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Genetics, Linguistics and the 'Serial Founder Effect'. A Case Study*

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Résumé

Après une rapide discussion des relations entretenues par la linguistique avec la génétique, l'article examine trois postulats : a) que les statistiques peuvent être appliquées de manière fiable à la phonologie ; b) qu'il existe une relation entre la taille d'une population humaine et la diversité de son système phonétique ; c) que ce qu'on appelle l' « effet fondateur » réduit la diversité phonémique. L'auteur vise à démontrer que ces trois postulats sont incorrects.

Abstract

After a brief discussion of the relation holding between linguistics and genetics, the paper will focus on three assumptions: a) that statistics can be reliably applied to phonology; b) that there is a relation between the size of a human population and the diversity of its phonetic system; c) that the so-called founder effect reduces phonemic diversity. The author will seek to demonstrate that all three assumptions are incorrect.

Mots-clés

Arbres génétiques et arbres linguistiques, changement linguistique, diversité linguistique, statistiques phonologiques

Keywords

Linguistic diversity, linguistic change, linguistic and genetic trees, phonological statistics

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1. PREMISE

When studying the relationship between genetics and linguistics, it is useful to remember that the study of the origins of language is an elusive matter, since language is not an object but a composite psycho-physical faculty, which can be observed only through the behavior, especially linguistic behavior, of humans, and only indirectly. Furthermore, the origins and the history of languages have never and will probably never be documented, except for the more recent phases—a tiny part of the whole—in which languages appear to us already perfectly formed. Consequently, the study of the origins of the language faculty does not have languages as its starting point, but a number of inferences based on the analysis of fossils (and what they tell us about posture, the size of the skullcap, the bony structure of the laryngeal and supralaryngeal tract), of artifacts (some of them of extraordinary importance, such as musical instruments) and, in recent years, of DNA. All this, however, does not really tell us much about the language faculty and even less about languages. Rather, these inferences point to the existence of the physical preconditions for the development of language or, in the case of artifacts, to the existence itself of languages, though these languages were not necessarily entirely verbal or based on a physical apparatus identical to ours.

As a consequence, linguists proper do not have much to say on this topic and therefore the famous ban of the "Societé de Linguistique" of Paris[1] was perhaps less backward and more sensible than what is usually considered. It is true however that the emergence of historical genetics, the offspring of population genetics, has established, or perhaps retroactively evidenced the existence of, a common ground between genetics and linguistics, if only for the reason that some geneticists (most notably, Cavalli Sforza) began to observe languages and to adopt concepts and categories derived from linguistics as their working instruments.

I will now offer a few preliminary considerations, mostly of a methodological nature, on the use that scholars from other fields make of the categories, concepts, and theoretical tools elaborated by the language sciences. Multidisciplinary fields are particularly riddled with pitfalls and it is therefore crucial to ensure that people know what they are talking about and, even more importantly, what their fellow scholars are talking about.

In particular I will focus on: a) the general question of the relation between genetics and linguistic history; b) the question of whether the sounds of languages, and specifically their representation called *phonemes*, can be an indicator and

1 Article 2 of the statute of the "Société de linguistique" of Paris, approved in 1866, reads as follows: "La Société n'admet aucune communication concernant, soit l'origine du langage, soit la création d'une langue universelle". It is therefore not entirely correct to say that the Société forbade any "evolutionary interpretation" of languages (Cavalli Sforza 2010, p. 47, 59).

meaningful reflection of migratory and genetic changes in human populations. For the second question, I will use a short article by Atkinson (2011) as a starting point, given that it has been the subject of much controversy and that it seems to me to be representative of a type of research that I do not find entirely satisfactory.

2. Genetic history and language history

The relation between genetics and linguistics (obviously from a non-racist and non-deterministic perspective) is an intensely debated issue. Nevertheless, it is useful to start off by asking ourselves, why consider this relation at all and whether it can contribute to our knowledge of language.

It is undeniable, of course, that there are analogies between genetic transmission and the way languages propagate, divide, contaminate and change. However, once any causal relation has been excluded (i.e., the notion that a language is in any way determined by the DNA of its speakers), I have some difficulty in perceiving the heuristic value of any similarities between these two series of events.

Languages, documented since about 5,000 years ago, are the main, if not the only, meaningful object of study for linguists and it is from here, in my view, that any scholar who studies languages, whether a linguist or not, should start. These 5,000 years, a short and insignificant period from a genetic perspective, have been characterized by an extraordinary number and variety of linguistic phenomena. Languages and linguistic communities have migrated, transformed and divided, giving rise to new communities and new languages. They have died out, stratified, merged, expanded, contracted and none of these events were predictable, nor did they correspond to any form of finality or to intrinsic laws of any given language.[2]

They were instead the result of the combination of two factors, neither of which can be explained by drawing on the genetic background of the speakers or the internal characteristics of any language.

