

The dynamics of interlinguistic transfer of VOT patterns in multilingual children

Marta Tessmann Bandeira
Márcia C. Zimmer
Universidade Católica de Pelotas

Abstract: *This article presents the results of an investigation on the differences regarding VOT patterns in English voiceless stops produced by 20 monolingual and 20 multilingual children learners of English. It also analyses the dynamics of interlinguistic transfer of VOT patterns of /p/, /t/ and /k/ in the three languages (Pomeranian, Brazilian Portuguese, and English) spoken by the multilingual children, departing from the notion of gestural drift (SANCIER; FOWLER, 1997; FOWLER et al., 2008).*

Keywords: *Multilingualism. VOT patterns. Phonetic-phonological transfer. Gestural drift.*

Introduction

Given the fact that the majority of the world's population speaks more than one language, there is currently an urge to investigate bi- and multilingual populations in several regards concerning their linguistic processing. Among them, the interphonology of multilingualism has been somehow neglected. This gap was brought to light by the workshop "Phonetics and Phonology in Third Language Acquisition", held in Freiburg in 2007. From then on, a few studies focusing on the relevance of phonetic-phonological studies on the possible positive and negative transfer in third language (L3) acquisition, as well as empirical evidence (case studies, corpus studies, experimental approaches) for positive transfer from second language (L2) to L3 started to appear. In this line, this article aims at accounting for the transfer of aspiration of voiceless stops in multilingual children speakers of Pomeranian/German (first language – L1) and Brazilian Portuguese (BP, L2).

The small town of Arroio do Padre, located in the south of Brazil, was colonized by Pomeranian and German immigrants

and is characterized as a geographic region of relatively limited access, which contributes for the daily use of Pomeranian and/or German as the L1 by its inhabitants. Therefore, the town is a very good example of a multilingual setting where Pomeranian is the L1 of the majority of the population, who learn Portuguese (L2) when they start school at the age of 6 or 7. Portuguese is usually used in social actions in school and outside. English, which is taught from the 3rd grade through secondary school, is considered to be their L3. Given these facts, we estimate that the majority of the population that regularly attend school is bilingual or multilingual, since, besides speaking Pomeranian and/or German along with BP, the population could also use English in their communicative practices, mainly in a scholar context.

Therefore, the aim of this study is twofold: 1) to compare the VOT patterns of voiceless stops produced in English by monolingual speakers of BP in the initial stages of English as a foreign language (EFL) learning with the VOT patterns produced in English as an L3 by bilingual speakers of Pomeranian (L1) and BP (L2) (between group analysis); and 2) to analyze the dynamics of transfer in the VOT patterns of the initial stops /p/, /t/ and /k/ in the three languages spoken by multilingual children (within group analysis).

Transfer

Transfer is a key mechanism underlying any kind of learning through the application of prior knowledge to new learning situations (MCKEOUGH, 1995). According to MacWhinney (2005, 2007), L1 and L2 are grounded on the same underlying neural architecture, so transfer is expected as a result of memory consolidation mechanisms, input quantity and quality, and L1, L2 and L3 typological distance. One of the first studies in the L3 acquisition field was the one by Ringbom (1987), who observed a Finnish group formed by speakers of Swedish as an L2, learning English as an L3. The group showed a relevant preference in tending to the Swedish language (L2), not to Finnish (L1), while producing the discourse in English.

Ringbom claimed there was a need to expand the focus of L2 research to investigate the influence of languages other than the L1 on the learning of an L3.

After further inquiry into L3 learning, there has been a body of growing evidence showing that the L2 influences upon L3 learning. Therefore, it is now possible to account for some of the factors that seem to cause interlinguistic transfer from the L2 to the L3.

The first factor is considered to be decisive in L2-L3 transfer: it is the typological distance observed between the two nonnative languages (HAMMARBERG, 2001; CENOZ, 2000). According to Cenoz (2000), this factor can determine the choice of an L2 as the main source of influence in L3 learning. Thus, L2 influence will be stronger if it is typologically closer to the L3 than it is to the L1.

A second aspect which may lead to L2-L3 transfer is the learner's proficiency level in his/her L2. According to Hammarberg (2001), a higher level in L2 proficiency may favor the influence of this L2 over the L3, especially if the learner has acquired and used it in a natural environment, not in a formal learning context. Nevertheless, it is observed that as the proficiency level increases, the learner does not need to resort to his/her L2 to perform his/her communicative tasks in the L3.

Therefore, there is no consensus about the L1 being the main source of influence on the patterns of an L3¹, since there is also a strong influence from the L2, and some authors assume that there is a higher transfer of the patterns from the L2 than from the L1 on the L3.

VOT patterns in BP, English, and Pomeranian

For many decades phoneticians and phonologists have been studying the articulatory, acoustic and perceptive

¹ Third language or L3 is used here to refer to any language learned after the learning of the L2. We do not make a distinction between L2 and foreign language, for we do not follow the distinction between learning and acquisition made by Krashen (1982).

characteristics of stop consonants, mainly the contrast between voicing and aspiration. Plosive stops are phonologically characterized as voiced or voiceless. To acquire the voicing contrast, besides the difficulties in controlling air pressure, the speaker needs to coordinate the glottic gesture that happens in the larynx, and the oral gesture that happens in the articulators. Voiceless stops are produced with different adjustments in the vocal folds, which inhibit their vibration, while the opposite happens for voiced stops, i.e., the vocal folds vibrate. Importantly, the synchrony among such adjustments is not the same for all languages (KHATAB, 2000).

