

Voice Onset Time in German-Italian simultaneous bilinguals: Evidence on crosslanguage influence and markedness¹

1 Introduction

This paper examines Voice Onset Time (VOT) in the two languages of adult bilingual speakers of Italian and German with exposure to both languages from birth, i.e. simultaneous bilinguals (henceforth 2L1s). More specifically, we compare German-Italian 2L1s, who grew up in Italy with German as their minority language, to German-Italian 2L1s, who grew up in Germany with Italian as their minority language. Our main purpose is to investigate potential effects of dual language exposure. We assume that early simultaneous bilinguals are a subgroup of heritage speakers. This entails that those early bilinguals who grew up in Italy are heritage speakers of German, whereas those who grew up in Germany are heritage speakers of Italian.

Despite a few early studies (Oh, Jun, Knightly & Au, 2003; Au, Knightly, Jun & Oh, 2002), phonology has been an understudied domain in the field of heritage language research, as noted by Benmamoun, Montrul and Polinsky (2013). Since then, there have been only a few more studies on this topic. These mostly focus on global accent and VOT and generally find that heritage speakers are perceived to sound different from monolinguals, while having advantages over late L2 learners (Kupisch, Barton, Hailer, Kostogryz, Stangen & van de Weijer, 2014; Chang, Yao, Haynes & Rhodes, 2011). Another general finding is that although heritage speakers tend to be (mis)taken for non-native speakers of their heritage language, they are often within the range of monolingual native speakers with regard to Voice Onset Time; see Au et al. 2002 on Spanish; Oh et al., 2003 on Korean; Lein, Kupisch & van de Weijer, forthcoming on French and German).

Most of these studies of adult heritage speakers have focused on *successive* bilinguals, for whom the heritage language was the only language at home. However, the disadvantage of studying these populations is that they differ in terms of when they were first exposed to the majority language, and these differences in age of onset (AoO) may result in different acquisition outcomes with respect to both the minority language and the majority language. Specifically, earlier exposure to the majority language could have a negative effect on minority language development (Montrul, 2008), while later exposure to the majority language might have a negative effect on the majority language. This means that once such speakers reach adulthood, it is unclear to what extent deviances from monolinguals are due to (i) AoO, (ii) diminished input, (iii) the interaction of their two languages, or a combination thereof. It is equally unclear whether they are the result of arrested development during childhood (“incomplete acquisition”) or the loss of previously acquired properties (“attrition”) during adulthood.

As mentioned in the previous paragraph, studies on heritage speakers have typically focused on the acquisition outcomes of *successive* bilinguals, but rarely on those of bilinguals with exposure to two languages from birth. However, there are advantages in studying

simultaneous bilingual heritage speakers. First, potential AoO effects are minimized both (i) when comparing the bilinguals' two languages and (ii) when comparing across bilingual individuals, because AoO coincides with birth. Second, 2L1s tended to be the focus of developmental studies (e.g., Deuchar & Clark, 1996; Kehoe, Lleó & Rakow, 2004). Consequently, we already know a lot about their development and are thus in a good position to speculate about the causes of acquisition outcomes, i.e., incomplete acquisition or attrition. More specifically, if a property is typically acquired early in life (when heritage speakers still have a lot of input in the heritage language), while being absent during adulthood, arrested development is not a plausible explanation. Finally, amount of exposure during the early years is generally considered to be crucial. Thus, simultaneous bilinguals could be seen as facing the greatest challenge when acquiring the heritage language, since their heritage language develops under the influence of the dominant language of the environment from birth.

The following provides an overview of VOT in acquisition, focussing on learners who acquire a Germanic language and a Romance language and comparing studies on child development with studies on acquisition outcomes in adults. Section 3 summarizes our study of VOT in adult simultaneous bilinguals. We discuss our results in section 4 and conclude in section 5.

2 Acquisition of VOT

VOT is considered to be the most salient cue differentiating the language-specific realizations of voiced (/b, d, g/) and voiceless (/p, t, k/) plosives. It refers to the interval between the release of the stop and the onset of voicing (Lisker & Abramson, 1964: 389). There exist three different types of VOT: (i) 'voicing lead' (voicing starts before the release), (ii) 'short voicing lag' (voicing begins with the release or shortly after it), (iii) 'long voicing lag' (voicing starts late after the release). Many of the world's languages distinguish two categories of stops, voiced and voiceless, which, depending on the language, are associated with different types of VOT. In Italian (i) voicing lead with negative VOTs characterizes voiced stops, and (ii) short voicing lag (with VOT values defined as < 30ms) characterizes voiceless stops. In German, voiced stops are produced with (ii) a short voicing lag, while voiceless stops are produced with (iii) a long lag. German voiceless stops have longer VOTs than Italian ones.

