To cite: Mayr, R. & Montanari, S. (2015). Differentiation and interaction in the vowel productions of trilingual children. In The Scottish Consortium for ICPhS 2015 (Ed.), *Proceedings of the 18th International Congress of Phonetic Sciences*. Glasgow, UK: the University of Glasgow. ISBN 978-0-85261-941-4. Paper number 0072.1-5 retrieved from http://www.icphs2015.info/pdfs/Papers/ICPHS0072.pdf

DIFFERENTIATION AND INTERACTION IN THE VOWEL PRODUCTIONS OF TRILINGUAL CHILDREN

Robert Mayr & Simona Montanari

Cardiff Metropolitan University; California State University, Los Angeles
rmayr@cardiffmet.ac.uk; smontan2@exchange.calstatela.edu

ABSTRACT

This study investigates the vowel productions of two simultaneous trilingual sisters, aged 6;8 and 8;1, who are growing up with English, Italian and Spanish in California. The children's realisations were analysed acoustically and compared to those of the main adult input providers in their home, using Watt and Fabricius' *S*-centroid vowel normalisation procedure [3, 16]. The results revealed a high degree of within-language and cross-language differentiation for both children, but also some evidence for cross-linguistically overlapping patterns. At the same time, many of the children's productions differed from those of the input providers. Together, the results suggest complex cross-linguistic interactions as well as the influence of socio-phonetic factors.

Keywords: Vowel production, acoustic analysis, multilingualism, cross-linguistic interactions.

1. INTRODUCTION

Many studies have investigated vowel systems in bilingual children [11, 17] and adults [5, 8, 13]. By and large, they have revealed that simultaneous and consecutive bilinguals are able to keep their vowel categories distinct cross-linguistically. For example, Guion [8] showed in her study of four types of Quichua-Spanish bilinguals that simultaneous, early and some mid bilinguals were consistently able to differentiate their L1 and L2 vowels. Only in late bilinguals was there evidence for significant cross-linguistic overlap, suggesting assimilation patterns.

Nevertheless, the vowel realisations of bilinguals are often different from those of monolingual speakers. Flege, Schirru and MacKay [5], for instance, showed that early Italian-English bilinguals produced English /eɪ/ with more vowel-inherent spectral change than monolingual English speakers. The authors argue that these patterns arose as a result of cross-linguistic dissimilation effects. In other words, the bilingual speakers exaggerated the diphthongal quality of the English vowel in an attempt to keep it maximally distinct from monophthongal Italian /e/. Cross-linguistic interactions are not inevitable, however. MacLeod, Stoel-Gammon and Wassink [12], for instance, showed that Canadian English-Canadian French bilinguals produced their vowels in much the same way as monolinguals of either language.

What is not clear, however, is how individuals cope when the demands are even higher, i.e. where more than two vowel systems are involved. The present preliminary study is the first to address this issue by investigating the monophthong productions of two school-age simultaneous trilingual children. On the basis of these data, it aims to address the following questions: (1) Do the children's vowel productions conform to those of the adult input providers in their home? (2) Do the children manage to differentiate their vowel categories cross-linguistically? (3) Is there evidence for cross-linguistic interactions across the three languages?

2. METHOD

2.1. Participants

The principal participants are two simultaneous trilingual sisters growing up with Italian, English and Spanish in California: Maya, aged 6;8, and Sofia, aged 8;1. The study also included the three main sources of linguistic input in the children's home: their mother, father and nanny. The children hear Italian from their native Italian-speaking mother and in their Italian-English dual language school, English from their American English-speaking father and the wider community, but Spanish only from their Mexican nanny. Note that while the father and nanny are monolingual speakers of English and Spanish, respectively, the children's mother is competent in all three languages. Despite greater input in Italian and English compared with Spanish, the children are fluent in all three languages.

2.2. Materials

This study aims to capture all monophthong categories in English, Italian and Spanish that occur in fully stressed position. Note that the vowel inventories differ in size across the three languages. Thus, Californian English [6, 9], in which the *cot-caught* distinction is neutralised, contains the nine monophthongs /i ɪ ɛ æ ʌ u ʊ ɚ ɑ/. In contrast,

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Standard Italian distinguishes seven monophthongs, i.e. /i e ɛ o ɔ u a/ [1], and Mexican Spanish five, i.e. /i e o u a/ [6]. Table 1 shows the materials used in the study.

Table 1: Vowel categories and target items used.