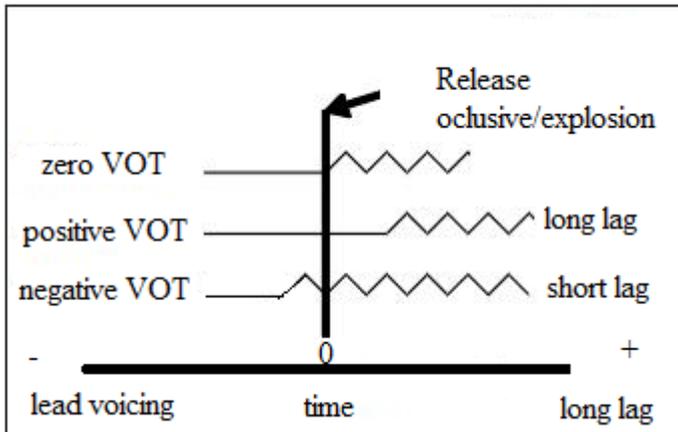
VOT is a term coined by Lisker and Abramson (1964) in their study of voicing in initial stops in which the authors carried out an experiment to test how well VOT serves to separate the stop categories in eleven languages. The measure of VOT was found to be highly effective in separating phonemic categories in the languages examined, although the languages differ in the number of phonological categories and in the phonetic features assigned to them. They defined VOT as “the time interval between the burst that marks release of the stop closure and the onset of quasi-periodicity that reflects laryngeal vibration” (p. 422).

Voicing patterns can be classified in three VOT categories: (1) negative, which presents a pre-voicing, i.e., certain vibration in the vocal folds before the release of a stop, generally about -100ms; (2) zero, which presents a little moment of silence, in which both the beginning of the voice and the release happen very close in about +10ms; (3) positive, it presents a somewhat longer period of silence, i.e., a delay in the beginning of the vibration of the vocal folds, around +75ms (LISKER; ABRAMSON, 1964). This can be better observed in Figure 1.

VOT values can vary according to the language, point of articulation, age, sex and speech rate. Cho and Ladefoged (1999) observed that in some languages the voiceless stops were located in a “space of time” of VOT along a continuum in between the short and the long lag, around 25-60ms. According to this, they established new categories considering the aspiration phenomenon: non aspirated stops (VOT=>0-40ms), low

aspirated stops (40-60ms), aspirated stops (60-100ms), and highly aspirated stops (100-160ms). This VOT continuum seems to be more adequate to explain the VOT transfer between languages which present strong degrees of aspirations and languages without aspiration, as is the case of English and BP VOT patterns, respectively. These features are described in detail in the following sections.

Figure 1 – Three types of VOT. The explosion is represented by the vertical line. The beginning of voicing is represented by the first “wave” from left to right of every kind of VOT



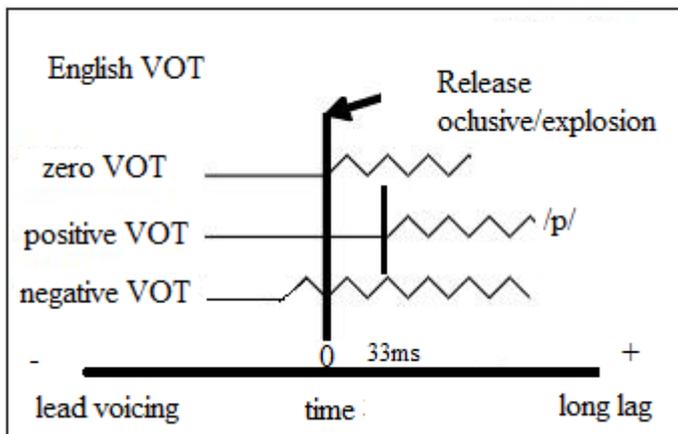
Source: adapted from GEWEHR-BORELLA *et al.*, 2011, p. 205.

VOT patterns in English

English is a language which has some aspirated sounds. In English it is not necessary to have any vocal fold vibration during the production of either of the pairs /p, b/, /t, d/, /k, g/. However, /p, t, k/ tend to be aspirated, while /b, d, g/ are mainly unaspirated and sometimes voiced. Thus, voicing cues for word-initial stops can be obtained not from the presence or absence of glottal pulsing during the production of the stops, but from the timing differences between glottal and supraglottal events

(KHATAB, 2000). Figure 2 provides a general (and simplified) view of the places English stops occupy along the VOT continuum.

Figure 2 – Schematic representation of English /p/ in the VOT continuum



As can be noted from the diagram, the VOT voiced stops in English have a short lag, while the voiceless are at an extreme end of the continuum. Although there is not an absolute value for the VOT of each plosive, some researchers (KENT; READ, 1992) point out that typical word-initial measurements in English range from 30 to 80ms, /k/ having the longest VOT, about 80ms, /t/ around 70ms, and /p/ about 55ms.

VOT patterns in Brazilian Portuguese

Although the literature concerning BP has no consensus about the values of the VOT patterns we are going to present some studies carried out in Brazil. The first study is a non-published paper by Istre in the 1980s, who found that the approximate VOT values in Portuguese are 38ms for /k/, 18ms for /t/, and 12ms for /p/.

In 1988, Behlau studied the BP plosives and found that the VOT means for the /pa/ segment is 10.37ms, 14.85ms for /ta/, and 43.73ms for /ka/. Another relevant research is the one carried out by Figueiredo (1995), who studied the VOT value of the segment /t/ in the word *laboratório* spoken in different positions within a sentence. He investigated the efficiency of the acoustic parameters to identify speakers; one of the parameters being VOT. He investigated nine participants (all men, ages 22-45); all from the State of São Paulo, Brazil. Twelve measures were analyzed for each participant. He states that the mean value for the VOT of this segment is 15.95ms.

