Stochastic time analysis of syllable-referential intervals and simplex onsets

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A B S T R A C T

We pursue an analysis of the relation between qualitative syllable parses and their quantitative phonetic consequences. To do this, we express the statistics of a symbolic organization corresponding to a syllable parse in terms of continuous phonetic parameters which quantify the timing of the consonants and vowels that make up syllables: consonantal plateau durations, vowel durations, and their variances. These parameters can be estimated from continuous phonetic data. This enables analysis of the link between symbolic phonological form and the continuous phonetics in which this form is manifest. Pursuing such an analysis, we illustrate the predictions of the syllabic organization corresponding to simplex onsets and derive a number of previously experimentally observed and simulation results. Specifically, we derive not only the canonical phonetic manifestations of simplex onsets but also the result that, under certain conditions we make precise, the phonetic indices of the simplex onset organization change to a range of values characteristic of the complex onset organization. Finally, we explore the behavior of phonetic indices for syllabic organization by progressively increasing the size of the lexical sample and concomitantly diversifying the phonetic context over which these indices are taken.

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1. Introduction

We offer a formal characterization of the temporal phonetic indices used in experimental work to assess syllabic organization. In this characterization, the temporal consequences of syllable parses are expressed as stochastic quantities whose statistics can be subject to analysis. These quantities are expressed in terms of continuous phonetic parameters referring to the timing of the consonants and vowels that make up syllables. These parameters can be estimated from continuous phonetic data. The resulting characterization serves as a link between qualitative syllable parses and their quantitative consequences. A formal characterization of this link enables a better understanding of the behavior of temporal stability indices under conditions which may affect timing. Specifically, we deduce closed-form expressions specifying, for a set of phonetic parameters, the expected values and variances of syllable-referential intervals used to infer phonological organization. The analysis is illustrated by deriving a number of previously observed experimental and simulation results. Finally, we explore how sampling over a lexicon influences the collective phonetics as expressed via stability metrics. Specifically, using articulatory movement data from Moroccan Arabic, we show that progressive increases in lexical size and concomitant diversification in phonetic contexts lead to a shift of the phonetic indices from values characteristic of the simplex onset organization to values characteristic of the complex organization.

2. Background

Linguistic and specifically syllabic structure shapes the continuous low-level temporal organization of articulatory movements during speech (e.g. Browman & Goldstein, 1988; Byrd, 1995; Byrd, Tobin, Bresch, & Narayanan, 2009; Honorof & Browman, 1995; Krakow, 1999; Sproat and **Q3** Fujimura, 1993). Syllabic structure is language-specific. Whereas in English sequences such as [kru] 'crew' or [gli] 'glee' are parsed into a single