English		Italian		Spanish	
VOWEL	ITEM	VOWEL	ITEM	VOWEL	ITEM
i	*eachy	i	*ice	i	*iche
ɪ	itchy	e	*ece	e	*eche
ɛ	*etchy	ɛ	*ecce	o	*oche
æ	*atchy	o	*oce	u	*uche
ʌ	*uchy	ɔ	*occe	a	hache
u	*ootchie	u	*uce		
ʊ	*utchy	a	*ace		
ɚ	*urchy				
ɑ	*otchy				

In order to control for phonetic context effects, the target vowels in the three languages were embedded in the context /ˈVtʃV/. Note that the syllable-final vowel was always an instance of an unstressed front vowel.

2.3. Procedure

Since Maya and Sofia are not only fluent, but also literate in all three languages, a reading task seemed appropriate. The children were recorded in individual sessions in a quiet room in their home, using a Zoom H2 Handy Recorder with a sampling rate of 44.1 kHz and 16-bit quantisation. They participated in separate recording sessions in each language carried out on different days to control for language mode effects [7]. The Italian recording session was administered by the children's mother, the English session by their father, and the Spanish session by their nanny. Since most target items constitute (phonotactically admissible) non-words (cf. asterisks in Table 1), they were primed by the use of high-frequency real words that contain the same vowel categories, e.g. *veloce* ('fast'), *croce* ('cross'), *voce* ('voice') for **oce* (Italian); *estuche* ('case'), *peluche* ('teddy'), *buche* ('maw') for **uche* (Spanish); *sketch*, *fetch*, *stretchy* for **etchy* (English). Wherever possible, rhyming words were used as primes. In each session, the children read multiple tokens of the real-word primes followed immediately by the /ˈVtʃV/ targets. The children's parents and nanny also recorded themselves, completing the same reading task as the children, however, only in their respective native language.

2.4. Analysis

For each participant, six tokens from each vowel category were analysed acoustically. Since the study focuses on vowel quality, only spectral information will be presented here. Using PRAAT software [2], the frequency of the first two formants of each vowel token was measured at the vowel mid-point via formant trackers. Where mistracking occurred, the automatically tracked formants were hand corrected. Due to the small number of participants, it was not possible to use inferential statistical methods. Instead, comparisons across and within individuals involved assessing the degree of spectral overlap in the vowel productions on the basis of descriptive statistical information. To compare child and adult participants, the raw Hertz values were normalised, using the *S*-centroid vowel normalisation procedure developed by Watt and Fabricius [3, 16], a type of vowel-extrinsic scale-factor normalisation. The procedure involves dividing raw Hertz values by the scale factor *S* which is based on the values of the most peripheral vowels.

3. RESULTS

3.1. Cross-language comparison: Adults

Figure 1 depicts a normalised F1~F2 plot of the Italian vowels produced by the children's mother, the English vowels produced by their father and the Spanish vowels produced by their nanny. The patterns observed closely mirror those from previous acoustic accounts of the three languages [4, 6, 9].

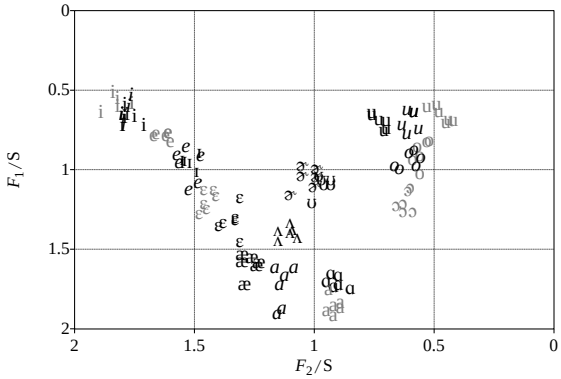

Figure 1: F1/S~F2/S plot of adult vowels in English (black), Italian (grey) and Spanish (italics).

Inspection of the figure shows a large degree of differentiation amongst the three languages. Thus, even categories with the same IPA symbol have clearly distinct realisations. For example, English /u/ is consistently more fronted than its Spanish counterpart, which, in turn, is more fronted than

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Italian /u/. Similar cross-linguistic differences are also apparent for mid front and open vowel categories. In line with Grijalva, Piccinini and Arvaniti's study [6], for instance, Spanish /a/ is more fronted than its English (and Italian) counterpart. Significant cross-linguistic overlap is only evident for Spanish /e/ and English /ɪ/; Italian /o/ and Spanish /o/; and /i/ across the three languages.