Gewehr-Borella *et al.* (2011) investigated 20 monolingual children and 10 bilinguals from different parts of the state of Rio Grande do Sul, located in the south of Brazil. Among the monolingual speakers of BP, the VOT means found in their study are 16.60ms for /pa/, 23.96ms for /ta/, and 37ms for /ka/.

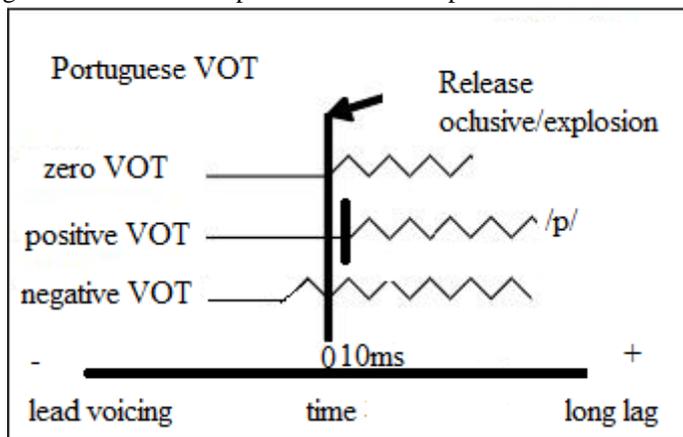
Table 1 summarizes the findings of the four studies regarding the VOT values for voiceless stops in BP.

Table 1 – VOT means for voiceless plosives in BP (rounded values)

Studies	Plosive segments		
	/p/	/t/	/k/
Istre (1980)	12ms	18ms	38ms
Behlau (1988)	10ms	15ms	44ms
Figueiredo (1995)	--	16ms	--
Gewehr-Borella <i>et al.</i> (2011)	16ms	24ms	37ms

For this study, the reference mean values used are the ones found by Behlau (1988), for her experimental work involved the investigation of VOT produced by monolinguals only (therefore, we can work with BP mean VOT values unbiased by bilingual production), and also because she investigated the production of voiceless plosives in different vocalic contexts (followed by the BP vowels /a/, /e/, /i/, /o/, /u/).

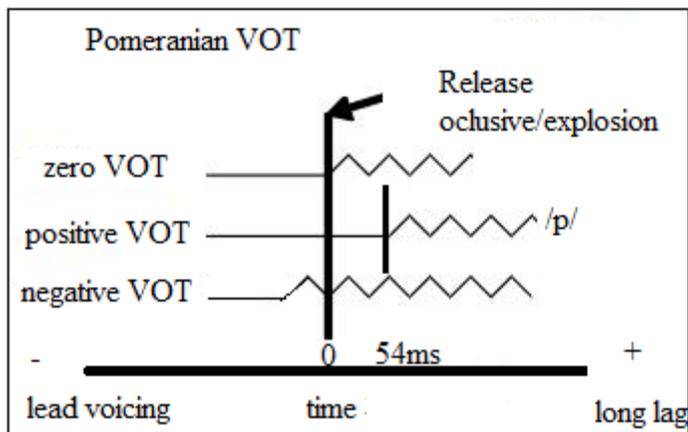
Figure 3 – Schematic representation of BP /p/ in the VOT continuum



VOT values in the Pomeranian spoken in Brazil

Pomeranian is a language spoken just in very few places of Brazil and it is not used anymore in its country of origin, which is nowadays part of Germany. This language has no written form and has been changing reasonably through time. The first study conducted about the phonetics/phonology of Pomeranian spoken in the south of Brazil was the one by Bandeira (2010), who carried out an experiment with 40 children, speakers of Pomeranian (L1), and BP (L2), in order to measure the VOT of Pomeranian voiceless stops. As previously mentioned, this was the first study investigating the VOT of Pomeranian spoken in southern Brazil, and the mean values found were 54ms for /p/, 44ms for /t/, and 76ms for /k/. Figure 4 exemplifies the high values of VOT in Pomeranian shown in the explosion bar, which happens at 54ms for the segment /p/.

Figure 4 – Schematic representation of Pomeranian /p/ in the VOT continuum



Another recent research about the Pomeranian spoken in Brazil was conducted in the southeastern Brazilian state of Espírito Santo, in another Pomeranian country village called Santa Leopoldina (SHAEFFER; MEIRELES, 2011). This study involved eight participants with ages ranging from 15 to 25 years. The segments studied were voiceless and voiced plosives followed by the vowel /a/. Table 2 shows the VOT means measured by Shaeffer and Meireles for the bilinguals who speak Pomeranian as their L1.

Table 2 – Compared means of VOT – multilinguals and monolinguals from the southeast of Brazil

Plosive Language	/p/		/t/		/k/	
	BP	Pom	BP	Pom	BP	Pom
Bilinguals ES	35	52	32	54	49	72
Monolinguals ES	16	--	20	--	38	--

Source: adapted from SCHAEFFER; MEIRELES, 2011, p. 4013.

Since there is no literature about Pomeranian phonology, a more precise study is needed to confirm the measures found in the small body of data available so far.

