

The Vanishing Phonemes Debate,  
apropos of Atkinson 2011

**How plausible is the hypothesis that population size  
and dispersal are related to phoneme inventory size?  
Introducing and commenting on a debate**

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**1. Introduction**

Researchers in linguistics are always pleased to see the important role of language in the evolution and dispersal of *Homo sapiens* across the world recognized by the scientific community at large. One group of linguists – those who study language change, historical-comparative linguistics, and the history of languages – has long been able to apply linguistic methods to the study of the history of relationships among languages and thus among groups of people. Now with the availability of world-wide databases documenting both language structure and ethnography, it is possible to test ambitious hypotheses relating language, culture, and evolution using statistical methods.

Despite the new-found relative ease of testing world-wide hypotheses, a basic requirement of scientific inquiry must not be neglected: hypotheses must have some inherent plausibility in terms of their fit with known causal mechanisms. Understanding is not much advanced by the identification of multiple indirect associations or by offering correlations that might turn out to be spurious.

The articles in this debate, which comment on Quentin Atkinson's article "Phonemic diversity supports a serial founder effect model of language expansion from Africa" in *Science* 332 (April 15, 2011), address both the plausibility of the hypothesis in terms of causal mechanisms in phonemic change and the statistical viability of the reported findings. In this introduction I will mention some (but not all) of the interesting points made in the following commentaries, while developing my own argument about the fit of the hypothesis with what is known about how phoneme inventories change.

The different commentaries published here make many of the same points, but the editors have not tried to eliminate this overlap because each author or set of authors makes their comments in a different way and in a different context.

## 2. Examination of the test

The hypothesis put forward by Atkinson is that the number of phonemes a language uses (termed “phonemic diversity”) decreases as small groups of people migrate away from the larger group, exhibiting a series of founder effects that parallel those found in studies of genetic diversity. This hypothesis is based on the finding by Hay & Bauer (2007) that the number of people who speak a language correlates positively with the size of the phoneme inventory of the language. An article by Peter Trudgill published in *Linguistic Typology* (2004) with a series of reacting articles noted that as the Austronesian groups expanded across the Pacific the languages that thus evolved had fewer phonemes the farther they were from the center of dispersal. None of the articles included in that debate concluded that this is a general effect; quite the contrary, the authors expressed skepticism about the possibility of finding a causal mechanism as well as the applicability of this pattern to other language families. However, based in part on this proposal, Atkinson predicts that the farther from Africa a language is spoken, the fewer phonemes it will have.

It is important to note that Hay & Bauer (2007) did not suggest any explanation for their finding, leaving it to the reader to infer that the relation they found was quite possibly an indirect one. Similarly, Trudgill (2004) did not suggest by any means that his observation about Austronesian would apply elsewhere in the world (see his comment here). However, Atkinson (2011) explicitly claims that on a crosscultural basis, phoneme inventories undergo founder effects.

From a linguist’s point of view, problems with the test of the hypothesis arise with each of the values used. First, the phoneme is a unit of analysis and different analyses can yield different numbers (see contributions by Maddieson et al., Rice, Donohue & Nichols for notes of such differences). That is, phonemes cannot be counted the way people can be. Second, the size of the phoneme inventory is an artifact of the sound changes that have taken place in the language. Thus a more direct causation would involve sound change, not phoneme inventories (see discussion in the next section). Third, a number of commentators noted that other measures of phonological complexity (such as phonotactics and word length) should also be taken into account to get a true measure of either diversity or complexity (Maddieson et al., Wichmann et al., and Donohue & Nichols). Fourth, there may be problems with the data as published at the time in the *WALS* database, as noted in Footnote 2 of the Maddieson et al. contribution. For this reason we highly recommend that all correlations be recomputed once the database is corrected.

In addition, the number of speakers of a language is also problematic. In relation to the hypothesis, current population counts are probably irrelevant as numbers of speakers have been profoundly affected by colonization in recent centuries as well as migrations in prehistory (see commentaries by Bower,

Dahl, Maddieson et al., Donohue & Nichols, and Sproat). Moreover, as mentioned by both Bowerman and Sproat, at the time that human beings began to disperse throughout the world, ALL populations were quite small; according to the reasoning of Sproat, they would be groups of a few thousand at a maximum.

