Modelling the sources and functions of speech variation : evidence from rhotic consonants

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Models of population ecology contribute to explain phenomena related to human language dialects. The unit of analysis in both cases is the population, which is a set (a collection) of individuals who are slightly different one from the other, because the community is by definition heterogeneous. These concepts, provided that they are parameterized with adequate phonetic variables, present a framework that might adequately model the dynamics and complexity of phonological systems.

Phonological systems can be regarded as population units that change over time and incorporate many dimensions: biological, physical and cognitive. As time and coordination of elements play a crucial role, this leads to evaluate the behavior of these systems as dynamic and complex. The dynamic aspects of phonological systems are highlighted by treating the phonetic changes in the same way that the concept of multistationarity in physics and cellular differentiation in biology. Mechanisms that are the cause of phonetic changes are beginning to be well known by linguists and when they are implemented or categorized in phonological systems they can be regarded as state changes. The inherent variability of speech is the source from which sound change emerge. Variations that are at their source may or may not spread in the linguistic communities that share a particular phonological system. That is why it is necessary to treat them as population units. Understanding the actuation of sound change leads to ask the question of why phonetic changes appear at a time and in a particular place. The formalization and the propagation of variations in phonological systems can be tackled with tools similar to those developed in the study of ecological population's phenomena.

The logistic equation (1) gives the basis for describing the dynamic behavior of phonological systems. This equation states that the degree of growth of a population is proportional to the product of the population and the difference between the total amount of resources used by the existing population.

$$\frac{dN}{dt} = rN\frac{K-N}{K} \quad (1)$$

The equation has a very simple phonological interpretation. The amount **(K-N) / K** is the fraction of the carrying capacity (the ability of the environment to carry the elements, that is to say, to distinguish them in the perceptual space when talking about phonological systems) that has not been taken into account by individuals who share a phonological system. This amount is the fraction of the total sound discrimination opportunities by speakers. The logistic equation is then obtained by multiplying the degree of initial increase, **r**, by the discriminatory possibilities of sound. From a phonological point of view, this may be designed as the total elements of a phonological system (phonemes, gestures, features) and the difference between perceptual discrimination and items used by people sharing the same phonological system.

It is obvious that this is a simplification of the processes involved in the dynamics of evolution of phonological systems, but the logistic equation seems to be an adequate framework to formalize these processes. The detailed description of the use of the logistic equation to model the evolution of the sound changes in a phonological system is a tool that should be tested with adequate data to assess its relevance. Such data are provided by the evolution of rhotic consonants in Dutch (Van de Velde 1996, Verstraeten et Van de Velde 2001, Tops 2009 & Sebreghts 2015). This will be discussed in the presentation.