VOT transfer

Rocca (2003) analyzed the VOT production of /p, t, k/ in initial stressed position in BP and English by bilingual adult speakers. The participants were three bilingual adults, ages 28-48, who lived in São Paulo, southeast Brazil. The corpus of this study was the recording of three words in BP (papa, tape, capa) and three words in English (pop, top, cop) read in a carrier sentence. The recording was done individually in a sound-proof booth. The participants received the sentences written on a piece of paper. They were told to read the sentences out loud in the most natural way and speed possible. The sentences were recorded 12 times by each participant. The data analysis was done by the CSRE (Canadian Speech Research Environment) from Avaaz Corporation. The mean VOT values found in this study were: 10ms for /p/, 15ms for /t/ and 43ms for /k/.

Alves *et al.* (2008) analyzed the acoustic production of aspiration in BP and English stop consonants, produced by Brazilian EFL speakers. They investigated VOT patterns among four participants aged 19-28 years in a reading activity. All the participants were recorded with an anechoic camera while reading two texts: one in BP and another in English. In the English text there were 30 words with /p/, 109 with /t/, and 79 with /k/. In the BP text there were 17 words with /p/, 69 with /t/ and 47 with /k/. The following VOT mean values were found for each voiceless stop: 14.16ms for /p/, 19.0ms for /t/, and 16.36ms for /k/. The authors suggested that the means produced by the BP speakers in the foreign language are close to the ones produced by native speakers of English, for the Brazilians produced BP voiceless stops with aspiration, which is not part of the BP phonetic inventory. According to the author, the fact the BP speakers in her study use English everyday can suggest that the more one uses a language, the easier it is to create hybrid features in the interlanguage.

In 2008, Reis and Nobre-Oliveira reported the results of a study conducted with 11 participants from the southern Brazilian state of Santa Catarina, whose ages ranged from 17 to 44 years.

All the participants had been studying English for four years. Two experiments – one in BP and one in English – were carried out in order to measure the VOT values in the two languages. In both tests the participants recorded a list of 21 monosyllabic words (CVC), seven with each voiceless stop consonant in the beginning of each word. The total number of tokens was 231. The VOT means found for BP were 17.27ms for /p/, 23.55 for /t/ and 46.55 for /k/.

Gewehr-Borella *et al.* (2011) analyzed the stops produced in mid-syllable position by four children and two adults, all bilinguals of Hunsrückisch and Brazilian Portuguese. Each participant of both groups produced 40 stops. The results show that the mean values for the VOT productions of /p/, /t/ and /k/ of Hunsrückisch are close to the BP stop voiceless consonants. Table 3 presents the results of the VOT means in BP and Hunsrückisch.

Table 3 – VOT means by BP and Hunsrückisch bilinguals (standard deviation within parentheses)

Segments	BP	Hunsrückisch
[p]	23.55 (5.21)	27.36
[t]	21.35 (1.84)	23.91
[k]	9.66 (12.08)	40.85
[b]	-104.10 (19.79)	--
[d]	-90, 35 (17.04)	--
[g]	-79,05 (19.27)	--
[p ^h]	--	87.18
[t ^h]	--	81.79
[k ^h]	--	91.19

Source: GEWEHR-BORELLA *et al.*, 2011.

As can be observed in Table 3, BP VOT values of voiceless stops and the mean VOT measures of Hunsrückisch voiced plosives are similar, so they tend to collapse into a single perceptual category. Departing from this finding, Gewehr-Borella *et al.* (2011) claim that the Hunsrückisch segments /p/, /t/ and /k/ could be considered minimal pairs of their aspirated counterparts, playing the role of voiced stops in Hunsrückisch.

Thus, the authors state that this can be one of the reasons for the frequent gradient change in the production of the stops made by bilingual speakers of Hunsrückisch/BP. This is also a very relevant finding for this study, as will be discussed in the results section.

As can be seen, there are a few studies in Brazil about VOT transfer and bilingualism, but there is nothing about VOT patterns and their transfer in multilingualism.

Method

The participants in this study were 40 children aged 8 to 10 years old, all students of the 3rd grade of a public school. They were divided into two groups, one with 20 monolingual children, and another with 20 bilingual children. The language spoken by the monolingual children was BP; the bilinguals, in turn, spoke Pomeranian (L1), German (L1) and BP (L2) on a daily basis. English was studied as an L2 by monolinguals and as an L3 by bi/multilinguals.

The data was collected with the aid of an adapted version of an oral production instrument created by Rinaldi (2008), which consists of a fairy tale called “The fairy tales have gone nuts” and a tic-tac-toe game. The story-telling sessions took place in three different days and were performed in three languages: BP, English and Pomeranian, and involved the participants in the most playful way possible. The stories in each language contained target words with beginning voiceless stops /p, /t/ and /k/ followed either by /a/, /i/ or /u/. After each story-telling session, the participants were recorded individually in a studio while playing the tic-tac-toe game. One of their tasks while playing the game was to use the target words in carrier sentences² which were the ‘spells’ the participants had to cast on

² There was one carrier sentence for each language in which the participants listened to the story and played the tic-tac-toe game. In English, the carrier sentence was: “Say ___ turn back again”, in BP: “Diga ___ volte ao que

the fairy-tale characters. The sentences the children produced individually in a studio were recorded with the use of the software Audacity, version 1.2.6. With this procedure, recordings of the voiceless stops in the three languages spoken by the participants were made over a period of a month. In total, the BP corpus comprised 840 productions (7 target words x 3 repetitions x 40 participants) of /p/, 840 of /t/ and 840 of /k/. The Pomeranian corpus contained 300 productions (5 target words x 3 repetitions x 20 participants) for /p/, 300 of /t/ and 300 of /k/. The English corpus contained 360 productions (3 target words x 3 repetitions x 40 participants) of /p/, 360 of /t/, and 360 of /k/.

