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ScienceDirect

Lingua 163 (2015) 40–60

Lingua

www.elsevier.com/locate/lingua

Understanding change through stability: A computational study of sound change actuation

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Received 24 September 2014; received in revised form 20 May 2015; accepted 21 May 2015
Available online 23 June 2015

Abstract

Many approaches to sound change attempt to derive common patterns of sound change from universal pressures, such as physiological and psychoacoustic constraints on speech. Accounts of this type face the following problem: it is not clear why universal pressures only lead to changes in some languages, but not in others. This issue is part of the so-called actuation problem. The question of sound change actuation is usually addressed by referring to social factors and individual differences that may inhibit or encourage the spread of a sound change in a community. While this paper acknowledges the importance of such explanations, it argues that some aspects of sound change actuation can also be approached by looking at structural factors that are typically associated with the initiation of sound change. I use computational simulations to investigate the evolution of sound systems under multiple pressures. The simulated sound systems evolve towards stable states in adaptive landscapes defined partly by universal pressures (e.g. phonetic biases and contrast maintenance) and partly by language-specific factors (e.g. the relative frequency of specific phonetic environments). The former create common pathways of change, while the latter lead to cross-linguistic variation. As it will be shown, this approach can account both for stability and change. The simulations also demonstrate how language-specific factors can be used to make predictions about the stable states towards which sound systems converge.

Keywords: Sound change; Actuation problem; Phonetic bias; Contrast maintenance; Computational simulation

1. Introduction

The main goal of this paper is to contribute to our understanding of how sound changes are constrained, and, specifically, why a given change may be more likely to take place in certain languages and varieties than in others. This issue is often referred to as the *actuation problem* (Weinreich et al., 1968; Baker et al., 2011). Many accounts of sound change identify two hurdles that need to be overcome for a sound change to take place. First, some speakers need to produce speech that deviates from the conventional speech targets of their community. Their innovative speech patterns then need to spread to a substantial number of other speakers within their speech community. These steps are usually referred to as the *initiation* and the *spread* of sound change (cf. Milroy and Milroy, 1985:347–348; Ohala, 1993:268; Janda and Joseph, 2003:17–18; Stevens and Harrington, 2014:4). When talking about constraints on sound change, the notions of initiation and spread are often used in rather different ways. Approaches to sound change that focus on initiation (e.g. Ohala, 1981, 1993; Blevins, 2004; Pierrehumbert, 2001) typically look at how universal properties of speech production

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http://dx.doi.org/10.1016/j.lingua.2015.05.010
0024-3841/

and perception constrain sound change. One important finding that has emerged from these approaches is that cross-linguistically common sound changes can almost always be traced to universal phonetic biases (Blevins, 2004:8–10). Research on the spread of sound change (Weinreich et al., 1968; Milroy, 1992; Labov, 2001) tends to have a different orientation: while it also incorporates some cross-linguistic elements, it puts a stronger emphasis on social patterns that are specific to the community under investigation. These patterns are seen as the main determinants of the paths along which innovations spread in a community. For instance, Labov's (1963) classic study of the English variety spoken on Martha's Vineyard established that the degree of centralisation of /ay/ and /aw/ (an ongoing sound change on the island) correlated strongly with speakers' attitudes towards life on the island, as well as a range of other factors including age, gender and occupation. This differential focus on cross-linguistic versus language-specific patterns has led some researchers to posit that studies looking at sound change initiation should not concern themselves with the actuation puzzle, since it can only be solved by looking at the spread of sound change (e.g. Ohala, 1993:268).

The view of sound change presented in this paper fully acknowledges the crucial role of social factors and population dynamics in the actuation of sound change. However, I will argue that factors traditionally associated with the initiation of sound change should also form an important part of research into the actuation problem. These include articulatory and perceptual pressures (e.g. Paul, 1880; Ohala, 1981; Blevins, 2004; Garrett and Johnson, 2013), a tendency towards the maintenance of lexical contrasts (e.g. Martinet, 1952; Campbell, 1975; Anttila, 1989; Labov, 1994; Wedel, 2006), innate learning biases (e.g. Chomsky and Halle, 1968; Saffran, 2002; Moreton, 2008) and a range of other factors. In this paper, I refer to these as *universal pressures* on sound change, since they follow from general properties of human cognition and the human speech apparatus. It has been argued that such pressures cannot provide insight into the actuation problem precisely because of their universality: how could they account for cross-linguistic differences if they are present in every speaker (see e.g. Weinreich et al., 1968:111–112)? According to this argument, accounts of sound change actuation based on universal pressures cannot explain 'why language fails to change' (Weinreich et al., 1968:112). I will show that this problem arises only when we look at sound changes in a vacuum, that is, changes to a single sound category under the influence of a single universal pressure. When we consider sound systems affected by multiple interacting pressures, we get more varied and realistic predictions, which can help us understand certain types of cross-linguistic differences.

To illustrate the problems outlined above, consider the two universal pressures that are the focus of this paper: *phonetic biases* and *contrast maintenance*. Phonetic biases are physiological and psychoacoustic constraints on speech. Contrast maintenance refers to a tendency for contrastive sound categories to remain well separated in phonetic space. Many scholars view these pressures as having ontologically different effects acting in opposite directions. Thus, phonetic biases are claimed to *enable* sound change by creating the variation that serves as its source (see e.g. Ohala, 1981, 1989; Labov, 1994; Blevins, 2004), while contrast maintenance *inhibits* sound change when it would endanger phonological oppositions (see e.g. Campbell, 1975; Anttila, 1989; Blevins and Wedel, 2009). While the precise effects of these two universal pressures may be somewhat more complicated (e.g. contrast maintenance itself may act as an active force that creates more contrastive variants, instead of simply inhibiting ongoing changes), it is clear that they can interact with each other. However, the details of this interaction remain unclear. How can we predict which pressure gains the upper hand in a particular language, leading to a particular type of change (or the absence of change)? This is a clear manifestation of the actuation problem referred to above.

This paper will suggest that the actuation problem and the interaction between different universal pressures on sound change are closely related. If we understand how the competition among opposing pressures is resolved, we also gain at least a partial answer to the question of why certain changes can go ahead while others are inhibited. I will argue that the interaction among universal pressures is not simply either-or. Their relative strengths in a given sound system are determined by language-specific factors. For instance, the effects of phonetic biases and contrast maintenance are mediated by lexical factors such as *functional load* and the relative frequency with which a specific category occurs in a biasing environment (henceforth *bias proportion*; these factors and their roles in sound change will be discussed in more detail below). We can view these language-specific factors as the context in which universal pressures apply. Sometimes, this context will be highly conducive for a given pressure, leading to a strong and visible effect. Other times, this context will not provide many opportunities for the universal pressure to apply, and it will not produce a strong effect. Since these factors are dependent upon specific properties of a given language at a given time, I refer to them as *contingent factors*.

As it will be shown, universal pressures and contingent factors define complex adaptive landscapes, which determine the possible pathways followed by sound systems during their evolution. If a particular sound system lies in an unstable part of the adaptive landscape, it will tend to move away from it. Conversely, if it is located in a stable part of the adaptive landscape, it will remain there. Since the shape of this adaptive landscape is determined partly by universal pressures, certain stable states will be cross-linguistically more frequent than others. However, cross-linguistic variation in contingent factors will dilute the strength of these universal tendencies.

An important part of the argument summarised above is the claim that the predictions made on the basis of universal pressures and contingent factors are primarily about the properties of stable sound systems, and only indirectly about the probability of sound change itself. Although this may seem like a subtle difference, it has far-reaching consequences.