ACQUIRING RHYTHMICALLY DIFFERENT LANGUAGES IN A BILINGUAL CONTEXT

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ABSTRACT

Using the Pairwise Variability Index (Grabe & Low, 2002), the rhythmic patterns of 3;0 year old German and Spanish monolingual and bilingual children are examined. Whereas the PVIs of monolingual Spanish data are low and those of monolingual German data are high, the data of the bilinguals do not greatly differ across languages. The PVIs of the bilinguals in German do not differ from those of the monolinguals, but the consonantal intervals of the bilinguals in Spanish are characterized by higher variability than those of the Spanish monolinguals. Several explanatory hypotheses are discussed, and an interpretation, which posits that consonantal intervals reflect properties of the language-specific phonology, is proposed. This implies that only the vocalic PVIs correlate with rhythmic class.

Keywords: rhythm, stress-timed, syllable-timed, bilingual acquisition, Pairwise Variability Index

1. INTRODUCTION

Since Pike's [10] proposal of a fundamental rhythmic difference between languages—syllable-timed vs. stress-timed—and Abercrombie's [1] attempt to operationalize the difference by means of isochrony, it has been difficult to sort out the variables contributing to rhythmic effects.

1.1. Measurement of rhythm

Reductionist attempts by phonologists to reinterpret rhythm in terms of phonological factors [4] have disclosed intriguing correlations between rhythmic type and phonological factors:

- Stress-timed languages have a greater variety of syllable types and more complex syllable structure than syllable-timed languages.
- Stress-timed languages, but not syllable-timed, contain processes of unstressed vowel reduction.

Lately there have been attempts to establish some type of acoustic criterion to define rhythm. Ramus et al. [11] developed a measurement technique based on the duration of successive vocalic and consonantal intervals. They calculated:

- the proportion of vocalic intervals within the sentence (%V),
- the standard deviation of the duration of consonantal intervals (ΔC).

The application of these two calculations lead to the distinction of well-known rhythm classes, lan–guages typically considered stress timed (e.g., English and Dutch) clustering together with low %V and high ΔC, and languages typically considered syllable timed (e.g., Spanish, Italian, and French) having high %V and lower ΔC values.

Grabe and Low [7] developed a similar meas–urement, which also divides the speech stream into intervals of consonants and vowels. However, they compute the Pairwise Variability Index both for vocalic intervals (nPVI-V) and for consonantal intervals (rPVI-C), where r refers to the raw or non-normalized version. The index is compiled by calculating the difference in duration between a pair of successive vocalic measurements, taking the absolute value of the difference and then dividing it by the mean duration of the pair.[1]

(1) Pairwise Variability Index (normalized version)

$$\text{nPVI-V} = 100 \times \left(\sum_{k=1}^{m-1} \left| \frac{d_k - d_{k+1}}{(d_k + d_{k+1}) / 2} \right| \Big/ (m-1) \right)$$

The main insight of this procedure is that when the duration of successive intervals is relatively similar, low variability indices will be computed, which should be the case in syllable-timed languages. When the duration of successive intervals is highly variable, high variability indices should be computed, as in the case of stress-timed languages.

1.2. Acquisition of rhythm

Recently, researchers have employed the PVI to investigate the rhythmic patterns of children

acquiring stress- and syllable-timed languages [5, 6, 13]. Grabe and colleagues compared the rhythm indices (the nPVI-V) of four-year-old English-, German- and French-speaking children with those of their mothers. Their findings support the view that the stress-timed rhythm of English is more difficult to acquire than the syllable-timed one of French [12], as only the rhythmic patterns of English children differed from those of their mothers, tending towards syllable-timing. The German rhythm indices fell in between the French and English ones.

As regards the rhythmic development of bilingual children, Whitworth [13] examined productions by bilingual German-English children (aged 5-13 years) using nPVI-V and rPVI-C. No rhythmic differences between German and English were found in the speech of the bilingual children or of their parents, with the exception of one child with higher nPVI-Vs in English than in German. German and English may not be sufficiently different though to test the interaction between languages in bilingual development.