In this study, we focus on the VOT of /k/. There are comparatively few studies on Italian VOT. For Calabrese, Soriano (1996) found that /k/ is produced with an average VOT of 24ms when the dialect was spoken, and 29ms when people from Calabria spoke Standard Italian. The data is based on a reading task and the VOTs have been measured in pretonic intervocalic syllables. Table 1 summarizes findings for /k/ in German from various studies.

Table 1. VOT in German

Study	No. of subjects	Type of data collection	VOT for /k/
Stock, 1971	6	Reading the news (word-medial stops)	37
Fischer-Jørgensen, 1976	2	Reading word lists	59.73
Haag, 1979	1	Reading sentences	66.5

There are several factors that influence VOT. Place of articulation is the most important one with a hierarchy of shorter to longer VOTs ranging from /p/ over /t/ to /k/ (e.g., Lisker & Abramson, 1964). VOT can further be influenced by syllable stress, speech rate (Kessinger & Blumstein, 1997), word length (e.g., Lisker & Abramson, 1964) and the quality of the following vowel (e.g., Fischer-Jørgensen, 1979: 98). There is also regional variation in German (Braun, 1996: 25) and possibly in Italian. Finally, stops in isolated words are said to have longer VOTs than those in spoken sentences and spontaneous speech (e.g., Baran, Laufer & Daniloff, 1977).

This variety of factors contributes to considerable variation of VOT within and across speakers and across studies. Despite variation, VOT is traditionally considered as the categorical unit par excellence: a sound is voiceless, e.g., if it has a certain VOT range, but if it crosses the relevant threshold, it is automatically perceived as voiced (see Eimas, Siqueland, Jusczyk & Vigorito, 1971, who showed that even new borns at 1-month of age can classify stops as discrete phonemic categories on this basis). Finally, despite variation it is safe to assume that the German VOT of voiceless stops is noticeably longer than the VOT of Italian voiceless stops, which leads to the prediction that a German influence on Italian will result in relatively long VOTs compared to those of monolingual Italian speakers. Conversely, an Italian influence on German will result in relatively short VOTs compared to monolingual German speakers (i.e. resulting in short lag, similar to the VOT of German voiced stops /b, d, g/).

2.1 VOT in bilingual development

VOT is a well studied phenomenon in the speech of bilingual children and adults who have one Germanic and one Romance language. As outlined above, the two language families at the same time differ and overlap in terms of their VOT realizations, which makes VOT a potentially vulnerable category. As for language development, Jong Kong, Beckman and Edwards (2012: 742) report that the short lag VOT category appears first in children's productions, the long lag VOT category appears next, and the lead VOT category appears last, often after the age of 5 years. With regard to language contact, phonological categories have been argued to be subtractive if (i) they are present only in one of the two languages of the bilingual, and (ii) they alternate with a category also belonging to the other language (Lleó, 2008). For example, a phenomenon like spirantization in Spanish, by which voiced stops alternate with approximants or so-called *spirants*, depending on the phonetic context, could be considered a subtractive category because (i) spirants are only present in Spanish but not in German, and (ii) spirants alternate with voiced stops, which are present in German as well. Similarly, bilingual German-Romance children might have difficulties with voiced stops (but not with voiceless ones) in their Romance language, and with voiceless stops (but not voiced ones) in their Germanic language, because those two categories are only present in one of their languages.

There have been a few studies on developing bilinguals children, focusing on VOT. Deuchar and Clark (1996) studied an English-Spanish 2L1 child (aged 1;7--2;3) raised in England.

They found that the VOT contrast between voiced and voiceless stops in English was acquired at age 2;3, and the child started distinguishing the Spanish stops just like monolingual children, suggesting language separation and monolingual-like development in her two languages. Similarly, Lee and Iverson (2012) showed that Korean-English 2L1s living in the US (15 children at age 5 and 15 children at age 10) acquired distinct VOTs in both languages.

