Age, Input, and Language Mode Factors in the Acquisition of VOT by English-Arabic Bilingual Children

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ABSTRACT

This paper investigates word-initial Voice Onset Time (VOT) patterns of three Lebanese-English bilinguals aged five, seven and ten and living in Yorkshire, England. The aim is to examine the extent to which children exposed to two languages establish phonetically distinct contrasts for either language. Results show that VOT patterns for each bilingual child differ across the two languages. But while the contrast in English resembles a monolingual-like model, that for Arabic exhibits persisting developmental features that are intricately related to age, complexity, and input. Furthermore, English words produced during code-switching in the Arabic sessions exhibit different VOT patterns from those produced during the English sessions. Such results highlight the importance of taking the language mode into account when investigating language differentiation.

1. INTRODUCTION

English and Arabic vary in the phonetic realisation of the stop voicing contrast. In English, utterance-initial VOICED stops are normally produced with short voicing lag or voicing lead, whereas VOICELESS stops are produced with long lag [2] (capital letter notation is used to refer to phonological status, while 'voiced' and voiceless' refer to phonetic status). In Arabic, the contrast is that of long lead for VOICED stops and short lag to slight aspiration for VOICELESS stops [6].

In a previous study [5] it was shown that English-Arabic bilingual children acquire different VOT production patterns for stops in each of their languages. More importantly, it was shown that they learn language-specific targets along the VOT continuum that are not represented by the three arguably universal phonetic categories: long lead, short lag, and long lag. Developmental features were identified in the subjects' productions, but no analysis of their parents' speech had been undertaken in order to examine the effect of the input that they receive. Moreover, only the tokens from the English-only and the Arabic-only sessions (see Section 2) were analysed, leaving out code-switches that the children had produced during the Arabic sessions. This paper therefore presents further analysis that will reinforce the findings in [5] and show the important role of age, input, and language mode in shaping the bilinguals' acquisition and production patterns.

2. THE STUDY

Three English-Arabic bilinguals who were born and raised in England were tape-recorded naming items in a picture book during English-only and Arabic-only sessions with different interlocutors. The subjects' parents were all native speakers of Lebanese Arabic who had been living in the UK for about 15 years, and who had exposed their children to English and Arabic from birth. Monolingual friends of the bilinguals were also recorded for the study, along with aged-matched monolingual Arabic controls from the same area of origin as the bilinguals' parents in the Lebanon. The parents of all bilingual and monolingual children were recorded reading lists of the words that were elicited from the children (Table 1). The purpose was to obtain a sample of VOT patterns found in the bilinguals' environment either through friends of a similar age or through adults in the community. In what follows, an overview of the major results that were obtained in [5] is given.

	Age 5	**Age 7**	**Age 10**	**Adults**	
	F	**M**	**M**	**F**	**M**
Monolingual E	E5	E7	E10	EF	EM
Bilingual	B5	B7	B10	BF	BM
Monolingual A	A5	A7	A10	AF	AM
Total = 23	**3**	**3**	**3**	**7**	**7**

Table 1: List of subjects and the codes used in the presentation of results.

3. AGE AND LANGUAGE FACTORS

In English (Figure 1), both monolingual and bilingual subjects produced VOT values that were expected for this language. Their VOICELESS stops fell in the long lag region with VOT means ranging between 59.94 and 78.48ms, while their VOICED stops fell in the short lag region with VOT means ranging between 2.51 and 25.65ms. Detailed results showed a gradual progression towards adult models in that the VOT values for the stops became shorter and less variable with age. Though a small number of prevoiced VOICED stops were found in the monolingual parents' productions [5], none of their children had any prevoicing. As for the bilinguals, only one child (B7) used prevoicing, which supports the view that the production of voicing lead in English is idiosyncratic [2]. On the whole, there was no significant difference between the

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monolingual and bilingual groups or individuals in the production of the VOICED or the VOICELESS stops [5].

