

A structured-population dynamical-systems approach to the evolution of morphotactic and lexical consonant clusters

Andreas Baumann
University of Vienna
andreas.baumann@univie.ac.at

Kamil Kaźmierski
Adam Mickiewicz University
kamil.kazmierski@wa.amu.edu.pl

Consonant clusters are articulatorily and perceptually disadvantaged as opposed to consonant-vowel sequences (Dziublska-Kończak 2002). Nevertheless, they stably exist in a number of languages. This can be partially explained by the fact that consonant clusters created by morphological operations – ‘morphotactic clusters’ – help in the identification of morphological complexity, as e.g. /nd/ in *weaken-ed*. However, this does not explain the diachronic stability of consonant clusters primarily appearing within morphemes – henceforth ‘lexical clusters’, e.g. /nd/ in *week-end*. While it has been proposed that lexical clusters benefit from the presence of morphotactic clusters via analogy (Hogg and McCully 1987), the so-called Strong Morphotactic Hypothesis (‘SMH’; Dressler et al. 2010) suggests the opposite: if a consonant cluster occurs across morpheme boundaries as well as within morphemes, this leads to semiotically less optimal configurations, thus weakening the cluster’s stability. In order to test these hypotheses and investigate the complex interaction of the two counteracting pressures from a diachronic perspective (for an acquisition-oriented approach see Calderone et al. 2014), we adopt a mathematical dynamical-systems approach.

The analysis is done in two steps. First, the short-term dynamics of consonant clusters are modelled in terms of a structured-population dynamical system (Hofbauer & Sigmund 1998; Caswell 2001). More precisely, for a specific cluster type the model combines the dynamics of the corresponding token populations of morphotactic clusters on the one hand and lexical clusters on the other hand. The growth rates of the two token populations are linked by analogy effects so that morphotactic and lexical clusters mutually benefit from each other. Furthermore, since higher fractions of lexical types a consonant cluster is part of (henceforth ‘lexical-type fraction’) reflect semiotically suboptimal scenarios, increasing lexical-type fractions are modelled to have a decreasing effect on the growth rate of the morphotactic subpopulation. The resulting structured-population model allows us to investigate the simultaneous short-term dynamics of morphotactic and lexical cluster tokens.

In a second step, the lexical-type fraction is modelled as an evolving parameter of the cluster type (Diekmann et al. 2007; Dercole & Rinaldi 2008). This is plausible, since the number of elements including a certain cluster can easily decrease or increase by processes such as cluster reduction or schwa deletion, respectively. Subsequently, the evolutionary long-term dynamics of the lexical-type fraction are investigated analytically as well as by simulations.

It will be shown that cluster types evolve such that the lexical-type fraction is either very small or very large, thus supporting the predictions of the SMH. Crucially, this holds true even if there is a mutual relationship between morphotactic and lexical clusters via analogy, as long as analogical effects are sufficiently weak. The actual direction of evolution can be understood by means of a phase transition: only if the lexical-type fraction of a cluster type is pushed beyond a certain boundary, for instance due to large-scale phonological changes, can the cluster’s long-term dynamics change qualitatively. This can be used to derive the ratio of morphotactic cluster types in the cluster-type inventory of a language, which can be tested against empirical data.

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