Kehoe, Lleó and Rakow (2004) studied the VOT of four simultaneous German-Spanish 2- to 3-year old bilinguals, who grew up in Germany. Table 2 shows the VOTs for /k/ measured for the four children in their two languages at different stages.ⁱⁱ The VOTs of the monolingual German controls were 88.9 ms and 76.1 ms at age 1;9--2;0, i.e., quite similar to those reported for adults in spontaneous speech (cf. Table 1). Given the monolingual German children's reference values, none of the bilinguals had monolingual-like VOTs during the first recording period, while Spanish VOTs were within the target-range (there were no monolingual Spanish controls but the bilinguals' productions correspond to those reported for L1 adult Spanish speakers). During the earliest stage in German, the bilinguals' long lag VOT category might still have been in the process of developing, or there was influence from Spanish to German. At the age between 2;3 and 2;6, two children, Simon and Nils, display target-like long lag VOTs in German. Simon also produces target-like VOTs in Spanish, while Nils' Spanish VOT is comparatively long, arguably due to influence from German. Stefan, on the other hand, produced comparatively short VOTs in German and only slightly shorter ones in Spanish, and the values produced in the two language become even more similar at a later age (2;9--3;0), suggesting that his German undergoes influence from Spanish or that his phonological development is still ongoing (cf. Nils at age 2;0-2;3). Overall, Kehoe et al's results indicate slight delays in the formation of age-appropriate VOT categories, but at the same time clear cases of language separation (Simon) and bidirectional influence (Stefan: Spanish to German, Nils: German to Spanish).

Table 2. VOT for /k/ in 2L1 children in German (Ge.) and Spanish (Sp.) (adapted from Kehoe et al., 2004)

	Robert	Stefan	Simon	Nils
2;0-2;3	(2;0-2;4)			
Mean Ge. VOT (Range)	28.8 (14-64)		23.8 (9-43)	39.3 (14-67)
Mean Sp. VOT (Range)	36.6 (17-115)		41.22 (17-112)	33.5 (18-75)
2;3-2;6				
Mean Ge. VOT (Range)		50.6 (24-80)	83.4 (23-123)	76.1 (45-134)
Mean Sp. VOT (Range)		39.5 (20-67)	26.1 (13-76)	59 (20-91)
2;9-3;0	--			
Mean Ge. VOT (Range)		33.9 (21-53)		
Mean Sp. VOT (Range)		40.6 (17-95)		

Splendido (2014) studied three French-Swedish 2L1 children in a semi-longitudinal fashion, i.e., recording them several times between 3;7 and 6;3. Overall, the children did not seem to differ from monolinguals and separated the two languages. However, Swedish long lag VOT was potentially delayed. Normally, Swedish learning children go through a period of VOT overshoots (VOT > 100ms). Splendido's 2L1 children also go through such a stage, but they dwell in that stage longer than monolinguals (see Splendido, this volume). The 2L1s'

prolonged phase of long lag overshoots suggest that bilingual children may show delays independently of the properties of their other language, possibly due to their relatively reduced input in each of their two languages.

Fabiano-Smith and Bunta (2012) showed that the /p/ and /k/ productions of eight Spanish-English 2L1s (aged 3;0--4;0) did not differ from those of Spanish monolinguals, while differing from those of English monolinguals, suggesting influence from Spanish to English. Watson (1990), by contrast, found that the VOT development of 15 English-French 2L1s (aged 6, 8 and 10 years) was similar to that of monolinguals in both languages. Comparing these studies, one might assume that 3--4 year-olds are still in the process of developing their systems, but they may perform monolingual-like a few years later.

In summary, studies on early developing bilingual children have come to various results including very early language separation, bidirectional crosslinguistic influence or even delays which cannot be traced back to a direct influence of the other language.

2.2 VOT in adult bilinguals

As for adults, Fowler, Sramko, Ostry, Rowland and Hallé (2008) set out to extend previous VOT investigations of voiceless stops to a larger sample of participants (n=78): monolingual English, monolingual French, French-English bilinguals from birth (2L1s), French-English bilinguals with English as L1 and French as L2 (they learned French at primary school, at around 4--5 years), and *viceversa*, French as L1 and English as L2 (they learned English at school, at around 9--10 years). They focused on the production of /p/, /t/ and /k/ by simultaneous bilinguals, the main research question being whether simultaneous bilinguals are affected by crosslinguistic influence. Results showed that simultaneous bilinguals produced long-lag VOTs in English shorter than those of monolingual English speakers; their short-lag VOTs in French were longer than those of monolingual French speakers. For sequential bilinguals long lag was shorter in L2 English and short lag was longer in L2 French, suggesting crosslinguistic influence.