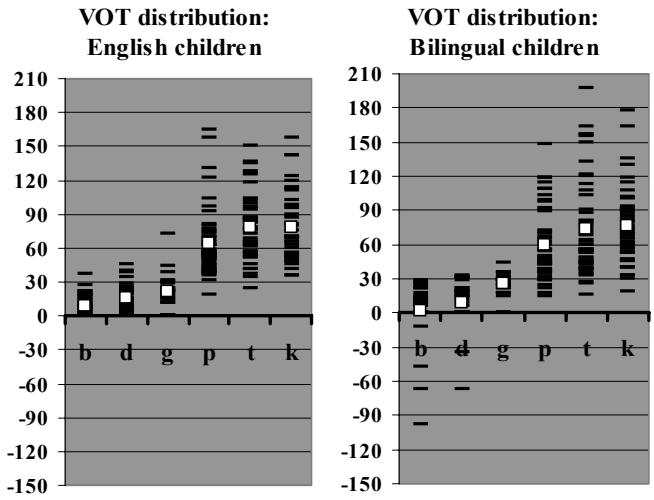

Figure 1: Mean VOT values (white squares) and distribution (in ms) for the monolingual English (left) and the bilingual children (right) speaking English. N = 497.

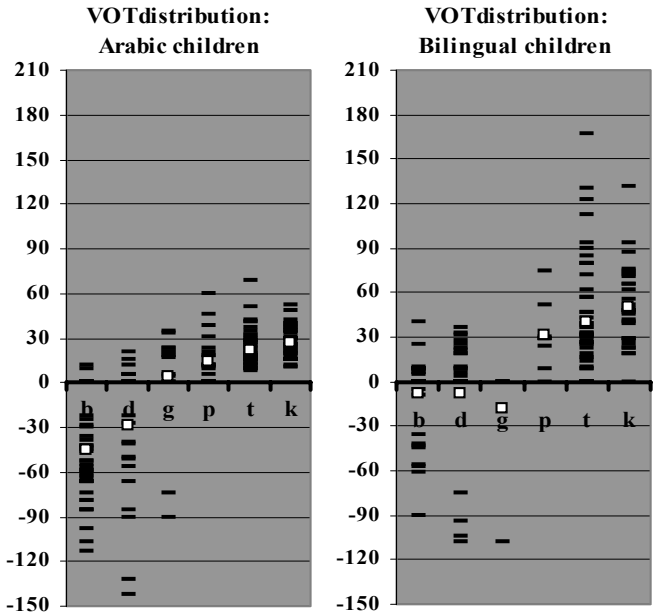

Figure 2: Mean VOT values (white squares) and distribution (in ms) for the monolingual Arabic (left) and the bilingual children (right) speaking Arabic. N = 365.

In Arabic (Figure 2), monolingual subjects produced their VOICELESS stops in the short lag region, with mean VOT values that showed gradual progression to the parents' values [4] and that ranged between 14.41 and 26.93ms. Another similarity with adult results was that VOT values for the Arabic VOICELESS stops produced by the monolingual children occupied higher ranges along the VOT continuum than those of the English VOICED stops produced by the monolingual English children. The difference was statistically significant for the bilabial and alveolar place of articulation [5]. Note that the difference in the distributions for /g/ across the two languages was insignificant partly due to the difficulty to maintain voicing lead in /g/, which caused the /g/ productions by the children to fall in the short lag region regardless of the language in question. Moreover, in Arabic, /g/ occurs in loan words only, which explains why its VOT production was not mastered as well as that of /b/ and /d/. Apart from /g/, A10 is the only subject who acquired full voicing lead for all VOICED stops (Figure 3). A7 and A5 showed signs of incomplete acquisition of voicing lead by producing many of their VOICED stops with short lag.

Although the three bilingual subjects generally produced higher VOT values for their VOICELESS stops in Arabic than their VOICED stops in English (Figures 1 and 2), the difference was not as big as that found between the monolingual English and Arabic subjects and did not reach significance [5]. The bilinguals had higher distributions for their Arabic VOICELESS stops than those of the monolinguals (group results significant at $p << 0.01$ for /t/, $p << 0.001$ for /k/), and fewer prevoiced tokens for their VOICED stops (20% for the bilinguals as opposed to 56% for the monolinguals). Although this may suggest that there is influence from English on the bilinguals' VOT production in Arabic, individual results proved important for explaining the patterns observed (Figure 3).