2. THE PRESENT STUDY

The current study is an analysis of rhythm in monolingual and bilingual children in two rhythmically different languages, German being stress-timed and Spanish syllable-timed. We measure rhythm employing the Pairwise Variability Index: nPVI-V and rPVI-C proposed in [7]. [2]

Our first goal is to establish whether there are cross-linguistic differences in the rhythmic patterns of monolingual German and Spanish children. Although this has already been shown to be the case with adult subjects [11, 7], this cannot be taken for granted with children, because child speech often tends to be syllable timed, regardless of the target rhythmic pattern [13, 2]. Assuming that we do observe cross-linguistic differences, our second goal is to examine the rhythmic patterns of bilingual German-Spanish children by comparing the two languages of the bilingual children with each other and with their respective monolingual controls. If there is no interaction between the rhythmic systems of the bilingual children, we should observe significant differences between the two languages of the bilingual child and non-significant differences between the rhythmic patterns of bilingual children and their respective monolingual controls. However, if there is interaction between the rhythmic systems of the bilingual children, several different patterns may be observed, which include: non-significant differences between the two languages of the bilingual child and significant differences between the rhythmic patterns of bilingual children and those of the respective monolingual groups.

2.1. Data

The data stem from monolingual and bilingual projects in which children acquiring German and/or Spanish in Hamburg (Germany) and in Madrid (Spain) were followed longitudinally. All children were recorded fortnightly in unstructured play situations. The bilingual children were visited by two separate teams: a German- and a Spanish-speaking team. For purposes of the current study, spontaneous productions from several children have been randomly selected:

- three German monolinguals (Br, Mn, Th),
- three Spanish monolinguals (Jo, Ma, Mi),
- three German-Spanish bilinguals growing up in Germany (Je, Mu, Si).

Twenty intonation phrases minimally five syllables long were selected for each child to calculate the PVI; the final syllable of each phrase was excluded because of final lengthening.

2.2. Results

The mean PVI scores for the monolingual German and Spanish children are plotted in Fig. 1, and the data for the bilingual children are plotted in Fig. 2. Vocalic variability (nPVI-V) is indicated on the Y axis and consonantal variability (rPVI-C) on the X axis. Each point represents the mean value for the intersection of nPVI-V and rPVI-C indices for each child. The letters near the values correspond to the initials of the children's names.

Fig. 1 shows that the mean PVI scores of the monolingual Spanish children are located in the left-hand corner and relatively low, whereas the PVI scores of the monolingual German children are in the upper right-hand corner. T-tests revealed significant differences between German and Spanish for both the nPVI-V ($p=0.014$) and the rPVI-C ($p<0.001$). No significant differences were obtained between the PVIs of the German subjects ($p>0.05$) or between those of the Spanish subjects ($p>0.05$), except Jo's vs. Mi's nPVI-V ($p<0.01$).

Fig. 2 shows that the mean PVI scores of the bilingual children tend to be located between these two extremes. The Spanish indices are situated towards the middle of the graph for all children.

Figure 1: PVI scores for the monolingual German and Spanish children.

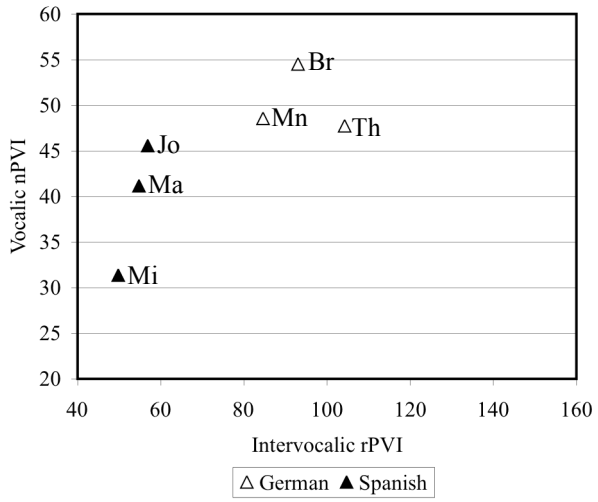
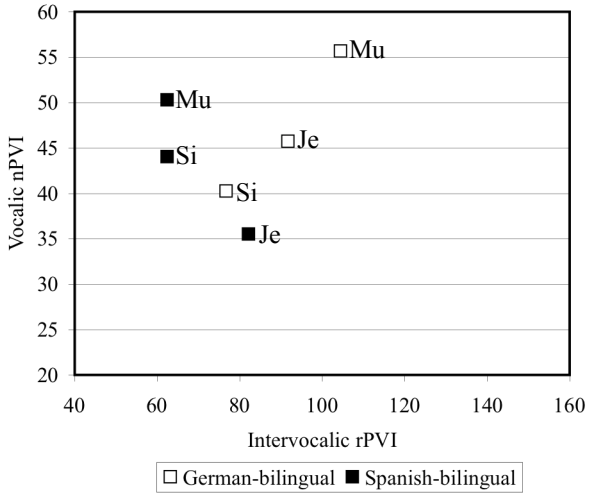


