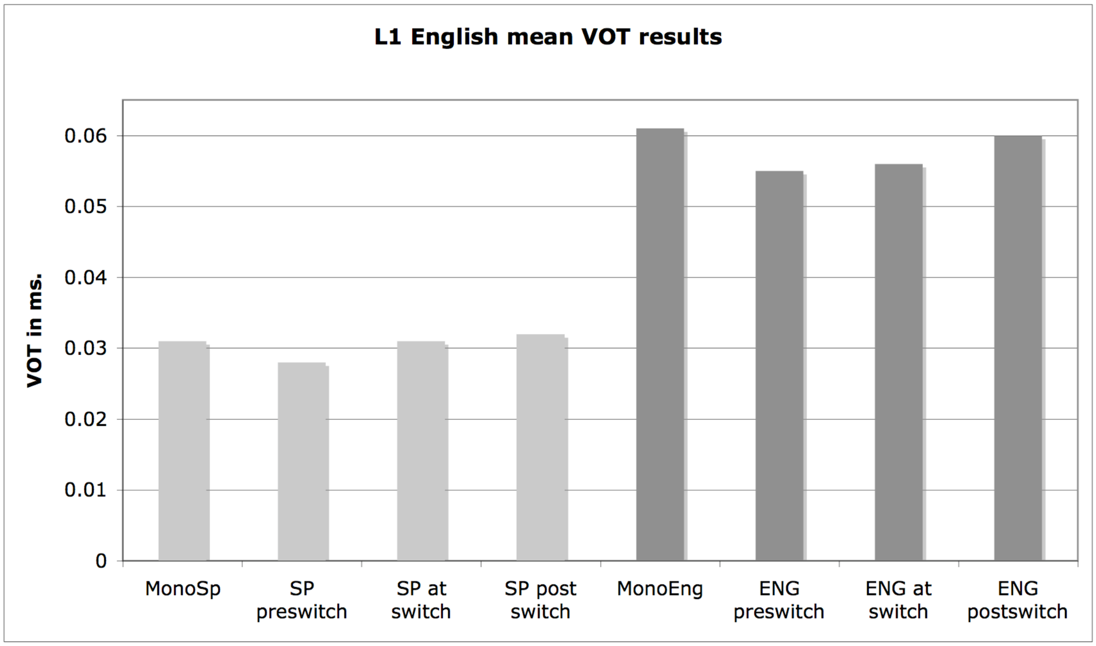

Figure 2: Results for L1 English speakers

5.2 Experiment 2: Discussion

The results for the L1 English speakers are remarkably similar to those of the L1 Spanish speaking group. Note that asymmetric convergence in code-switching is confirmed, but here, *only in the L1,* not the L2. Unlike the L1 Spanish participants, the English speakers produced significantly lower Spanish VOTs before switching into English as if enhancing the contrast between the VOTs in the two languages. Further, the patterns of convergence of English to Spanish for this group are identical to those for the Spanish speakers. That is, the precursor language is irrelevant; both in anticipation of and directly after a code-switch with Spanish, VOT lowering is observed in English. And, as with the L1 Spanish group, the observed effect of code-switching on phonetic performance is temporary; English speakers recover their monolingual VOT values quickly after a code-switch.

6. Interpretation and Implications

As the above analysis has demonstrated, the L1 is not phonetically stable in bilinguals and does not determine performance, at least for those who are highly proficient in the L2. These speakers are capable of fine phonetic control, to the point of enhancing contrast between the VOTs in their two languages (Flege and Eefting 1987) and of resisting the influence of their L1 in code-switching. At the same time, though, they were unable to avoid the influence of Spanish in their L1. The asymmetry observed in both groups of participants was in the same direction; code-switching between Spanish and English provokes convergence toward more Spanish-like VOTs regardless of which language initiates the utterance.