However, not all researchers find crosslanguage influence in simultaneous bilingual production. Sundara, Polka and Baum (2006) analysed the production of word-initial /t/ and /d/ by Canadian English-French simultaneous bilinguals and by monolingual adults in each language, based on the VOT differences (long lag vs short lag in English, and short lag vs lead in French). Articulation place was also considered, because coronal sounds are alveolar in English and dental in French. The main inquiry was whether simultaneous bilingual adults produce such language-specific differences. This is indeed the case, according to the results, although monolinguals differentiated more phonetic cues in their productions of /t/ and /d/ than bilinguals. Note that both Fowler et al.'s and Sundara et al.'s studies were carried out in Canada, where French and English are official languages. Although official bilingualism in Canada does not imply that each individual region is bilingual and that bilinguals speak the two languages in an accent-free manner, access to both languages is greatly facilitated through TV and other media as well as the presence of fluent bilinguals. The question is to

what extent these results are mirrored in European countries which are not officially bilingual, though often *de facto* multilingual.

Lein, Kupisch & van de Weijer (forthcoming) studied the VOT for /k/ in simultaneous bilinguals during adulthood. Their participants had been exposed to German and French from birth and had grown up in either Germany or France. Most bilinguals produced VOTs in different ranges in their two languages. Comparison of French-dominant bilinguals (grown up in France) and German-dominant bilinguals (grown up in Germany) further revealed that the French VOTs of the German-dominant speakers were monolingual-like in both languages, while the French-dominant speakers were less target-like in German, although they had been living in Germany at the time of testing. Since most German-dominant speakers had attended a French school throughout their childhood, the study leaves open whether this group had an advantage in their minority language through intensive exposure during their school years. Alternatively, French /k/ might be easier to produce than German /k/.

As for Italian, Nagy and Kochetov (2013) compared the VOT of Italian, Ukrainian and Russian heritage speakers in the English-speaking part of Canada across three to five generations. Their results indicated that Italian heritage speakers were more resilient than the other bilingual groups to influence from English in their VOTs. While the Ukrainian and Russian speakers' VOTs drifted towards more English-like long-lag VOTs over the generations, the Italian heritage speakers' VOTs remained in the short-lag range.

One aspect recently reported in bilingual studies relates to the malleability of segmental production, which can show accommodation to various idiolectal characteristics of the interlocutor and thus to crosslinguistic influence (e.g., see Street, 1983 on speech rate, turn duration and vocalization duration, as well as Kessinger & Blumstein, 1997 on effects of speaking rate on VOT, specially on long lag and pre-voicing). Sancier and Fowler (1997) report the case of a bilingual speaker with L1 Portuguese and English AoO at the age of 15 years. VOT values changed significantly as a function of the ambient language. After staying a few months in a monolingual English context, her VOTs for voiceless stops (short lag in Portuguese and long lag in English) became longer in both languages, and after staying 2 months in Brazil, VOTs became shorter. As Fowler, Sramko, Ostry, Rowland and Hallé (2008) comment, "this suggests a psychological link between similar categories". Such a link has been proposed in Flege (1995)'s Speech Learning Model (SLM), according to which categories of an L2 with a certain similarity to categories of L1 are classified as "equivalent categories". The SLM can explain that voiceless stops were treated in a parallel fashion in the two languages, in spite of a different phonetic implementation in the two target systems. Such findings have important consequences with regard to development, as the order of acquisition is partly dependent on markedness and on the system's lay out.

2.3 Summary

Bilingual children may show delays in acquiring target-like VOT categories, possibly due to crosslinguistic influence, especially with respect to the more marked VOT categories, i.e. long lag and especially voicing lead (Davis, 1995).ⁱⁱⁱ Studies on adult and child bilinguals indicate

that VOT categories are not stable, neither during childhood nor during adulthood. This raises the question whether in simultaneous bilingualism monolingual-like development is guaranteed at least in one language and whether this one language is always the majority language. Moreover, if we find gradual differences, based on few milliseconds, between the various participant groups analyzed, can we still maintain that VOT is categorical?

This paper will add new data from 12 simultaneous bilinguals, who grew up hearing and speaking Italian and German from birth. We compare speakers in different countries (Italy and Germany), and we investigate VOT in the (dominant) majority language and in the (weaker) minority language. The main goal is to find out whether monolingual-like VOTs can be attained and maintained in both languages, or, if not, whether only the heritage language is affected by language influence. Our research questions are:

- (i) Is there evidence for crosslinguistic influence (CLI)?
 - a. If there is CLI, is it *bidirectional* or *unidirectional*?
 - b. If CLI is unidirectional, does it mean that VOT in one language is monolingual-like?