A comparison of the mean F2/S values across all categories suggests that the vowel space of English is more fronted than that of Spanish and Italian, with mean values of 1.183, 1.126 and 1.065 Hz/S, respectively. Moreover, owing to the greater number of mid and open vowel categories, it is also more open overall (English mean F1/S: 1.159; Italian mean F1/S: 1.017; Spanish mean F1/S: 0.99).

3.2. Cross-language comparison: Children

Plots of Sofia's and Maya's vowel realisations in English, Italian and Spanish (in raw Hertz values) are shown in Figures 2 and 3, respectively.

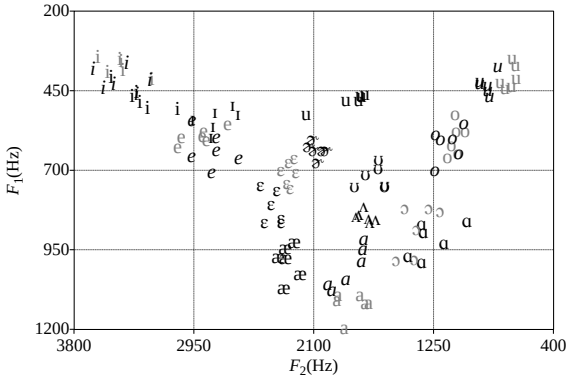

Figure 2: F1~F2 plot of Sofia's vowels in English (black), Italian (grey) and Spanish (italics).

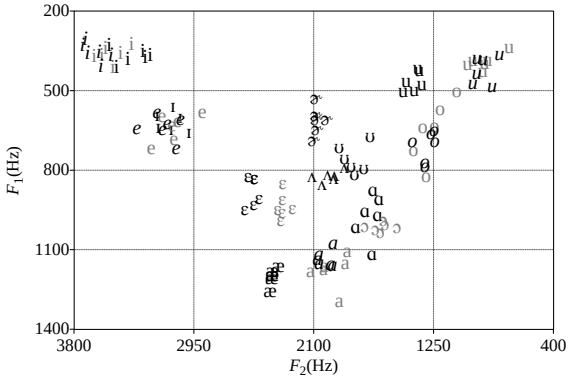

Figure 3: F1~F2 plot of Maya's vowels in English (black), Italian (grey) and Spanish (italics).

The results for both children indicate substantial differentiation across the three languages. However, their productions do not always match those observed in the adults. For example, in contrast to the adult data, both children produced more fronted realisations of English /ɛ/ than Italian /ɛ/. Moreover, their Italian and Spanish /a/ categories exhibited equal degrees of frontness, while in the adult productions Spanish /a/ was much more fronted than its Italian counterpart.

The children also showed more cross-linguistically overlapping patterns than the adults. For example, both Maya and Sofia failed to produce a clear spectral distinction between English /ɑ/ and Italian /ɔ/. At the same time, there were also differences between the two sisters. Thus, the older sister Sofia differentiated Italian and Spanish /u/, and Italian and Spanish /e/, while her younger sister did not.

3.3. Within-language comparison: Children vs adults

Finally, the children's productions were compared with those of the respective adults in each language. Accordingly, Figure 4 shows a comparison of Maya and Sofia's English productions with those of their father, Figure 5 shows a comparison of their Italian productions with those of their mother, and Figure 6 shows a comparison of their Spanish productions with those of their nanny.

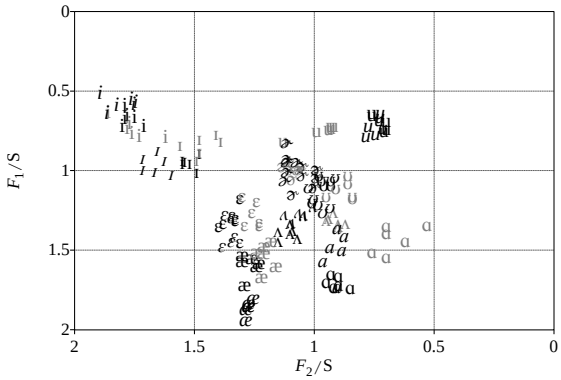

Figure 4: F1/S~F2/S plot of English vowels: father (black), Sofia (grey) and Maya (italics).

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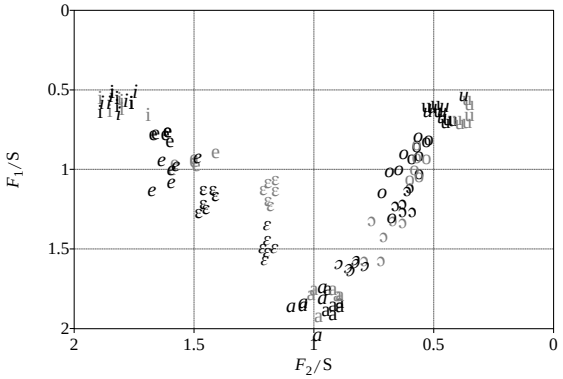

Figure 5: F1/S~F2/S plot of Italian vowels: mother (black), Sofia (grey) and Maya (italics).