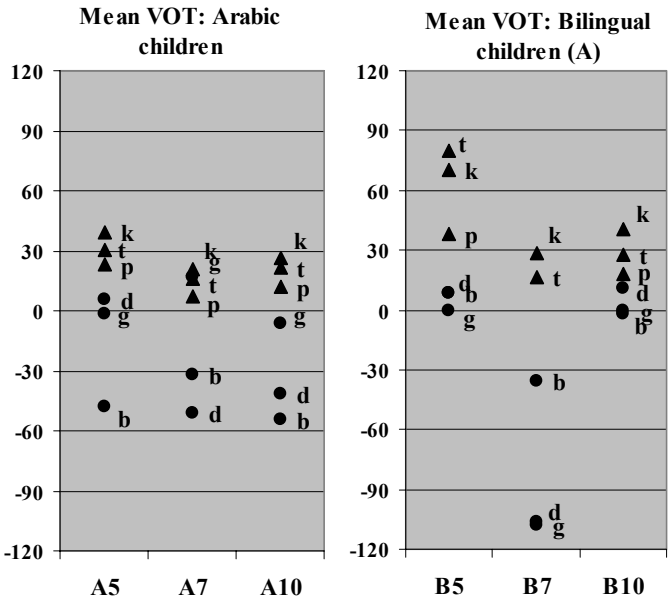

Figure 3: Mean VOT values (in ms) for each of the monolingual Arabic children (left) and bilingual children speaking Arabic (right). N = 415.

With respect to the high values for VOICELESS Arabic stops, B5 was actually responsible for most of the long lag productions. This could be explained by the fact that B5's VOT values for VOICELESS stops were high regardless of the language in question. Nevertheless, B5's VOT distributions for Arabic VOICELESS stops were still significantly lower than those for English VOICELESS stops ($p << 0.001$ for both /t/ and /k/).

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With respect to prevoiced tokens, individual results (Figure 3) showed that B7 was the only child who acquired the production of voicing lead in Arabic. While studies of monolingual development in languages that realize VOICED stops with voicing lead show a gradual acquisition with age [1], results from this study show that age on its own is not the only factor involved in the acquisition of such a complex feature. The role of input (Section 4) suggests that complex features require ample exposure at an early age in order to be acquired.

4. INPUT FACTORS

Results from an earlier study conducted with B7 and B10 only [4] show that 18 months prior to the current study, neither of the two brothers had acquired voicing lead in Arabic. At the time of the recording for the current study, the brothers had been attending a weekend Arabic school for 15 months. Knowing that the two brothers experienced the same changes in Arabic input, the uneven change in their behaviour (Figure 4) may be attributed to their age. While B7 was still five years old when he experienced the increased Arabic input, his brother was eight and was probably past the critical age required for the acquisition of voicing lead [3]. As in monolingual situations, the acquisition of certain complex features that require early and extensive exposure might therefore be delayed or not acquired if these features are lacking in the input.

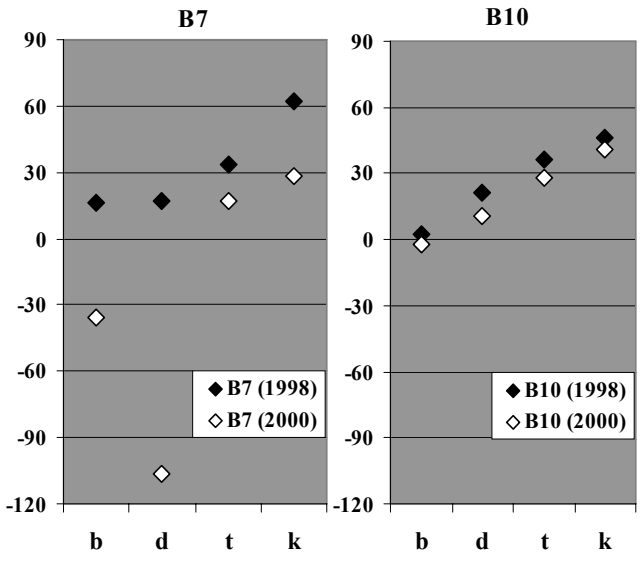

Figure 4: Mean VOT values for Arabic /b d t k/ by B7 and B10 in 1998 and 2000. N = 176.

