A Dynamic Analysis of English Vowel Production of Brazilian Learners at Different Ages

Ronaldo Lima Jr

Federal University of Ceará

ronaldo.lima.ufc@gmail.com

This study investigated the acquisition of [i', \mathbf{I} , $\mathbf{\epsilon}$, $\mathbf{\alpha}$, \mathbf{u} ', $\mathbf{\upsilon}$] by 30 Brazilian English as a Foreign Language (EFL) learners who were taking the last semester of their advanced EFL courses, and who had acquired English exclusively in Brazilian classrooms. Learners and 10 native speakers of English were recorded reading tokens with the target vowels in a carrier sentence. The corpus consisted of three tokens for each vowel, which were randomly presented four times, totaling 72 vowels per participant. The duration and spectral quality (F1, F2 and F3) of the 2880 vowels were extracted and analyzed.

For the initial analysis, learners were categorized into three groups according to the age they had started studying English, with 10 learners in each of the following groups: those who had begun studying EFL between ages 8 and 11, between ages 12 and 15, and after 17 years of age. F1-F2 vowel spaces of these three groups were plotted and compared with native speakers' vowel space. Analyses included ANOVAs of duration and of F1 and F2 values, as well as the calculation of Euclidean distances between group target vowels. Both duration and F1-F2 analyses revealed a large gap in production accuracy between native speakers and early beginners. Learners tended to assimilate the

pairs [i: 1], $[\epsilon, \alpha]$ and $[u: \upsilon]$ to the prototypical phonological categories of Brazilian Portuguese, i.e. [i,

ε, u], producing little to no phonological contrast between the vowels in each pair under analysis.

Among the learners, though, no single critical period, after which vowel production declined abruptly, was found, but rather a gradual decline in students' production as their age of onset increased. There was statistical difference among the three groups of students and negative correlations between vowel production accuracy and age of onset. Very few exceptional learners with duration and F1-F2 values close to those of native speakers were found, which was enough to justify a second, more dynamic and individualized, analysis of the data.

The second analysis was based on Complex/Dynamic Systems approaches to second language acquisition (Larsen-Freeman, 1997; De Bot, 2008; Cameron, 2003; Ellis, 1998), taking into account Flege's Speech Learning Model (1995), and (acoustic-) articulatory phonology (Browman and Goldstein, 1987, 1993; Albano, 2001). Therefore, in this second analysis, instead of looking at group means and group plots, learners' production data were analyzed individually, thus acknowledging individuality of production due to the dynamic nature of interlanguage. In other words, even though all learners were in the last semester of their EFL advanced courses when the data were collected, this does not mean that they were all at the same stage of acquisition.

The mean F1-F2 values of each learner's vowels were used to analyze their production in relation to the production of the native speakers. Euclidean distances from each learner's vowel to that of native speakers were also calculated. This way, it was possible to identify the few exceptional learners who produced vowels with duration and F1-F2 values at or near those of native speakers. Also, by plotting learners individually in a F1-F2 plot together with the data from native speakers, it was possible to see, and hence document, the movements that learners' vowels tend to make towards attractor states, with the production of exceptional learners moving into different attractor states due to self-organization of their interlanguage.

The next step in this research is to better understand what the exceptional learners have done to take their phonological development in the direction of native-like vowel production. All learners completed a questionnaire assessing their motivation, commitment, extra exposure to the L2, and beliefs concerning language learning in a classroom context in order to check if any of those extralinguistic characteristics correlated with exceptional phonological development, but no significant correlation was found. Also, a future development of this study is to analyze learners' phonological acquisition longitudinally, more in keeping with a dynamic approach to Second Language Acquisition. The relevance of this study is manifold, but it especially sheds light on age-related research in the foreign language context of acquisition and it documents, acoustically, the movement of Brazilian learners' phonological interlanguage towards the prototypical phonological categories of their native language, though not dismissing the possibility of exceptional phonological acquisition by learners of any age.

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