Phonetics

Sound check

by Maximilian G. Burkhart

Source: picture alliance/Photoshot

Phonetician Jonathan Harrington uses technology to measure with scientific precision how individuals form and perceive sounds. The results suggest possible models of how languages evolve over time.

In December 2006, one of Britain's infamous tabloids appeared with the provocative headline "Does the Queen Speak Cockney?", suggesting that the Head of the Commonwealth might have picked up a working-class accent. The story behind the headline also caught the attention of upmarket media like the *Times* and the BBC. And the man behind the story was a respected researcher – charming, witty and with the native British gift for understatement.

"Does the Queen Speak Cockney?"

Professor Jonathan Harrington comes from the southeast of England, and some of his ancestors were German. He studied Linguistics at Cambridge University, then moved to Australia, where he began to study sound change. All philologists encounter this topic in their introductory university courses. For example, students of German learn that a strong verb like *biegen* (to bend) belongs to "the second ablaut sequence" and takes the forms *biegen, biuge, bouc, bugen, gebogen* (Infinitive, Imperative, Past Indicative Singular and Plural, Past Participle) in Middle High German. These in turn derive from their Old High German equivalents *biogan, biugu, boug, bugum, gibogan*. These apparently arbitrary differences pose a fascinating question: how and why do languages change with time? Indeed, this is such an important question that the European Research Council has given Jonathan Harrington a grant of 2 million euros to search for an answer.

Philologists have been attacking the problem for the past two centuries, but Harrington, who is Professor of Phonetics and Digital Speech Processing at LMU, has come up with a new approach. He plans to use instrumental techniques borrowed from the natural sciences to quantify various aspects of speech production and perception, and thus quantify the process of sound change. This approach has the great advantage of providing empirical data which can be used to verify or reject competing theoretical models.

Sound change occurs very slowly. A significant shift in individual vowels, like that from *bugum* via *bugen* to the current form *bogen* (of the verb *biegen*) takes many centuries. Harrington intends to probe the possibility of a link between the historical evolution of spoken language and the process of language acquisition in childhood. The underlying thesis is that typical errors in speech production and perception that young children make eventually become fixed in the everyday speech of a language community. Moreover, it should be possible to trace changes in usage in the speech of individuals. To do so, Harrington needed speakers from areas in which sound change is known to have occurred, whose language use could be assessed over a long period.

It was known from earlier research that sound change had taken place in the standard accent of English, known as "Received Pronunciation", over the past 50 years. To follow the process over time, Harrington had the bright idea of studying recordings of the Queen's annual Christmas broadcasts, which are archived by the BBC. To his surprise, Buckingham Palace responded positively, and within three weeks, to his request for permission to perform a phonetic analysis on this material.

Harrington analyzed vowel sounds from the recordings, focusing particularly on the quality of the *u*. In the upper-class speech of pre-war England (also adopted by the BBC), the accented vowels in the sentence *Lucy threw the balloon to Sue* were sounded as long *u*. Today, it generally sounds more like *Lücy thrü the ballün to Sü*. Standard pronunciation of long *u* has shifted toward the *yu* sound that occurs in a dialect known as Estuary English which is similar to Received Pronunciation but with some influences from a London accent. Harrington compared the Queen's pronunciation of this and other vowels in her early and more recent broadcasts with those used by present-day female newsreaders. The analysis revealed that, over the years, the Queen's vowels had shifted towards

a more modern form of the Standard English accent. Hence, the shift is also detectable in the Queen's speech, which now sounds less aristocratic than it once did. "Her accent has become more demotic," says Harrington. So does the Queen now speak Cockney? "The headline is of course nonsense," Harrington says. Nevertheless, the shift in the Queen's pronunciation does provide an important clue to an understanding of the evolution of spoken language.