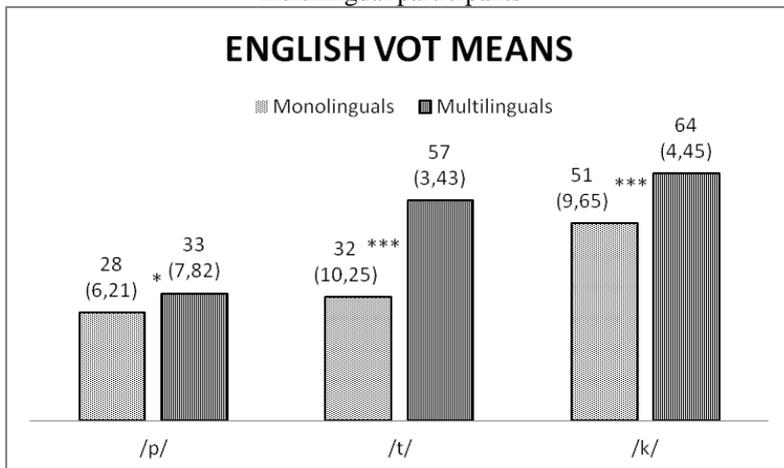
VOT was measured in the software Praat, version 5.1.43 (BOERSMA; WEENIK, 2010).

Results

The first goal of this study was to compare the VOT patterns of voiceless stops produced in English (L2) by BP monolingual speakers with the patterns produced in English (L3) by bilingual speakers of Pomeranian (L1) and BP (L2). The results indicate that the VOT patterns prevailing when the multilingual children spoke English (L3) are similar to those of their mother tongue (Pomeranian). The mean values and standard deviations (SD – within parentheses) found for English spoken by the monolingual and multilingual children are shown in Figure 5.

era”. In Pomeranian a similar sentence was used, which we do not reproduce here because Pomeranian does not have a written form.

Figure 5 – English VOT rounded means by monolingual and multilingual participants



* : $p < 0.05$, *** : $p < 0.001$

The VOT means produced in English by the multilingual and monolingual participants, when contrasted by a t-test, show a significant statistical difference ($p < 0.001$) concerning the segments /t/ ($t=10.42$) and /k/ ($t=5.76$), and the segment /p/ ($t=2.38$, $p < 0.05$), as shown in Figure 5.

Considering that in Pomeranian there is aspiration in these segments, it was expected that the VOT patterns would be transferred across the languages involved. Therefore, it is interesting to display the mean VOT values of the voiceless plosives in BP and in English produced by the participants, as well as the mean values found in the literature for each language, as can be seen in Table 4.

Table 4 – Mean VOT values of plosives produced in BP (L1/L2) and in English (L2/L3)

Participants	/p/		/t/		/k/	
	BP	Eng	BP	Eng	BP	Eng
Monolinguals	20	28	18.18	32	35	51
Multilinguals	48	33	52.45	57	70	64
<i>Literature</i>	12	55	18	70	38	80

Furthermore, the VOT means produced by monolinguals and multilinguals in English can be organized according to the three different vocalic contexts, which are displayed in Table 5.

Table 5 – VOT means and SDs (English) produced by mono and multilinguals in the different contexts

Context	Monolinguals Mean (SD)	Multilingual Mean (SD)	<i>p</i>
/p/ + /i/	27.01ms (3.91)	33.47 (7.95)	0.002**
/p/ + /a/	26.32ms (7.66)	32.40ms(12.02)	0.064
/p/ + /u/	30.52ms (7.80)	38.93 (12.01)	0.012*
/t/ + /a/	31.69ms (10.80)	53.76 (10.86)	<0.001***
/t/ + /u/	32.27ms (12.11)	50.81 (13.00)	<0.001***
/k/ + /i/	53.57ms (18.84)	63.49 (7.82)	0.010**
/k/ + /a/	50.73ms (11.55)	58.91 (6.75)	0.036*
/k/ + /u/	49.00ms (12.94)	70.46 (9.57)	<0.001***

In all /p/ contexts, the standard deviations for the bilabial voiceless plosives were higher for multilinguals compared to monolinguals. Although the VOT means produced by multilinguals were higher than the ones produced by monolinguals, standard deviations practically did not differ in the two groups in the /t/ + vowel contexts. Contrary to the trend found in all the contexts for the voiceless stops, the standard deviations were considerably higher among monolinguals than multilinguals concerning the production of voiceless coronals in English.

As to the VOT means produced by monolinguals and multilinguals in BP, the comparison between the two groups also resulted significant for all contexts, as can be observed in Table 6. The context /t' + /i/ was not measured in the studied languages

because alveolar plosives – both voiced and voiceless – are usually palatalized before /i/ in most BP spoken variants.

Table 6 – VOT means and SDs (BP) produced by mono and multilinguals in different phonological contexts

Context	Monolinguals	Multilinguals	<i>p</i>
/p/ + /i/	20.66ms (7.43)	50.52 (6.77)	<0.001
/p/ + /a/	19.68 (4.65)	50.21 (10.67)	<0.001
/p/ + /u/	23.34ms (4.67)	50.97 (8.62)	<0.001
/t/ + /a/	20.29ms (6.65)	54.49 (7.91)	<0.001
/t/ + /u/	15.03ms (3.13)	56.63 (8.57)	<0.001
/k/ + /i/	36.17ms (13.35)	74.24 (3.55)	<0.001
/k/ + /a/	35.12ms (7.48)	64.29 (9.08)	<0.001
/k/ + /u/	37.21ms (8.25)	72.28(7.93)	<0.001

Differences concerning VOT values produced in BP may stem from issues related to gestural drift (SANCIER; FOWLER, 1997). According to Sancier and Fowler (1997), speech perception may foster imitation. In addition to being a possible indicator of the tendency to imitate speech, gestural drift may also be of interest because, when it gives rise to L2 influences on the L1 phones, it may expose the kinds of cross linguistic-category correspondences proposed by Flege (2002).