One possible explanation for the language asymmetry may be found in the inherent differences between the languages. There is a wider range of long lag VOT values for voiceless stops available in English, entailing that there is more gestural precision required to maintain short lag Spanish stops than long lag English ones. Hence, there is "room" for convergence in English but not in Spanish.

Further, Spanish voiceless stops are in a subset relation with English (Escudero and Boersma 2002) in that they fall along the VOT continuum in the same region as English *voiced stops*. Thus, English speakers may learn to produce unaspirated voiceless stops in the L2 by simply compressing their long lag stops as if producing English voiced consonants. If speaker control is at issue, then the same asymmetric pattern in the two groups of speakers may arise from the different group proficiencies. Our L1 Spanish speakers had a lower proficiency in their L2 than did our L1 English speakers. Thus, the Spanish speakers could easily control their Spanish VOT but not their English values when code-switching. Conversely, our L1 English speakers, with their professional experience in Spanish, may have *over-controlled* their Spanish VOT and, as a consequence, their Spanish-like productions carried through to English when code-switching. In essence, the L1 English speakers performed the code-switching task with a Spanish accent, at least with respect to the VOT variable.

These experimental results are difficult to interpret in relation to the concepts proposed in other studies of switching: gestural drift, precursor/guest language effects, and bilingual language mode. Gestural drift fails to account for the observed effects of code-switching on phonetic production because there is no clear evidence that Spanish VOTs are shifting toward English, although we expect that they might in a less proficient L1 English group of speakers. Instead, we offer a different metaphor, borrowed from tonology, in interpretation of our results. Since there is both an anticipatory and a perseverative effect of Spanish short lag consonants on English voiceless stops in code-switching, the effect for both groups is one of "downstepping" their English VOTs immediately before and after a switch with Spanish, as illustrated in (5) where L represents short (or low) Spanish VOT and H represents long (or high) English VOT.

(5) The "Downstepping" Effect of Spanish–English Code-Switching

L || ↓H   H
↓H || L   L

Note that other patterns are possible. For instance, if the direction of the code-switch were crucial with the precursor language influencing the guest language as a carryover assimilation of gestures, we would expect a code-switching pattern as shown in (6).

(6) Precursor/Guest Effects of Spanish–English Code-Switching

L || ↓H   H
H || ↑L   L

However, there is no evidence that English "upsteps" Spanish, so (6) is not an accurate depiction of the phonetic effects of code-switching and, likewise, the precursor/guest model of switching fails to account for bilingual performance. Finally, if language mode alone were the crucial factor in determining production, we would expect a speaker to adopt compromised VOT values in all bilingual contexts, producing the following pattern.

(7) Bilingual Language Mode Model

L || ↓H   ↓H

That speakers instead quickly recover their monolingual-like English VOT values after the switch indicates that the observed effects are due to code-switching and, as represented in (5), they are local and not global as would be predicted by the notion of bilingual language mode.

7. Conclusion

Despite the limitations of this study in terms of the unequal L2 proficiency between our participant groups and, perhaps, the small sample size, we maintain that the findings provide a compelling demonstration that, contra Grosjean and Miller (1994), code-switching has a direct effect on a bilingual's phonetic production and one that is not amenable to extant psycholinguistic accounts. That the effect should be manifest in the L1 of our English-speaking participants may, in part, be due to the gradient nature of the VOT differences between the languages, to the fact that voiceless Spanish stops are a subset of English stops and, thus, relatively easy to control, or to the speakers' advanced proficiency. It is possible that a more categorical disparity between the two languages, such as the presence of vowel reduction in English versus its absence in Spanish, might reveal different patterns of stability versus convergence, even in highly proficient L2 speakers. Nonetheless, the present work has demonstrated that the dominant L1 phonetic system is not deterministic in bilingual performance.

Notes

[1] We extend our warmest gratitude to our colleague, Nuria Sagarra, for her invaluable assistance with the experimental design and the statistical analysis of this research.

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