What is particular about B7's prevoiced stops in English and Arabic is that in the majority of prevoiced tokens, the auditory impression was sometimes that of a homorganic nasal preceding the stop (e.g. [ˀmˈbɛdʒɹʉm] 'bedroom'; [ˈmbɑʔɾɐ] for /ˈbɑʔɾa/ 'cow'), and other times that of an implosive (e.g. [ˈɓʌtʰə] for 'butter'). Spectrographic analysis revealed that the laryngeal voicing preceding these stops was accompanied by energy above the F0 level and traces of formant structure (Figure 5). Similar results have been found for children acquiring prevoicing in other languages [1]; in most cases, the children are choosing an articulation that does not involve a complete obstruction of the airstream in order for them to prolong the voicing articulation and therefore aid the production of voicing lead. However, nasals and implosives were not only used by B7 as developmental features, as closer analysis of his mother's prevoiced tokens (BF7) revealed very similar patterns. (BF7) frequently produced audible and acoustically detectable nasals before her VOICED stops in English and Arabic (Figure 6). The nasals were homorganic with the stops, e.g. [mbɛːɾ] 'bear', [ndoːɾ] 'door' and were sometimes preceded by what sounded like a schwa, e.g. [ˀmˈbaskɪt] for 'basket'. Note that these tokens did not sound like pause-fillers as might be expected, and only occurred with voiced tokens, never with voiceless ones.

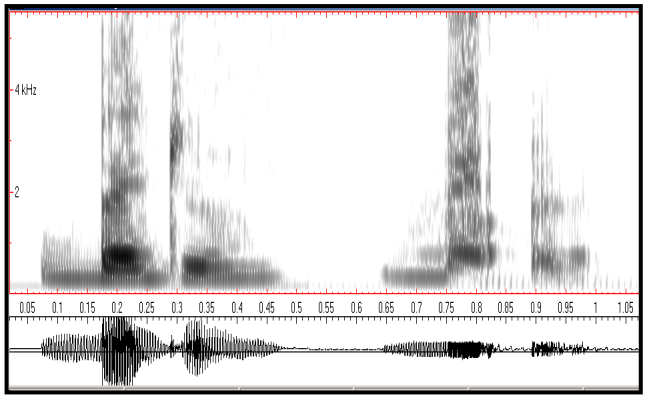

Figure 5: Spectrogram of the words 'bedroom' (left) and /ˈbɑʔɾa/ 'cow' (right) as produced by B7.

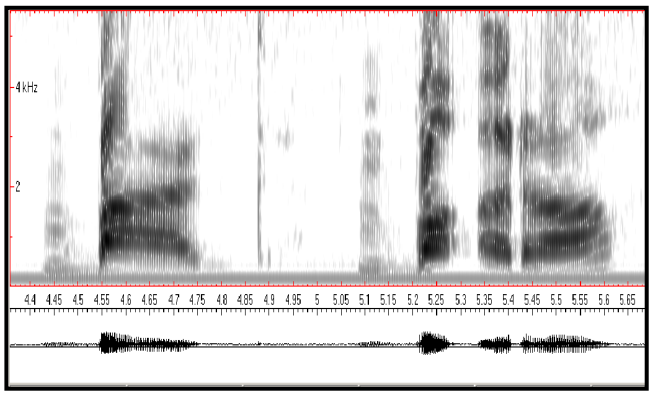

Figure 6: Spectrogram of the words 'bag' (left) and /ˈbɑʔɾa/ 'cow' (right) as produced by BF7.

5. LANGUAGE MODE FACTORS

So far the discussion has concentrated on either the English tokens produced by the bilingual children during the English sessions or the Arabic tokens produced during the Arabic sessions. Code-switches to English during the Arabic sessions were also extracted for analysis and the VOT patterns in these tokens did not conform with the patterns produced by the children during the English-only

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sessions. Table 2 illustrates the difference by showing a small selection of words that were produced by the bilinguals in both the English and the Arabic sessions.

		Arabic sessions		English sessions	
	Gloss	**IPA**	**VOT (ms)**	**IPA**	**VOT (ms)**
p	pool	puːˤl	28	pʰʉɤ	84
	po	pʰoʊ̯	56	pʰɔʊ	92
t	tummy	ˈtʌmiː	12	ˈtʰʊmɪ	42
	teapot	ˈtiˑpɔtˀ	19	ˈtʰiːpɔtʰ	76
k	kettle	ˈkɛtəl	37	ˈkʰɛtəɬ	70
	carrot	ˈkɐɻət	25	ˈkʰaɹət	57
b	bottle	ˈbɔtəl	0	ˈbɒtɐ	12
	beer	bːiəɻ	-165	bɪə	0
d	deer	diːɾ	13	dɪə	31
	duck	d̥ɜk	12	dʊk	21
g	guitar	g̊iˈtɋˌɻ̊	13	g̊ɪˈtʰɑː	34
	goat	gɑːt	25	gəʊt	21

Table 2: VOT measurements of English target words produced by the bilinguals during each of the Arabic and the English sessions.