This influence of an L1 production category on the authenticity of a similar L2 phone production is called transfer. Accordingly, these L1 and L2 productions are tied to one another, and, because they belong to the same L1, they are in correspondence. With this correspondence in place, L2 production also influences L1 production, i.e., there is a “restructuring” of the L1 category.

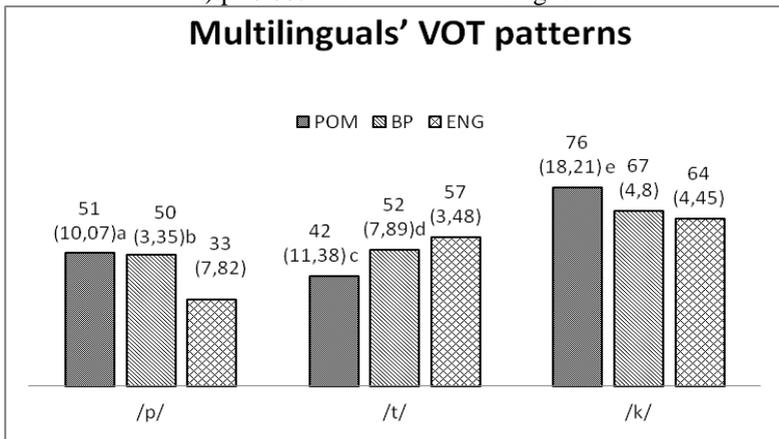
The second goal of this study was to analyze the dynamics of transfer in the VOT patterns of the initial stops /p/, /t/ and /k/ in the three languages spoken by multilingual children (within group analysis). Considering that in Pomeranian the voiceless plosives are aspirated, we expected that the other languages spoken by the multilinguals would present some aspiration of these segments.

Indeed, we observed that the bilinguals produced very high values of aspiration, even in Portuguese, in which the voiceless

stops are not aspirated (/p/: 48ms, /t/: 60ms, and /k/: 70ms). The VOT pattern values for BP are: 12ms for /p/, 18ms for /t/, and 38ms for /k/.

In English the following values were found: 40ms for /p/, 56ms for /t/, and 65ms for /k/. The values for the English native speakers are: 55ms for /p/, 70ms for /t/, and 80ms for /k/ (KENT; READ, 1992). In Pomeranian, the mean values found were: 54ms for /p/, 44ms for /t/, and 76ms for /k/. The mean values found for each language spoken by the multilingual children are shown in Figure 6.

Figure 6 – Mean VOTs and SDs produced by multilingual speakers in the three different languages, and levels of statistical significance:
 a) $p < 0.001$: Pomeranian and English; b) $p < 0.001$: BP and English;
 c) $p < 0.001$: Pomeranian and BP; d) $p < 0.001$: BP and English;
 e) $p < 0.005$: Pomeranian and English

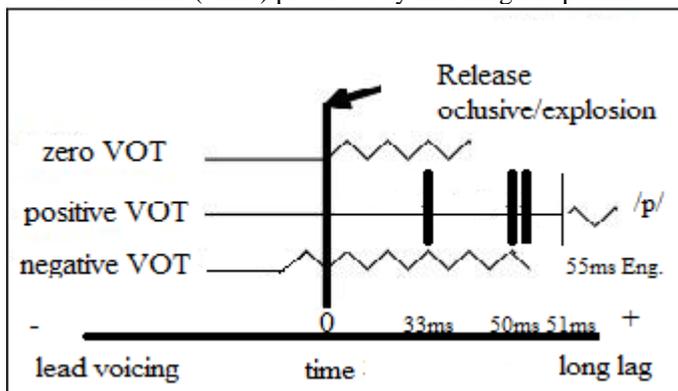


Parametric (3-way Anova) and non-parametric (Kruskal Wallis) statistical tests were run to identify differences in the multilinguals' VOT patterns. As both statistical analyses yielded very similar results, we report here only the figures regarding the parametric tests. The Bonferroni test was chosen as the post-hoc test to discriminate the exact differences. As can be seen in Figure 6, for the plosive /p/, the 3-way Anova indicated a significant difference among groups ($p < 0.001$), and the

Bonferroni test indicated that there was no significant difference between Pomeranian and BP, but the difference was significant both between the mean VOT values of Pomeranian and English and between the mean measures of BP and English. For the alveolar voiceless stop, the Anova indicated a significant difference among groups ($p < 0.001$), while the Bonferroni analysis showed a significant difference between the mean VOT values of Pomeranian and BP and between Pomeranian and English. No significant difference was found between BP and English. For /k/, the Anova indicated a significant difference among groups ($p < 0.005$), and the Bonferroni test indicated that there was no significant difference between BP and English, but the difference was significant between the mean VOT values for Pomeranian and English.

We could represent the continuum of VOT means for /p/ produced by multilinguals in their three languages in Figure 7.

Figure 7 – VOT means of /p/ in English (33ms), BP (50ms) and Pomeranian (51ms) produced by multilingual speakers



The results discussed in the next section highlight the gradient values in the intralinguistic transfer of VOT means among the languages spoken by multilinguals.

Discussion

There is no consensus about which language of a multilingual speaker influences the patterns of a third language. In this study, it is possible to observe that the transfer occurs both from the L1 to the L2 and from the L2 to the L3.