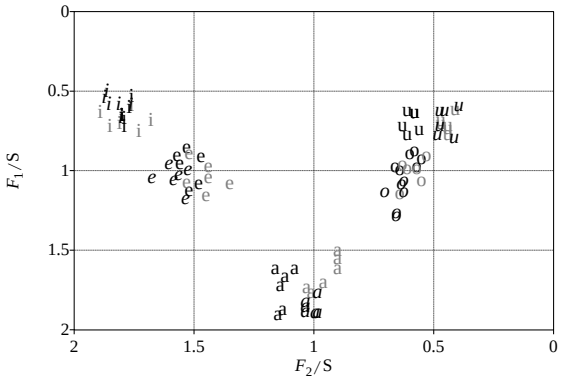

Figure 6: F1/S~F2/S plot of Spanish vowels: nanny (black), Sofia (grey) and Maya (italics).

Inspection of the figures shows that the children produced all categories distinctly within each of the three languages. Moreover, their realisations of many categories overlapped substantially with those of the adults, including Italian /i a o/, Spanish /i e o/ and English /i ɚ ʊ/. Other categories, in contrast, showed clear differences between the child and adult productions. For example, the children's Italian /e/ and /ɔ/ were more open than their mother's, while their Italian /ɛ/ was more retracted, and in the case of Maya, more open than their mother's. Similarly, the children's Spanish /u/ and /a/ realisations were more retracted than their nanny's. Interestingly, the results also show differences between the sisters. Thus, Sofia's English vowel space is more retracted than Maya's overall (Mean F2/S: 1.134 vs 1.21), with substantially lower F2/S values for most categories, in particular /ɑ/. Note, however, that the pattern for her English /u/ goes in the opposite direction with more fronted realisations.

4. DISCUSSION AND CONCLUSION

This study investigated the vowel productions of two simultaneous trilingual children and compared them with those of the main input providers in their home. The results revealed a large degree of within-language and cross-language differentiation for both children, but also substantial differences from the adult realisations as well as unexpected instances of cross-linguistic overlap.

Theoretically, these patterns could be due to developmental factors. However, this is unlikely considering the children's relatively advanced age and the fact that vowel systems are usually in place by around 3;0 [15]. Nevertheless, linguistic experience seems to have played some role since the older sister Sofia achieved greater cross-linguistic differentiation than her younger sister.

Another factor that could explain the observed deviation from the adult patterns is socio-phonetic variation. For instance, it is likely that Sofia's fronted realisations of English /u/, which conform to known trends in American English [e.g. 10], are due to the influence of her peer group. However, socio-phonetic variation cannot explain all adult-child differences. The children's fronted realisations of Spanish /u/ and /a/ compared with the nanny's, for instance, cannot be explained in this way since they do not hear Spanish from anyone else.

Instead, it is more likely that the children's patterns are predominantly a result of cross-linguistic interactions. Such interactions have, of course, been documented widely for bilingual vowel systems [5, 8, 11, 17]. What the present study adds is a preliminary glimpse at the complexity involved when speakers have to handle three vowel systems.

Thus, the results suggest complicated interactions involving all three languages. The children's open Italian /ɔ/ realisations, with values that overlap with English /ɑ/, for example, suggest an interaction between Italian and English vowels, while their retracted Spanish /u/ realisations point to an interaction between Spanish and Italian. The same could account for their retracted Spanish /a/ productions. However, alternatively, they could be a result of dissimilation from their more fronted English /æ/.

The patterns observed here hence suggest that all three languages are involved in interactions. This finding is interesting as it differs from a previous study on the children's VOT patterns [14], which indicated an influence of their English stop categories on their Italian ones, but not on their Spanish ones. It was argued that this asymmetry was due to the different settings in which the children

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receive input in Spanish and Italian. It is interesting that the same input setting had a different effect on their vowel productions. Further research, using a substantially larger sample, is needed that builds on the findings from this preliminary study and investigates systematically how different input settings affect cross-linguistic interactions as well as why and how interactions may manifest differently in different areas of pronunciation. In addition, future research should examine how differences in the complexity of vowel systems may affect cross-linguistic differentiation and interaction in trilingual speech.

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