# Learning the Dynamics of Vowel to Vowel Phonotactics

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## Introduction

Is phonetic information encoded by distributional biases in the lexicon? Are phonotactic constraints robust enough to help a learner infer the phonic pattern of a language? Our work in progress attempts to shed light on these questions via: (i) statistical description of the distributional biases in phone sequences in a lexical database and (ii) connectionist simulation. The simulation focuses on V-to-V relations in V(C)'C(C)V phone strings since both harmony and contour constraints (the tendency for the vowels to share or avoid repetition of phonic properties, respectively) have been found in the distributional study (Albano, 2002).

## Experiment and Current Results

An SRN (Elman, 1995), with a compression layer added between the input and the hidden layers, was trained to predict the next phone in the word. The 3700 penultimate stressed words in the training set were fed to the network phone by phone. The context layer activation was reset after each word. Phones were encoded as 35 orthogonal vectors; so no phonetic information was supplied to the network. The training set consisted of trisyllabic nouns only. Since the focus of the experiment was the intervocalic transitions, testing was performed by presenting the network with 12 non-words [pV'pVpV], thus controlling for the effects of consonants. The hidden unit activations produced for each phone in the test set were then analysed using PCA, averaging for the 5 harmonic and 7 contour non-words (means were tested for significance with ANOVA).

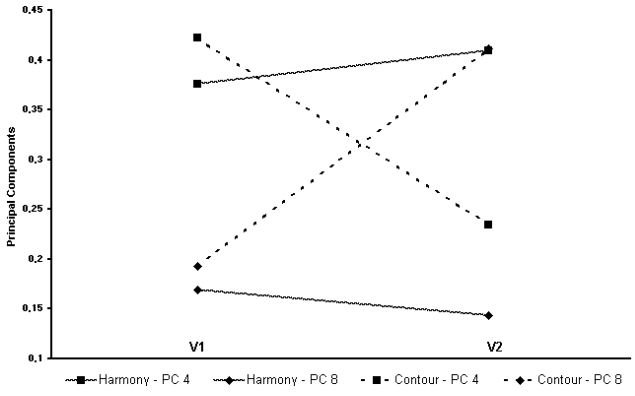


Figure 1: V1 to V2 Transitions according to PCs 4 and 8.

It is possible to identify dimensions in the principal component space which discriminate for Harmony and Contour. Figure 1 depicts the transition between vowels along the dimensions coded by the 4th and 8th principal components. It can be seen that harmonic vowel pairs are not strongly distinguished in any dimension. In contrast, contour vowel pairs differ significantly in both dimensions.

The trajectories associated to transitions in the subspace spawn by the $4^{th}$ and $8^{th}$ components (Figure 2) show that the dynamics for harmony is opposite to the one for contour.

Figure 2: Harmony vs. Contour dynamics for PCs 4 and 8. The direction of the V1V2 vectors is opposed for harmonic and contour vowel pairs.

Phonotactics is best described by non-categorical, probabilistic biases, embodied in the lexicon as constraints on lexical forms which are emergent properties of the operation of dynamical systems that shape language behaviour. So, understanding phonotatics depends on adopting a dynamical point of view.

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## References

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