Furthermore, in research on heritage speakers there is an ongoing discussion about whether differences between monolinguals and bilinguals during adulthood are due to incomplete acquisition or attrition— a question that is hard to answer in the absence of longitudinal data. Since it is typical for early bilinguals to have comparatively more input in the heritage/minority language *before* entering school, one might assume early acquired categories to be acquired and to stabilize before input in the majority language becomes predominant. We might therefore hypothesize that phenomena in the speech of adult bilinguals that deviate from monolingual-like behavior are (i) the result of attrition if typically acquired early and (ii) the result of incomplete acquisition if typically acquired late. In both cases, it is important to control whether such effects are restricted to the heritage language. If not, more general mechanisms of crosslinguistic influence could be at play.

3 VOT study

3.1 Participants

Data for this study were taken from the HABLA corpus, a publicly available corpus of interviews with bilingual speakers (Kupisch, Barton, Bianchi & Stangen, 2012; <http://www1.uni-hamburg.de/exmaralda/files/e11-korpus/public/index.html>). The recording sessions consisted of loosely prestructured interviews of 20--30 minutes duration in a relaxed atmosphere. The speakers selected for the present study were recruited in Hamburg, Rome and Milan. In the following analysis, we examine the speech of German-Italian bilinguals who are second generation speakers of German (2L1s from Italy) and have one parent born in Germany as well as German-Italian bilinguals who are second generation speakers of Italian (2L1s from Germany) and have one parent born in Italy. All were exposed to both languages at home when they were children. Most of the 2L1s from Italy (n=6) had attended German

schools in Milan or Rome. None of the 2L1s from Germany (n=6) attended Italian schools, but two of them studied Italian in the context of a Bachelor's program at the University of Hamburg. Table 3 provides an overview of the bilingual participants. With respect to their heritage language, we indicate the parents' place of origin.

Table 3. Overview of bilingual participants

	2L1s from Germany	2L1s from Italy	L1 German	L1 Italian
No. of participants	6	6	5	5
Male/female	2/4	4/2	2/3	4/1
Age range	20-40	20-40	20-60	22-35
Place of origin	Hamburg	Milan, Rome	Hamburg, Bochum	Liguria, Veneto, Sicily
Parent's place of origin in heritage country	Calabria, Tuscany, Liguria, Piemonte, Veneto	Hamburg, Erfurt, Frankfurt, Munich	--	--

The monolingual data was collected later in a picture-based story-telling task, in which the depicted objects started with a voiceless stop. The speakers' task was to invent stories that included all depicted characters and objects.

3.2 *Methods*

VOT of /k/ was acoustically analyzed, using Praat (Boersma & Weenink, 2013). Following Lisker and Abramson (1964: 422), we identified the “time interval between the burst that marks release [of the stop] and the onset of periodicity that reflects laryngeal vibration”, with reference to the waveform. We focused on the velar stop /k/, analyzing only words with initial stress and with /k/ in word-onset prevocalic position. Since in Italian, words with more than two syllables carry stress on the penultimate syllable and since monosyllabic words are rare, the analysis in this language is restricted to disyllabic words, all of them being trochaic, i.e. stressed on the first syllable. In German, by contrast, beside disyllables, we included monosyllabic words, because disyllabic ones are comparatively less frequent and monosyllables were necessary to outbalance the total number of items in the two languages. Each /k/-word was coded for number of syllables and quality of the following vowel (high-medium-low, front-back). Cases in which /k/ was produced as /g/ were excluded from the analysis (this only happened in the group of 2L1s from Italy).

We had two reasons for choosing /k/ as the focus sound of our study: a) stops produced at the velum have the longest VOT values, the large area involved in velar production should facilitate the characterization of such segments as produced with crisp edges or with a lot of overlap; b) /k/ is acquired later than other consonants (Macken & Barton, 1979; Bortolini, Zmarich, Fior & Bonifacio, 1995), thus being potentially more vulnerable in bilingual development.

3.3 *Results*

3.3.1 *Monolingual data*

As shown in Table 4, the monolingual Italian speakers produced VOTs between 35.5ms and 46ms (individual means) and the monolingual German speakers between 65.1ms and 93.9ms (individual means). For both languages, the values are higher than those previously reported in the literature (cf. Table 1), suggesting an effect of methodology. Recall that the monolingual data reported in the literature is mostly based on list readings and that VOTs are said to be longer in isolated words than in spoken sentences and spontaneous speech (e.g., Lisker & Abramson, 1964: 514), contrary to what we found. We suspect that our data display an effect of storytelling. Specifically, words that constitute the focus of the story made up by the participants have been emphasized. Interestingly, there is also a difference in SDs between the two languages: the monolingual Italian speakers tend to show lower standard deviations, thus deviating less from the mean than the monolingual German speakers. The reason for this difference might be related to /k/'s VOT being short lag in Italian and long lag in German, thus offering a much longer time span in German than in Italian.