Several of the contributions to the discussion here examine the statistical tests used and provide further analysis or attempts at replication using other databases. These contributions generally express a need for a more sophisticated measure of phonological complexity and even grammatical complexity as well. Wichmann et al. replicate Atkinson's results on a different database but find that mean word length is a significant player as well. Maddieson et al. replicate the effects found by Atkinson but note that tone, vowel, and consonant inventory size have different effects, meaning that "number of phonemes" is probably not the right measure of phonological complexity. They note that another variable they tested, an index of syllable complexity showed no relation with distance from Africa. They also argued for strong local effects in particular language families. Donohue & Nichols attempt a replication of Atkinson's finding about population size with a different database and find no correlation. Instead, they argue that there are certain local hotspots for phonological complexity that make it appear as if there were a worldwide trend. Similarly Ross & Donohue note "each dimension relevant to the description of vowel complexity has its own story and its own distribution". Dahl finds that the number of speakers in the family provides a better correlation with mean phoneme inventory size, though that would not be predicted by Atkinson's hypothesis. Jaeger et al. offer a detailed analysis of the statistical methods used by Atkinson, largely replicating his results, but noting that the distance effect may not hold up in further testing.

### **3. Plausibility of the explanatory mechanisms**

In this section I discuss a number of issues relating to how phoneme inventory sizes may change over time. Specific examples that I cite are not intended as counterexamples to the statistical generalization given by others, but are intended to illustrate the knowledge about the patterns and causes of phonological change that are part of the collective knowledge of linguists.

Note to begin with that no explanation is available for why population size would correlate positively with phoneme inventory size. Trudgill (2004) and Hay & Bauer (2007) were all reluctant to float explanations because this correlation does not correspond well with what is known about phonological change.

As pointed out by Bowerman, Maddieson et al., and Pericliev, the relevant level for the reduction in diversity would be the phonetic level, not the phonemic level. As Maddieson et al. say "[a]fter all, a subgroup of speakers of a given language does not use a subset of phonemes of the language, but all of them".

The diversity that might be lost in migration would be phonetic, as the number of dialects speakers are in contact with is reduced.

Furthermore, the serial founder effect cannot apply to language the way it does to genes. Genetic diversity is reduced when a segment of the population moves away from the original group because the genes are inherent to the individuals who carry them. Thus the migration itself causes the reduction in diversity. Phonological change has causes that are independent of migration and population size. It is well established that sound change follows certain trends that are driven most commonly by articulatory pressures deriving from sequential processing in production and (in my opinion, secondarily) by acoustic and perceptual factors that make certain sounds difficult to distinguish in certain contexts. Sound change can cause both increases and decreases in phoneme numbers (see Ringe). A common type of change that has articulatory motivation creates new phonemes by assimilation. For instance, Old Spanish had the following phonemes that did not exist in Latin: /ts/, /dz/, /tʃ/, /ʒ/, /ʃ/, /j/, /ly/, /ny/ (Penny 1991). These all arose because of a set of highly related palatalization changes that took place over several centuries. Such examples occur in all languages. Another instance is Eastern Norwegian where sequences of the retroflex /ɾ/ followed by a dental, such as /t/, /d/, /n/, or /l/, have fused into a series of four new retroflex consonant phonemes (Vanvik 1972). Examples of loss of phonemes include the loss in English of the voiceless velar fricative and front rounded vowels, which are documented in Old English.

Thus if we are looking for causal mechanisms relating number of phonemes to size of population, we have to look at sound change, the mechanism by which phonemes are created or lost. However, the relation between number of sound changes and number of phonemes is quite indirect. In the Norwegian examples just mentioned, the fusion of the retroflex with dental consonants would be considered just one change, but it created four new phonemes. This raises the question of whether sound change itself would bear any relation to population size. As Bowerman points out, "small populations are expected to exhibit slower rates of change" because of their dense social networks (see references there). Taking this point into account one would expect a founder population to have fewer sound changes and so maintain the number of phonemes they left home with.

The question of whether more sound change occurs in small or large populations has not been tested on a worldwide sample, and indeed would be difficult to test, as it is difficult to construct a non-biased sample of sound changes that have occurred in languages in the past. One might speculate that the greater the number of speakers using the language the greater the chances are of changes occurring in pronunciation. However, whether or not these changes become sound changes depends upon many factors, including who is speaking to whom, what the sociolinguistic situation demands in terms of adherence

to conventions versus freedom to innovate, and other factors (see below). The anecdotal evidence is conflicting: the Austronesian speakers living in smaller more isolated groups jettisoned more consonants (Trudgill 2004), but the Germanic language Icelandic, spoken in a remote area with a smallish group of speakers is considered very conservative in all aspects. Rice, in her commentary, studies in some detail the changes in inventories of Athapaskan languages, finding no particular indications that larger or smaller, closer or more remote related languages have more or less sound change, smaller or larger phoneme inventories. Donohue & Nichols also cite cases in Australia and the Americas of very small populations maintaining phoneme systems very typical of their language families.