Figure 2: PVI scores for the bilingual German-Spanish children.



The German index is situated towards the middle for Si only, while the ones for Je and Mu align with those of the monolingual German children. Except in the case of Mu, we do not find a great difference between the two languages of the bilinguals. In the case of Je and Si the rhythm indices obtained for German were **not** significantly different from those obtained for Spanish ($p>0.05$). But in the case of Mu the consonantal rhythm obtained for his German **was** significantly different from the one obtained for his Spanish (rPVI-C: $p=0.01$). Moreover, statistical tests revealed that the rhythm indices obtained for bilingual German were **not** significantly different from those obtained for monolingual German ($p>0.05$). However, the consonantal rhythm indices obtained for bilingual Spanish **were** significantly different from those obtained for monolingual Spanish (rPVI-C: $p<0.05$), although the vocalic intervals were not (nPVI-V $p>0.05$).

2.3. Discussion

The first aim of the study was to determine whether there were cross-linguistic differences between the rhythm scores of monolingual German- and Spanish-speaking children. The results confirmed the expectations. Consonantal and vocalic variability scores were significantly greater in German than in Spanish, a pattern consistent with the different rhythmic classifications of the two languages (stress- vs. syllable-timing). The second aim of the study was to analyze the rhythmic patterns of bilingual children in order to determine whether they develop independently or whether they interact. While the rhythm scores of monolingual and bilingual children did not differ in German, they did differ in Spanish, suggesting that this was the language particularly affected in the bilingual situation. With the exception of one child, our results showed no significant differences between the rhythm scores of German and Spanish in the bilingual children's productions at about 3 years of age. The differences shown by one of the children related only to the consonantal intervals.

These findings contain several intriguing aspects. First, the expected syllable timing attributed in the literature to young children was not found in the German data. This might be due to the children being beyond the initial stages of phonological development, as 3;0 year olds have had considerable exposure to the rhythmic characteristics of their language. Second, the tendency of the bilingual Spanish rhythm to approximate the German rhythm is in need of an explanation. We have tried several analyses, in order to look for the factors that might have lead to these results:

- The input data of one of the Spanish mothers, who had been living in Germany for about 10 years, was analyzed following the same methods we had applied to the child data, and compared to the rhythm data of a German adult. The adult data showed significant differences across languages, thus suggesting that the Spanish rhythmic input had not undergone changes due to the influence of German.
- The bilingual children's data were submitted to further analyses of language dominance. On the

basis of criteria, such as percent of utterances produced in the target language and MLU (see [3] for more detailed analyses), the conclusion was reached that all three children were balanced bilinguals.