Table 4. VOT (in ms) in monolingual Italian and monolingual German adult speakers (German data from Lein et al. forthcoming)

Italian				German			
	mean (range)	SD	N		mean (range)	SD	N
<i>CAR</i>	35.7 (8.3-63.7)	11.8	36	<i>MAR</i>	72.6 (39.6-107.8)	16.8	39
<i>MAT</i>	35.5 (20.1-54.6)	8.6	35	<i>MAT</i>	79.9 (46.3-110.9)	16	49
<i>ANT</i>	33.8 (16.3-71.6)	14.2	48	<i>ROS</i>	93.9 (35.7-171.8)	24.6	64
<i>SAN</i>	46.0 (26.8-73.1)	11.4	32	<i>FRA</i>	65.1 (20.4-121.5)	22.3	43
<i>MAR</i>	40.8 (15.9-60.8)	11.6	38	<i>JAN</i>	73.7 (33.8-163.9)	24.8	61
mean	38.4				77.04		

3.3.2 Bilingual data

The highest VOTs were produced by the 2L1s from Germany in German (mean 59.3 ms), and the lowest VOTs were produced by the 2L1s from Italy in Italian (mean 36.5 ms). The 2L1s from Germany produced higher VOTs in Italian (mean 43.8 ms) than the 2L1s from Italy, as expected under the influence from German; the 2L1s from Italy produced lower VOTs in German (mean 52.5 ms) than the 2L1s from Germany, as expected under influence from Italian. Table 3 shows mean values and ranges for each individual speaker (top to bottom) in each language (Italian on the left, German on the right).

Table 5. VOT (in ms) in bilingual German-Italian speakers from Germany

		Italian			German		VOT diff.	
		mean (range)	SD	N	mean (range)	SD	N	
2L1s from Italy	COR	32.6 (20-47)	6.8	35	39.8 (23-60)	8.4	36	7.2
	CLF	30.8 (17-49)	8.0	20	62.1 (26-143)	28	19	31.3
	FRA	35.7 (6-74)	13.7	31	60.3 (11-81)	15.7	22	24.6
	LUC	43.5 (2-108)	19.4	25	49.0 (29-79)	13.1	30	5.5
	VAL	39.6 (21-64)*	15.8	14	58.8 (33-95)	17.3	19	19.2
	JON	36.7 (19-55)	10.3	19	45.1 (25-65)	11.9	19	8.4

Mean (range)		36.5 (2-108-)			52.5 (11-143)			145	16
2L1s from Germany	GIU	44.4 (36-60)	9.7	10	66.1 (35-112)	21.6	25	21.7	
	DAR	39.0 (26-62)	9.2	20	55.2 (28-146)	31.7	19	16.2	
	PAT	48.4 (29-83)	19	8	64.6 (37-106)	15.8	49	16.2	
	DOM	33.3 (24-66)	9.6	21	48.8 (14-109)	17.3	56	15.1	
	ALE	43.8 (21-80)	14.2	32	53.1 (31-92)	13.2	40	9.3	
	LUI	53.9 (38-99)	17,3	11	68.0 (47-107)	16.1	17	14.1	
Mean (range)		43.8 (21-99)			59.3 (14-146)			206	15.4

*produced many instances of /k/ as Italian /g/, i.e. with a perceived voicing lead

Table 5 further shows a comparatively high degree of variation in both mean VOTs and VOT differences between the two languages (rightmost column). Although all speakers have lower VOTs in Italian, the VOT differences between their two languages vary considerably: there are *short differences* of less than 10 ms (COR, LUC, JON, ALE), *intermediate differences* between 10 and 20ms (DAR, PAT, DOM, LUI) and *long differences* above 20ms (CLF, FRA, GIU, VAL^{iv}). Given that the difference between our two monolingual groups amounts to almost 40ms, only those speakers with VOT differences around and above 20ms (CLF, FRA, GIU, VAL) are arguably resilient to crosslinguistic influence.

4 Discussion

4.1 Crosslinguistic influence

Going back to the reports from the literature, it is safe to expect crosslanguage effects in the case of simultaneous bilinguals. On this basis, we have hypothesized that German influence on Italian should result in relatively long VOTs for /k/ compared to those of monolingual Italian speakers. Conversely, an Italian influence on German should result in relatively short VOTs for /k/ compared to those of monolingual German speakers (i.e. resulting in short lag, similar to the VOT of German voiced stop /g/). An alternative hypothesis is based on markedness: since short lag is the least marked of VOT categories, German long lag VOT might be more vulnerable than Italian short lag VOT (Kehoe et al. 2004).