Some researchers (Trudgill, Dahl) would like to point to language contact to account for promoting sound change that causes phoneme increase or decrease. However, sound change due to borrowing is not as common as internally-motivated sound change. As Ringe points out in the history of Indo-European consonant inventories the cases of borrowed phonemes are rare, constituting only 8 % of the count he undertakes. One can find instances of phoneme gain through language contact, as a new phoneme appears in a language because it occurs in borrowed words, however, I disagree with Trudgill's hypothesis that loss in complexity occurs because of second language learners. One problem with this hypothesis is that there are many different types of situations involving language contact and most of them would not impact native speakers. For instance, in a case where migrants enter a new language situation, native speaker adults do not change their pronunciations or grammar because they are speaking to non-native speakers. While the non-native adults may never acquire the language completely, their children will, so the effect of non-native speakers would be quite fleeting in these situations. Studies of language change where bilingualism is more stable do not show more change in bilingual speakers vs. monolingual speakers (Poplack & Levey 2010, Poplack et al. 2011).

Another point that may be relevant is that even after daughter languages have diverged from one another geographically and started to become distinct dialects or languages, they may still undergo very similar changes, as if the seeds of these changes already existed in the language before the split in the population. Sapir labeled this trend "drift" (Sapir 1921). So "bottlenecks" do not necessarily start a language on a new path of change. For instance, diphthongization of long high vowels began in the fifteenth century in English, more than 600 years after the Angles and Saxons left their relatives on the mainland and arrived in the British Isles. Yet a similar diphthongization of long high vowels occurred in German and Dutch around the same time (Donaldson 1983). Polynesian languages underwent loss of consonant phonemes, a trend that continued in languages that had split from the main group (Trudgill 2004).

It is possible that certain properties of the sounds or constructions of a language predispose a language to certain types of changes and these can occur in a parallel fashion in related dialects/languages long after populations have split.

Another fact that makes it unlikely that phoneme inventories contain a “signal” from the distant past is that phonological change takes place too quickly and too often for a trait such as phoneme inventory size to bear any trace of what a language was like even 10,000 years ago, much less 50,000 years ago. Perkins (1989) used the vowel inventories in Maddieson 1984 to measure vowel inventory variation within families as compared to word order variation and found substantially more variation in vowels. Similarly, consonants were less associated with language families than word order. This means that vowels and consonants change faster than grammatical features. This makes their inventories less likely to contain a signal from the distant past than other features of grammar.

To illustrate with one well-studied case, in less than 1,500 years, the phonological system of Latin has been so transformed in languages such as French, Spanish, and Portuguese that they are entirely different from one another in number of vowel phonemes, phonotactic patterns, and in rhythmic type. All three languages have more consonant phonemes than Latin had despite a migration pattern out from Rome. However, they share some grammatical features, such as nominal gender, agreement of adjectives for gender and number, and agreement of verbs for person and number, that are inherited from Proto-Indo-European. Thus if one were to look for a signal from the past among existing languages about their origins, phonology would be the last place to look as it changes much more quickly than other aspects of language structure.

Finally and perhaps most importantly, if there are relations between linguistic features and socio-cultural features, we need to use more sophisticated measures of cultural features than just population size. For example, Murdock’s measures of cultural complexity include social stratification, size of communities, craft specialization, type of agriculture, regional organization, and inheritance patterns (Murdock 1967). Perkins 1992 argues that these factors can influence the degree to which speakers share experience and presuppositions with their interlocutors. This in turn can influence the maintenance or loss of certain structural features of grammar, such as inflectional deixis. But the influence is not in the direction that Atkinson’s hypothesis would predict. Perkins found that cultures with smaller community sizes, less craft specialization, less stratification, and so on had more inflectional deictic markers such as person/number agreement and tense. In other words in this domain, there was more complexity with a smaller community size (see also Dahl and Nichols for similar comments).

#### 4. Conclusion

Thus I am skeptical about Atkinson's findings and the conclusions he draws from them primarily because they do not fit well with the vast knowledge of phonological change that the field of (historical) linguistics has amassed over almost two centuries, as well as with more recent studies of sound change as ongoing. As Pericliev observes in his conclusion, there are several bits missing from the argument Atkinson makes and one of them is "a good illustration that a founder effect is indeed operative in language". From my point of view, this is the most important gap in the argument but I have serious doubts that this gap can be filled given what is known about language change.

Received: 5 July 2011  
Revised: 5 August 2011

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