The results in this study suggest that high VOT patterns are present in all the three languages spoken by the multilingual children, even in BP which is a language that normally has very low VOT values. But why would this happen? One of the factors to be considered is the typological distance mentioned by Hammarberg (2001) and Cenoz (2000). Cenoz (2000) establishes that the L2 influence will be stronger if it is typologically closer to the L3 than it is to the L1. What can be seen in our results is that there is more typological proximity between L1 (Pomeranian) and L3 (English) than from L2 (BP) to L3, but it does not mean that the transfer will happen in the same order. Another factor could be explained as a gestural drift (SANCIER; FOWLER, 1997), which is a perceptually-guided change in speech-production, a change in VOT reflecting a change in the relative phasing of a laryngeal devoicing gesture and an oral constriction gesture. According to Sancier and Fowler (1997), gestural drift occurs because there may be “an underlying disposition of listeners/ speakers to imitate the speech they hear” (p. 422). This means that there may be a tendency to imitate the ambient language, which may be due to the fact that “perception of speech may foster imitation” (SANCIER; FOWLER, 1997, p. 422).

Considering the participants of this study, real EFL beginners, why would they transfer the VOT patterns from the L2 to the L3? Actually, if we examine Table 6 carefully, we can notice that the BP VOT is much higher than the VOT produced by the monolinguals in all contexts. One finding that should not be overlooked is the multilinguals’ significantly lower VOT means for the segment /p/ in English compared to the means they produced for that phone in BP and Pomeranian. In this sense, Pomeranian and BP VOTs may indicate that the participants can

detect a correspondence between L1 /p/ and L2 /p/. There is evidence that individuals are disposed to imitate what they perceive. Parallel gestural drift may happen in plosives in both languages because the speaker detects these correspondences. In the phone /k/ there is more similarity among the VOT mean values of BP and English than Pomeranian and BP. Gesturally, voiceless plosives in the two languages are very similar. Each has an oral-constriction gesture and a laryngeal devoicing gesture.

Another important finding concerns the production of the segment /t/. This phone does not show the same VOT pattern as the other two voiceless plosives. In this segment it can be seen that the highest VOT happens when the multilinguals speak English not Pomeranian, as seen in /p/ and /k/.

The study presented by Fowler *et al.* (2008) and the present study suggest some flexibility of the production of phonetic categories among language users. According to Fowler *et al.* (2008), malleability may be observed because the L2 is in the process of being learned or because the speakers' language environment changes. This flexibility that is observed suggests that consequences of learning supporting L1 and L2 language use are not independent.

Another relevant question brought by Fowler *et al.* (2008) is related to gestural drift: if speaking an L2 leads to phonetic influence on an L1, why do not the oral production of segments of a given language cause another segment in that language to drift? The same can also be applied to an L3. Why is each kind of stop not influenced by the others in the other languages spoken by the multilingual? For speakers of Pomeranian, aspirated and unaspirated stops are not identified as allophonic variants.

The findings by Gewehr-Borella *et al.* (2011), presented earlier in this paper, can help us explain it: in their study, they found that BP VOT values of voiceless stops and the mean VOT measures of Hunsrückisch voiced plosives are very similar. Although they tend to collapse into a single perceptual category, one can state that the Hunsrückisch segments /p/, /t/ and /k/ could

be considered as minimal pairs of their aspirated counterparts, playing the role of voiced stops in Hunsrückisch. The same may be occurring with the participants in this study; therefore, we could consider the aspirated phones as allophones of voiceless stops in BP, while in Pomeranian they are the sole production possibility for the voiced phonemes, thus falling into a different phonemic class. Thus, this can be one of the reasons for the frequent gradient change in the production of stops in both Pomeranian and BP.

Further investigations should be made in order to ascertain whether this phonetic variation in production, i.e., the gestural drift observed among our multilingual participants, can lead to phonological contrast.

References

ALVES, M. A.; SEARA, I. C.; PACHECO, F. S.; KLEIN, S.; SEARA, R. *On the voiceless aspirated stops in Brazilian Portuguese*. In: TEIXEIRA, A. et al. (Ed.). *PROPOR 2008*, LNAI 5190. Springer-Verlag Berlin Heidelberg, 2008. p. 248-251.

BANDEIRA, M. *Diferenças entre crianças monolíngues e multilíngues no desempenho de tarefas de funções executivas e na transferência de padrões de VOT (Voice Onset Time) entre as plosivas surdas do pomerano, do português e do inglês*. Dissertação (Mestrado em Letras) – Programa de Pós-Graduação em Letras, Universidade Católica de Pelotas, Pelotas, 2010. Disponível em <http://antares.ucpel.tche.br/poslet/dissertacoes/Mestrado/2010/>.

BEHLAU, M. S.; PONTES, P. A.; TOSI, O; GANANÇA, M. M. Análise espectrográfica de formantes das vogais do português brasileiro falado em São Paulo. *ACTA AWHO*, v. 7, p. 67-73, 1988.

BOERSMA, P.; WEENINK, D. *PRAAT: doing phonetics by computer*. Version 5.1.43. Available at: <http://www.praat.org>. Access on: 16 Sep. 2010.

CENOZ, J. Research on multilingual acquisition. In: CENOZ, J.; JESSNER, U. (Ed.). *English in Europe: the acquisition of a third language*. Clevedon: Multilingual Matters, 2000. p. 39-53.

CHO, T.; LADEFOGED, P. Variation and universal in VOT: evidence from 18 languages. *Journal of Phonetics*, 27. 207-227, 1999.