Sound shifts occur slowly, unconsciously and uncontrollably. And they are highly context-dependent. For one thing, they are influenced by the speaker's social context. The fact that the Queen's speech now sounds less "posh" is certainly due in part to social transformations in the 20th century, Harrington says. But change is also a function of phonetic context. "Take the *a* in *man*; most people hear no difference between this and the *a* in *bad*. But the two vowel sounds are acoustically quite distinct. To pronounce the *a* in *man*, unlike the *a* in *bad*, one must lower the velum to let some of the air out through the nose. Thus, the *a* in *man* is nasalized because it is influenced by the surrounding nasal consonants." Harrington can be sure that this is the case, because he makes use of an articulograph to support what he hears. With the aid of a magnetic coil and sensors placed on the tongue, lips and jaw, this instrument accurately records the movements of the organs of speech as they form and emit sounds. As a complementary approach, he also carries out perceptual tests on his experimental subjects.

We do not perceive the nasalized *a* in *man* as such, because we have learned that its nasalized character is not intrinsic to the vowel, but results from its consonantal context. We subtract the nasalisation from the vowel, and therefore usually don't hear the difference between the *a* sounds in *man* and *bad*, although the two are acoustically quite different. But if this is so, how do we manage to distinguish and understand the wide range of sounds in natural language? When one considers the diversity of sounds we use, and how they vary depending on factors such as age, gender, dialect, social position and other parameters, it becomes clear why it is so difficult to design effective software for speech recognition. Unlike computers, the human brain is capable of perceiving the *a* sounds in *man* and *bad* as the same. "It essentially removes the contributions of the temporal overlap of the nasals *m* and *n* with the vowel sound," Harrington explains, "and this is why the *a* in *man* and the *a* in *bad* are heard as the same, despite the fact that one is a nasal sound and the other oral."

Queen Elizabeth II making her Christmas broadcast to the peoples of the British Commonwealth from Auckland / New Zealand in 1953.

Source: picture-alliance/dpa

Speech is a very complicated process, but then so is comprehension. It's not surprising that errors should often occur. Indeed, Harrington suspects that errors are the root cause of sound change and are ultimately responsible for the unceasing evolution of languages. The *a* in the Latin word for hand, *manus*, is an oral sound, despite its position between nasal consonants. At some stage though, some speakers of varieties of Latin began to ignore this context. "They ceased to filter it out at a perceptual level," as Harrington puts it. And because speech organs are lazy and like to drop sounds, the *n* was eroded and the *a* nasalized, giving rise to the French equivalent *main*. However, one should not conclude from this example that every *a* in found in the context of a nasal consonant like *m* or *n* will one day be converted into a nasalized vowel. If that were the case, the

trajectory of this transformation should be the same in all languages but, as Harrington emphasizes, this is not the case.

Sound shifts are in part arbitrary, and are influenced by interactions with other speakers or by contact with other languages. As Harrington insists, sound change is organic, cognitively determined and unpredictable, but nevertheless follows comprehensible laws. To explore these laws, he goes back to one of their possible sources in the process of language acquisition during childhood. "Children have to learn to compensate for variation. That is why the sound overlaps in children's speech are much greater than in adults – indeed so much so that they cannot be perceptually filtered, simply because language is infinitely variable. Harrington therefore suspects that sound changes originate during language acquisition. We learn language only by making mistakes, and in doing so, we drive the incessant evolution of all living languages.

Prof. Dr. Jonathan Harrington holds the Chair of Phonetics and Digital Speech Processing and is Director of the Institute of Phonetics and Speech Processing at LMU. Born in 1958, Harrington studied at Downing College, Cambridge University, obtaining his doctorate in Linguistics in 1986. He went on to teach and conduct research at Edinburgh University and Macquarie University in Sydney. In 2002 he accepted a professorship in Phonetics and Digital Speech Processing at the University of Kiel, before moving to Munich in 2006. In 2011 Harrington received an Advanced Investigator's Grant from the European Research Council (ERC).