The group means seem to confirm the first hypothesis: The German VOTs of 2L1s from Italy are “too short” (compared to German monolinguals), while the Italian VOTs of the 2L1s from Germany are “too long” (compared to Italian monolinguals). However, a closer look at the 2L1s from Italy with short VOT differences indicates that two of them (JON, COR) lean towards Italian-like VOTs when speaking German, while one speaker (LUC) produces VOTs which are neither clearly German-like nor clearly Italian-like. Interestingly, these three speakers also have comparatively low SDs when producing German VOTs, a property that seems typical of Italian monolinguals (cf. Table 5). This could suggest that their German productions are affected by Italian.

A closer look at the six 2L1s from Germany shows a long VOT difference only for GIU. Most others have intermediate or short VOT differences. Two speakers (LUI, PAT) lean towards

German-like VOTs in Italian, which indicates influence from stronger to heritage language. ALE, DOM, DAR, by contrast, produce comparatively short VOTs in German and quasi Italian-like VOTs in Italian. These findings for the latter three speakers are unexpected under the assumption that crosslinguistic influence is unidirectional from stronger to heritage language, but they make sense once markedness is taken into consideration, because long lag is more marked than short lag. The assumption of Italian-like VOTs for ALE, DOM and DAR is supported by their comparatively low SDs, typical of Italian monolinguals.

Returning to our research questions, influence is seldom *bidirectional*. In our study, only LUC (and possibly ALE) seems to represent such a case. The more common patterns is *unidirectional* influence from Italian to German for speakers in Italy (JON, COR) and from German to Italian (LUI, PAT) for speakers in Germany. For these speakers, *unidirectional* influence also means that the stronger (i.e. societal) language tends to display monolingual-like values. By contrast, ALE, DOM and DAR seem to be affected in their *dominant* language as well (though not to the extent the values are completely off the monolingual range). Interestingly though, this only happens in German but not in Italian. Put differently, in the stronger language, *long* lag may be affected while *short* lag is never affected.

In summary, our data confirm existing interaction between the two languages of bilinguals, including adult speakers with exposure to both languages from birth. Most of the time, the heritage language is influenced by the majority language: Italian is heritage in Germany, but in Italy German is heritage. This answers the second question we posed, namely whether in simultaneous bilingualism monolingual-like development is guaranteed at least in one language, and whether this one language is always the majority language. According to our results monolingual-like VOTS are *mostly* found in the majority language. However, some speakers do not conform to such a pattern, which seems to allocate an additional role to markedness. Short lag has often been described as being less marked than long lag, which is the reason why children begin producing short lag, irrespective of the VOT categories of their target language. These observations seem to be mirrored in our data: Crosslinguistic influence can easily bring the values down (long lag becoming shorter), *while it seems to resist a large increase* in the sense of short lag becoming slightly longer, but not much. Moreover, the likelihood that German-dominant bilingual deviate from monolingual-like productions in their German VOTs is higher than the likelihood that Italian-dominant speakers deviate from monolinguals in their Italian VOTs. We attribute this pattern to short lag being unmarked in relation to long lag.

4.2 Is VOT gradient or categorical?

A final issue relates to whether VOT is comprised of discrete categories or whether it is a gradual reality. As discussed in section 2, VOT is considered to be categorical *par excellence*, as it corresponds to categories like phonologically voiced and voiceless. Since Lisker and Abramson's (1964) seminal paper such categories are clearly quantifiable, and classifiable into long lag, short lag and voicing lead. However, these three categories are applied to a continuum, and arrangements are possible: for instance, a new category has been proposed, with intermediate values between long lag and short lag (Jong Kong et al., 2012), for certain dialects of Japanese, for Canadian French and Hebrew. This poses the question whether we

can still consider VOT to be categorical. We believe that the creation of an intermediate category does not affect the categorical status of VOT, if overlap does not exceedingly increase. It just shows that between short and long lag there is unused space.