Two major patterns emerged from looking at the data in Table 2. First, English words with initial VOICELESS stops had shorter VOT when produced during the Arabic sessions than when produced during the English sessions. This pattern applied mainly to B7 and B10, while B5's production tended to follow the English pattern regardless of the language session. As for VOICED stops, there was no significant difference in VOT production of the 'same' words depending on the language session; this may be due to the fact, that two of the bilinguals did not produce any prevoicing for their Arabic stops anyway. There was, however, a tendency to produce longer VOT in the English sessions than in the Arabic ones. More importantly, VOT was not the only feature that changed depending on the language session. As can be seen from Table 2, a whole set of language- and dialect-specific phonetic and phonological features appeared to vary in the production of the 'same' words depending on the language context. This included clear versus dark variants of /l/, rhoticity, vowel quality, etc. All three children showed evidence of code-switching at the phonetic and phonological level.

6. CONCLUSION

The language context in which the children produced target VOT tokens turned out to be crucial for the interpretation of the resulting production patterns. Very few studies on VOT have specified the linguistic context in which the bilingual subjects' production occurred and the effect this may have had on the resulting patterns. In this study B7 and B10 showed strong awareness of the language context and of their ability to manipulate VOT patterns of English words depending on whether these were produced in an Arabic or English context. If the patterns found for the English words produced during the Arabic sessions were to be included with the rest of the data that were analysed in Section 3, one might have reached the erroneous conclusion that the bilinguals have not acquired separate patterns for each of their languages. However, by taking the language mode into account [4], one can see that the bilinguals may actually be showing signs of sociolinguistic competence by manipulating vocalic, consonantal, and prosodic features to make words sound more Arab- or more English-like.

B7's acquisition of voicing lead shows that, when the two conditions of input and age are met, bilinguals will follow similar acquisitional patterns to those of monolinguals, or even 'catch up' with them. In the process of doing so, bilinguals will exhibit developmental patterns that are once more similar to monolingual ones, such as the use of short lag instead of voicing lead, or the use of continuants preceding the prevoiced stops. B7's use of strategies that are similar to those used by monolinguals points to the necessity of looking for normal developmental processes in order to explain the speech patterns observed in bilinguals before resorting to explanations based on language interference. Moreover, B10's use of short lag is not necessarily caused by an influence from English, but may be due to the fact that he did not receive enough Arabic input at an early age to master the complex articulatory features required for the production of voicing lead. What is considered a developmental feature may also turn out to be part of adult speech, such as the production of nasals and vowels before prevoiced stops by BF7.

REFERENCES

[1] G.D. Allen, "How the young French child avoids the pre-voicing problem for word-initial voiced stops", *Journal of Child Language,* vol. 12, pp. 37-46, 1985.

[2] G.J. Docherty, *The Timing of Voicing in British English Obstruents*, Berlin & New York: Foris Publications, 1992.

[3] J.E. Flege, "Second language speech learning: theory, findings, and problems", in *Speech Perception and Linguistic Experience: theoretical and methodological issues,* W. Strange (ed.). Baltimore: York Press. pp. 233-272, 1995.

[4] F. Grosjean, "The bilingual's language modes", In *One Mind, Two Languages,* J.L. Nicol (ed.). Oxford: Blackwell, pp. 1-22, 2001.

[5] G. Khattab, "VOT production in English and Arabic bilingual and monolingual children", in *Perspectives on Arabic Linguistics XIII-XIV,* D.B. Parkinson & E. Benmamoun (eds.). Amsterdam: John Benjamins, pp. 1-38, 2002.

[6] G.H. Yeni-Komshian, A. Caramazza, & M.S. Preston, "A study of voicing in Lebanese Arabic", *Journal of Phonetics,* vol. 5, pp. 35-48, 1977.