FIGUEIREDO, R. M. Description of a real case involving the identification of a speaker and the authentication of a magnetic tape recording. In: JACOB, B; BONTE, W. (Ed.). *Advances in forensic sciences*. Verlag: Dr. Köster, v.3, 1995. p.35-44.

FLEGE, J. E. Interactions between the native and second-language phonetic systems. In: BURMEISTER, P; PIRSKE, T.; RHODE, A. (Ed.). *An integrated view of language development: papers in honor of Henning Wode*. Trier, Wissenschaftliger Verlag, 2002. p. 217-243.

FOWLER, C. A.; SRAMKO, V.; OSTRY, D. J.; ROWLAND, S. A.; HALL'E, P. Cross language phonetic influences on the speech of French–English bilinguals. *Journal of Phonetics*, v. 36, n. 4, p. 649-663, 2008.

GEWEHR-BORELLA, S.; ZIMMER, M. C.; ALVES, U. K. Transferências grafo-fônico-fonológicas: uma análise de dados de crianças monolíngues (Português) e bilíngues (Hunrückisch-Português). *Gragoatá*, v. 30, p. 201-219, 2011.

HAMMARBERG, B. Roles of L1 and L2 in L3 production and acquisition. In: CENOZ, J.; HUFSEISEN, B.; JESSNER, U. (Ed.). *Cross-linguistic influence in third language acquisition: psycholinguistic perspectives*. Clevedon: Multilingual Matters, 2001. p. 21-41.

ISTRE, G. L. *Fonologia transformacional e natural: uma introdução crítica*. Unpublished manuscript. Florianópolis: UFSC, 1980.

KENT, R.; READ, C. *The acoustic analysis of speech*. San Diego: Singular Publishing, 1992.

KHATAB, G. VOT production in English and Arabic bilingual and monolingual children. In: Nelson, D.; Foulkes, P. (Ed.). *Leeds working papers in Linguistics* 8. Leeds: University of Leeds, 2000. p. 95-122.

KRASHEN, S. *Second language acquisition and second language learning*. Oxford: Pergamon Press, 1982.

LISKER, L.; ABRAMSON, A. S. A cross-language study of voicing in initial stops: acoustic measurements. *Word*, v. 20, 384-422, 1964.

MACWHINNEY, B. Language evolution and human development. In: BJORKLUND, D.; PELLEGRINI, A. (Eds.). *Origins of the social mind: evolutionary psychology and child development*. New York: Guilford Press, 2005. p. 383-410.

MACWHINNEY, B. A unified model. In: ELLIS, N.; ROBINSON, P. (Ed.). *Handbook of cognitive linguistics and second language acquisition*. Lawrence Erlbaum Press, 2007.

MCKEOUGH, A. *Teaching for transfer: fostering generalization in learning*. Mahwah, New Jersey: Lawrence Erlbaum, 1995.

REIS, M; NOBRE-OLIVEIRA, D. Effects of perceptual training on the identification and production of English voiceless plosives aspiration by Brazilian EFL learners. In: RAUBER, A. S.; BAPTISTA, B. O.; WATKINS, M.A. (Ed.). *New Sounds: INTERNATIONAL SYMPOSIUM ON THE ACQUISITION OF SECOND LANGUAGE SPEECH*, 5., 2007, Florianópolis. *Anais...* Florianópolis: UFSC, 2008. p. 398-407.

RINGBOM, H. *The role of first language in foreign language acquisition*. Clevedon: Multilingual Matters, 1987.

RINALDI, L. *Procedimentos para avaliação instrumental da pronúncia do português brasileiro por crianças de 5 a 7 anos de idade*. CELSUL, 8, 2008, Porto Alegre. *Anais do Celsul*. Porto Alegre: UFRGS, 2008.

ROCCA, P. D. Bilingualism and speech: evidence from a study on VOT of English and Portuguese voiceless plosives. *DELTA*, v. 19, n. 2, p. 303-328, 2003.

SANCIER, M. L.; FOWLER, C. A. Gestural drift in a bilingual speaker of Brazilian Portuguese and English. *Journal of Phonetics*, v. 25, p. 421-436, 1997.

SCHAEFFER, S. C. B.; MEIRELES, A. R. Padrões de vozeamento de consoantes plosivas em falantes de pomerano (L1) e de português (L2). In: CONGRESSO INTERNACIONAL DA ABRALIN, 7., 2011, Curitiba. *Anais...* Curitiba, 2011. p. 4009-4021.

TORIBIO, A. J.; BULLOCK, B.; BOTERO, C. G.; DAVIS, K. A. Perseverative phonetic effects in bilingual code-switching. In: GESS, R. S.; RUBIN, E. J. (Ed.). *Theoretical and experimental approaches to Romance Linguistics.*, 2005. Salt Lake City: John Benjamins. p. 291-306.

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Título: *A dinâmica da transferência interlinguística de padrões de VOT em crianças multilíngues*

Resumo: *Este artigo apresenta os resultados de uma investigação sobre as diferenças relativas aos padrões de VOT em plosivas surdas do inglês produzidas por crianças monolíngues e multilíngues, aprendizes de inglês. Também apresenta uma análise da dinâmica da transferência dos padrões de VOT das plosivas /p/, /t/ e /k/ nas três línguas (pomerano, português brasileiro e inglês) faladas pelas crianças multilíngues, a partir da noção de deriva gestual (SANCIER; FOWLER, 1997; FOWLER et al., 2008).*

Palavras-chave: *Multilinguismo. Padrões de VOT. Transferência fonético-fonológica. Deriva gestual.*