Another objection to the categorical status of VOT is related to the results of the present study: Under certain circumstances is in between category values: long lag and short lag vary from speaker to speaker, especially in bilinguals (see, e.g., LUC and ALE in Table 5). Here, the edges of the relevant category are moved up and down the continuum. The divisibility of the VOT continuum might be seen as comparable to the partition of the color spectrum, which is divided differently depending on the language. Such categories built on continua tend to be variable towards the edges and, as proposed by the Speech Learning Model (Flege, 1995) and by the Magnet Model (Kuhl & Iverson, 1995), they can increase their range and become more encompassing, while not necessarily losing their categorical status. It would seem that some of the speakers we investigated have inbetween categories, while others have clearly distinct ones. However, even for the speakers who produce VOTs at the edges between short and long lag in both languages, we cannot conclude that they have no separate categories for short vs. long lag, because their intermediate VOTs may simply be a strategy to facilitate production, which is not necessarily mirrored in perception. A decisive way of finding out whether bilingual speakers abide by discrete categories would be to carry out a perception test.

4.3 *Incomplete acquisition or attrition*

One of our motivations for studying simultaneous bilinguals was that previous research on adult heritage speakers often included populations with different AoOs in the majority language, while studies on developing bilinguals are often based on simultaneous bilinguals. In this study, we focused on simultaneous bilinguals, knowing that they show delays in their VOT development. Ideally, determining whether target-deviant production during adulthood is due to loss or to incomplete acquisition would require longitudinal data. But even in the absence of such data, our knowledge about 2L1 development allows us to speculate which of the two possibilities is more reasonable. Knowing that short lag VOT is acquired very early, one might speculate that speakers who produce long lag instead of short lag may have acquired the short lag category but subsequently lost it under the impact of the majority language. For our case, this is not plausible because short lag still exists in the other language, though it is associated with a different phonemic value. Similarly, one might speculate that speakers who produce short lag instead of long lag have lost the long lag category or never acquired long lag because it is acquired rather late. Again, we do not find this plausible because even the 2L1s with the lowest VOTs in German manage to produce values up to at least 60 ms, i.e., within the range of monolingual German productions. Finally, restricting the discussion of heritage language competencies to incomplete acquisition and attrition might be inept. Although influence is predominantly unidirectional from stronger to weaker language, we have seen that crosslinguistic influence may occur independently of incomplete acquisition or attrition for reasons such as markedness.

5 Conclusion

This study has confirmed that the two languages of adult bilingual speakers interact, leading to VOT values differing from those of monolingual speakers, even if these speakers had been exposed to both languages from birth. Despite having the same age of onset, there is noticeable variation regarding the speakers' influence patterns, including *bidirectional*, but mostly *unidirectional* influence, going predominantly (though not exclusively) from stronger to weaker (i.e. heritage) language. The fact that influence is sometimes bidirectional indicates that more than one factor is at play. The stronger language, if affected, is comparatively more vulnerable in the case of long lag VOT, suggesting that markedness has a prominent role to play. Although these findings are robust, the study is limited in scope, because it has focused on the short lag of /k/ in Italian and its long lag counterpart in German. However, the story does not end here, because Italian also has voicing lead. Voicing lead is the most marked VOT, acquired late by monolingual, "often after the age of 5 years" (Jong Kong et al. 2012: 742). Studies including lead voicing are required to substantiate our ideas.

An open question remains why we found smaller SDs in Italian. One reason could be that we excluded productions of /k/ as /g/, but since this only happened in the 2L1s from Rome, it cannot be the only explanation. Another reason might be the one adduced in section 3, namely that there is a higher probability of hitting the right value if the time span is short (as in Italian) than if it is long (as in German). In other words, there is a higher probability of overshooting into the long lag direction than into the short lag direction, which would again be consistent with markedness considerations, as the least marked of the VOTs, i.e. short lag, is also the shortest one. The idea that markedness can determine the direction of crosslinguistic influence receives support from previous research in segmental bilingual acquisition, e.g., Lleó (2002) on truncation, and Lleó and Rakow (2005) on spirantization.

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ⁱⁱ We concentrate on /k/ here because that will be the focus of our own study. The stages in Kehoe et al.'s study are not exactly the same for all children and one child was studied only during one stage.

ⁱⁱⁱ Davis (1995) has proposed an innovative explanation for the most marked status of voicing lead, which appeals to the fact that lead voicing would enhance the perception of lead plosives, as the latter, besides having lead, also have a very short lag between the release of the plosive and the beginning of sonority.

^{iv} We excluded some instances of Italian /k/ from the data of this speaker from Rome, since they were produced as /g/. The phenomenon is consistent with Hualde and Nadeu's (2011) report on lenition in Rome Italian. Including these lenited consonants in the analysis would have decreased the Italian VOT means, thus leading to a more pronounced difference between his Italian and German productions.