It should be noticed that from the two types of intervals analyzed, only the consonantal intervals were altered in the Spanish of the bilinguals, i.e. only their PVI-C was statistically different from the PVI-C of the monolinguals. This result could be interpreted as a by-product of the more advanced syllable structure (in particular, coda consonant) development of the Spanish bilinguals, since we have observed that bilingual children acquired codas earlier and faster in Spanish than monolingual children [9]. However, by the age of 3;0, most children were making few errors of syllable structure with the exception of occasional cluster reduction. And yet, one aspect in which monolinguals and bilinguals differed relates to their treatment of Spanish resyllabification, since bilinguals resyllabify less than monolinguals. This leads to a greater presence of codas in the bilingual data, which in its turn leads to more varied syllable structures, and thus to higher PVI-C. This result, if it can be confirmed by further analyses, makes evident that the PVIs that genuinely correlate with rhythm are the vocalic ones, whereas the consonantal PVIs are just a by-product of syllable structure. This hypothesis seems to be confirmed by data of a monolingual German child [8], who developed more slowly than the ones reported here, and who had much less variable PVI-C, given the reduced amount of syllable structures that he produced. It would also explain why Grabe and Low's results show that it is vocalic intervals, not consonantal ones, that tend to correlate with the typical rhythm classes.

3. CONCLUSIONS

Our analysis of the vocalic and consonantal intervals of bilingual German-Spanish children suggests that the rhythmic systems of bilingual children do not remain separate but interact. Whereas monolingual German and Spanish children displayed different rhythmic patterns, bilingual children tended to display similar patterns in their German and Spanish productions. When comparing their results to those of monolingual children, they evidenced greater consonantal variability in Spanish, with statistically significant differences. Spanish was thus the language most affected. These findings, although preliminary, suggest that PVI-C reflects syllable structure and lack of resyllabification in the Spanish of the bilingual children, whereas PVI-V remains the most telling criterion for rhythm.

4. REFERENCES

[1] Abercrombie, D. (1967). *Elements of general phonetics*. Edinburgh: University Press.

[2] Allen, G. & Hawkins, S. (1978). The development of phonological rhythm. In A. Bell & J. Hooper (eds.), *Syllables and segments* (pp. 173-185). Amsterdam: North-Holland.

[3] Arias, J., Kintana, N., Rakow, M., Rieckborn, S. (2005). Sprachdominanz: Konzepte und Kriterien. *Arbeiten zur Mehrsprachigkeit, Folge B* (Nr. 68). Universität Hamburg: Sonderforschungsbereich Mehrsprachigkeit.

[4] Dauer, R. (1983). Stress-timing and syllable-timing reanalyzed. *Journal of Phonetics*, *11*, 51-62.

[5] Grabe, E., Gut, U., Post, B. & Watson, I. (1999a) The acquisition of rhythm in English, French, and German. In I. Barrière, G. Morgan, S. Chiat & B. Woll (eds.), *Current research in language and communication: Proceedings of the child language seminar* (pp.157-163). London: City University.

[6] Grabe, E., Post, B. & Watson, I. (1999b). The acquisition of rhythm in English and French. *Proceedings of the Intonational Congress of Phonetic Sciences*, *2*, (pp. 1201-1204) San Francisco.

[7] Grabe, E. & Low, E. (2002). Durational variability in speech and the rhythm class hypothesis. *Papers in Laboratory Phonology 7*. Cambridge University Press: Cambridge.

[8] Lleó, C. (2007). On the markedness of stress-timing: Evidence from L1 German. Paper presented to the Workshop on L1 Phonological Acquisition of German. University of Konstanz, Januar 15th-16th, 2007.

[9] Lleó, C., Kuchenbrandt, I., Kehoe, M. & Trujillo, C. (2003). Syllable final consonants in Spanish and German monolingual and bilingual acquisition. In N. Müller (ed.), *(Non)Vulnerable Domains in Bilingualism* (pp. 191-220). Amsterdam: John Benjamins.

[10] Pike, K. (1945). *The intonation of American English*. Ann Arbor, MI: University of Michigan Press.

[11] Ramus, F., Nespor, M. & Mehler, J. (1999). Correlates of linguistic rhythm in the speech signal. *Cognition*, *73*, 265-292.

[12] Vihman, M. (1996). *Phonological development: the origins of language in the child*. Oxford: Blackwell.

[13] Whitworth, N. (2002). Speech rhythm production in three German-English bilingual families. *Leeds Working Papers in Linguistics and Phonetics*, 9 (On-line Publication).

[1] See [7] for a more detailed description. Grabe & Low (2002) argue that normalization is desirable for vocalic but not for consonantal intervals.

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