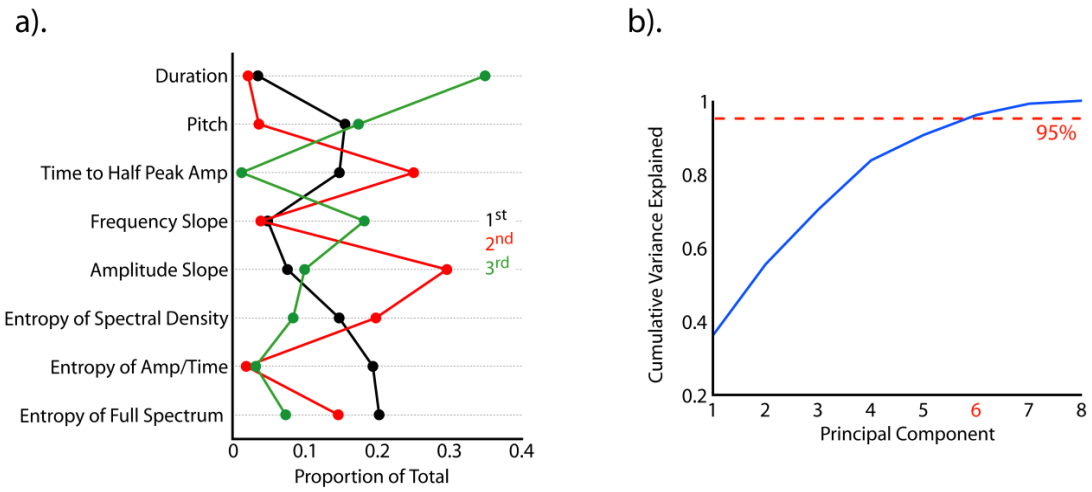
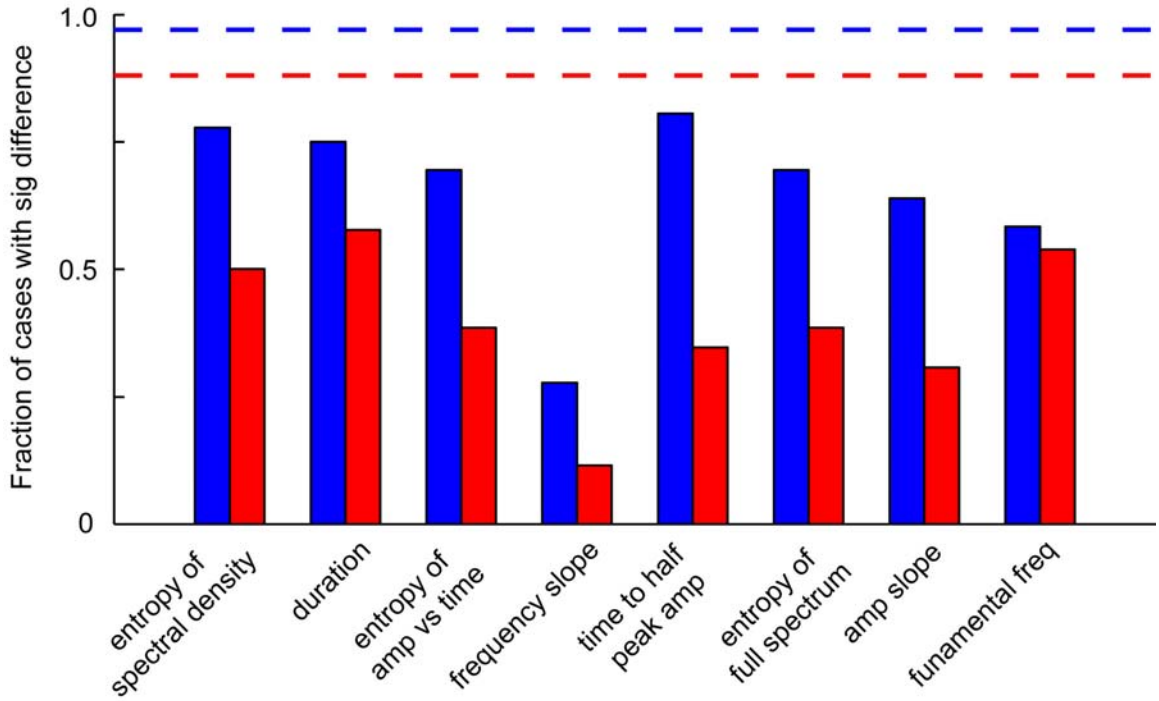
Supplemental Materials



Supplemental Figure 1: Details of the PCA for syllable similarity (a) The contributed proportion of each parameter to principal components 1, 2, and 3 (black, red, and green, respectively). (b) Percent variance explained by the addition of each principal component. 95% of the variance of the data set is explained by the first 6 principal components.