Complicated consonant combinations

Speaking in tongue-twisters

Repeat this sentence as rapidly as you can: "She sells seashells on the seashore." That could be a pithy description of Marianne Pouplier's research methodology. Like Jonathan Harrington, Pouplier works at the Institute of Phonetics and Speech Processing at LMU, and studies the process of phonetic change using quantitative techniques. Like Harrington, Pouplier, who has just completed her *Habilitation*, also received research funding from the ERC recently, in the form of a Starting Grant for outstanding junior researchers. The two phoneticians work in the same area, but they focus on different questions. Pouplier is interested in a class of words that seem especially difficult to pronounce.

"Language diversity is essentially infinite," says Marianne Pouplier, "and yet there are structures that turn up in almost – but not quite – all of them." One such universal is the rule that words should consist of a sequence of vowels and consonants. When we speak, vowels carry most of the acoustic energy. "The vowels are what make consonants audible." But some languages, including certain Berber dialects, as well as many Slavic languages, have words that lack vowels altogether. The name of the Croatian island of Krk, a popular holiday resort, is a well-known example.

Another example is the word *krb*, which means *fireplace* in Slovak. "There is no grammatical indication that there is a hidden vowel in the word," Pouplier explains. But what exactly defines a true vowel and a true consonant? Laboratory tests provide an answer. "When one looks at the acoustic signal for *krb*, there does appear to be vowel-like acoustic energy present – between the first two consonants." The technical term for this phenomenon is "open transition schwa", and it arises from the fact that in spoken Slovak the consonants emerge slightly separated in time. One question that Pouplier's project seeks to answer is the extent to which this phenomenon accounts for the existence of vowel-free words in natural languages.

Why do people bother to use such words in everyday speech – words that might look like tongue-twisters to speakers of other languages? And are such consonant combinations perhaps more prone to phonetic shifts precisely because they would seem to be more difficult to pronounce? With regard to the second question, Pouplier is sceptical. After all, *krb* is a tongue-twister only for those who don't speak Slovak. Adult Slovaks, as her studies show, have no trouble articulating this word as part of their everyday speech. This is why she does not believe that such consonant clusters are less stable or more vulnerable to phonetic shifts and ultimately sound change. Words that lack vowels and other complex phonetic structures are a product of a language's history, and are retained simply because native speakers have learned how to articulate and perceive them in everyday conversation.

Like her colleague Jonathan Harrington, Pouplier has little time for theories that are not amenable to experimental tests. So, for example, she also studies native speakers of Russian in her lab. The sequence *bla* occurs frequently in Russian, as it does in German. On the other hand, the cluster *lba*, which ➔

is unknown in German, is also used in Russian, albeit less frequently than *bla*. Because *lb-* is relatively rare in the world's languages, it is thought that it is inherently more difficult to pronounce than *bl-*. What exactly makes a word difficult to pronounce is an issue that is hotly debated. Pouplier is now trying to approach the problem experimentally. However the experiments work out, the results will have wide-ranging consequences, because the question touches on an age-old issue in linguistics. Do linguistic universals, i.e. structures that are common to all languages, really exist? Pouplier's response suggests that she is not exactly overwhelmed by the long history of the debate: "Universal trends probably do exist; they are just not universally realized."

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Dr. phil. habil. Marianne Pouplier is a member of the academic staff of the Institute of Phonetics and Speech Processing at LMU. Born in 1971, she studied German and English at Freiburg University, and qualified as a secondary-school teacher in 1998. In 1999 she moved to the Haskins Laboratories at Yale University (USA), where she obtained a PhD in Linguistics in 2003. She subsequently held postdoctoral positions at the University of Maryland and Edinburgh University. Since 2007, she has led an independent research group at LMU, with support from the Emmy Noether Program funded by the German Research Foundation. In 2011, Pouplier was awarded a Starting Grant by the European Research Council (ERC). In 2012 she completed her *Habilitation*.

The original article appeared in „Einsichten – der Forschungsnewsletter No. 1, 2012", LMU's German-language research newsletter.
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