Sequence-dependent differences in individual acoustic parameters

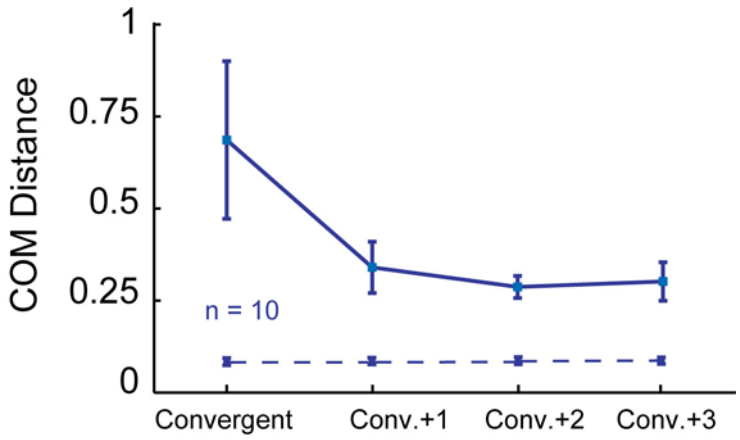
In our primary analysis, we perform principal components analysis (PCA) on a set of eight acoustic parameters and used the resulting PCA loadings to ask whether the acoustics of song syllables were significantly different at convergent and divergent syllables. Supplemental Figure 2 shows the result of univariate analyses in which a single acoustic parameter is used to quantify the prevalence of sequence-dependent differences in phonology. As shown, the univariate analyses frequently revealed significant phonological differences at convergent (blue bars) and divergent (red bars) syllables. However, none of these univariate analyses detected significant effects as frequently as the PCA analysis (dashed lines), reflecting the increased statistical power derived from analyzing all eight acoustic parameters simultaneously.



Supplemental Figure 2: Univariate analyses Vertical bars show the proportion of convergent (blue) and divergent (red) syllables in which significant ($p<0.05$, t-test) acoustic differences were found when only analyzing a single acoustic feature. Dashed horizontal lines show the proportion of cases found to be significantly different in the primary analysis, in which all eight acoustic parameters were used.

Longer sequences of convergent and divergent syllables

In Figure 5 in the main text, we show sequence-dependent phonological differences for convergent and divergent syllables that share at least two syllables in addition to the convergent/divergent one (e.g. a convergent syllable B in sequences ${}_{A}B_{XZ}$ and ${}_{C}B_{XZ}$). In this analysis, the sequence effects for both convergent and divergent syllables were still significant as far as two syllables away from the convergent or divergent syllable (Fig. 5). To examine whether sequence-dependent differences persist 3 syllables after convergent syllables, we applied an even stricter criterion (e.g. ${}_{A}B_{XYZ}$ and ${}_{C}B_{XYZ}$) and obtained 10 convergent syllables. The results of this analysis are shown in Supplemental Figure 3 below, which shows that the acoustic difference remains significant and appears to reach an asymptote at the +3 position. We were unable to perform this analysis at the –3 position (that is, three syllables before a divergence), since applying the necessary criterion (e.g. ${}_{ABC}D_{E}$ and ${}_{ABC}D_{G}$) resulted in the identification of only 4 syllables, too few to allow a statistically significant analysis.



Supplemental Figure 3: Extended Effects of Sequence: Convergent syllable sequences with at least four syllables in common. Mean +/- 1 SE COM distances for each position in the convergent syllable sequence. All COM values are significantly different from chance ($p > 0.05$, one-sided KS-Test). The dashed line represents the chance level of COM distance (that is, the distribution of COM distances under the null hypothesis that no sequence-dependent effects on phonology exist, see Methods). Other plotting conventions as in Figure 5.