The first factor, which is of the utmost importance and has often been neglected both in structural and generative linguistics, is the intrinsically unstable, undetermined, vague, plastic nature of languages, of all languages, which causes them to shift constantly, diachronically as well as synchronically. This vague nature of languages is also what makes their extraordinary semiotic power possible, along with their enmeshment in the ever-changing material and mental world shared by their speakers. It is precisely the vagueness of languages that allows them to represent anything (or almost anything) that can be thought or experienced, and it is the fact

2 A different view is held by Jakobson (1962 [1928]; 1962 [1929], p. 110 "au lieu d'un hasard aveugle une évolution tendant vers un but", (in explicit contrast with Saussure), and Martinet (2005 [1955]).

that human enunciations exist in and refer to a shared world that allows them to be uttered and understood. This is what we have learned from Saussure's *jeux de signes*, from Bühler's *Spielraum* or Wittgenstein's *Sprachspiel*.[3]

After all, the radical historicity of languages—to use De Mauro's expression—, the fact that languages reproduce themselves through imperfect imitation and interpretation rather than exact copy, is a necessary consequence of the fact that languages are learned (while DNA is inherited)[4]. A consequence of the above, which should always be kept in mind, is that in languages there are no discrete and isolated entities, like blood types or DNA proteins. When linguistic entities are represented as such, it is almost always a consequence of the categorical metalinguistic grid that has been imposed on languages by grammarians, rather than an objective characteristic.

The second factor is an external one and consists in the history (economic, cultural, etc.) of the community of speakers, which helps determine, independently from any teleology, the expressive needs of the speakers and the material and cultural horizon within which these needs manifest themselves and are satisfied by languages. It is worth remembering, however, that this too happens independently of any specularity between what were once called "structure" and "superstructure", between the material characteristics of a society and the characteristics of its language.

In the next paragraph, I will present two well-known, and in my opinion exemplary, cases of fragmentation. I may note in passing that, because of the limited space of the present paper, I will not discuss some of the famous cases of convergence, such as the emergence (and disappearance) of the *lingua franca* (Venier 2012), an event completely independent of genetics, not contemplated by the *Stammbaumstheorie*, and belonging instead to the great family of areal phenomena, the *Sprachbünde*, which includes pidgins and creoles, from whose observation much could indeed be learned (and much has been learned by those who have been willing to look at them).

None of the two cases of fragmentation we shall discuss here can be explained by genetics, nor could they be predicted based on linguistic data.

3 "Une figure vocale devient une forme depuis l'instant crucial où on l'introduit dans le jeu de signes appelé langue" (Saussure 2002, p. 38) ; "Die sprachliche Darstellung läßt allenthalben *Spielräume* der Bedeutungsunbestimmtheit offen, die auf keine andere Weise wie durch den Hinblick auf die, objektiven Möglichkeiten' geschlossen werden können und in jeder menschlichen Reden auch faktisch geschlossen werden" (Bühler 1934, p. 66); "J'appellerai aussi 'jeu de langage' l'ensemble formé par le langage et les activités avec lesquelles il est entrelacé" (Wittgenstein 1953, § 7).

4 I know there is nothing new in what I am saying (it would suffice to take a look at De Mauro 2008) but I say it anyways because it seems to me that it would be useful to share it also with those who study the relation between languages and genetics.

2.1. The linguistic fragmentation of Latin-speaking Europe

Let us consider the case of the fragmentation of Latin and of the linguistic articulation of Latin-speaking Europe. It is a well-known case, perhaps the most studied and documented one, and has provided both explicitly and implicitly the empirical foundation for all modern models of linguistic relations and reconstruction. What happened? The administrative and cultural structure of the Roman empire collapsed, leading to the decline of economic and cultural relations between the center and the peripheries[5], a more significant emergence of local substrata with the development of social and geographical differences—which were already present but previously (apparently) marginal[6]—and the arrival of new populations, especially Germanic ones, introducing linguistic superstrata (Gothic, Frankish, Lombardic). This was the origin of the fragmentation of Latin-speaking Europe. In less than a thousand years, between, let us say, Hadrian and Charlemagne, this led to a tremendous linguistic change.

2.2. The linguistic fragmentation of the Aegean-Anatolian area.

Let us move on to a different topic, starting with the comparison of Hittite and Mycenaean Greek: these two languages are both Indo-European, geographically adjacent (the area of Anatolia, Syria, Mesopotamia, the South-East Mediterranean, an incredibly rich linguistic mosaic), and their written documents (all from the second millennium B.C.) are less than one thousand years apart. Yet they remain profoundly different. According to Gimbutas's model (in Villar 1997 [1996]), the split must have occurred around the year 3500 B.C. and therefore the interval of time in which the history of their differentiation occurred is comparable to that of Latin-speaking Europe. Consider also the phonemic and morphological distance between Hittite and Mycenaean Greek (and between Hittite and all other Indo-European languages, at least from what we can infer from their writing systems). The distance was so great that the deciphering of Hittite undermined the first part of the reconstructed *Stammbaum*, since the structure of Hittite, the oldest attested Indo-European language, did not comply with the model of Indo-European built by the Neogrammarians through the accumulation of phonemic and morphological characteristics derived mostly from Sanskrit and Greek. In particular, the meager verbal and nominal morphology of Hittite did not fit with a theory centered on the

5 For example, the barbarian invasions severed the connection between Roman senators and their properties in the provinces.

6 As attested by texts such as Trimalchio's dinner in the *Satyricon*, or the graffiti in Pompeii, already in the I century A.D., or the epigraphs from the periphery of the empire, or, in the classic age, the language of Plautus, Livy's "patavinity", the awareness of the existence of a *sermo urbanus* and of a *sermo rusticus* and so on.

idea of a simplifying trend from synthetic and complex structures (e.g. Sanskrit) to analytic and simple ones (e.g. English).[7]

2.3. Chance rather than necessity

The extent of our knowledge of the respective contexts of these two linguistic phenomena is certainly very different. However, we have no reason to assume that the typology of factors that determined the fragmentation of Latin (or of common Germanic or common Slavic, if they ever existed) and the fragmentation of the hypothetical Indo-European, is any different from the one that determined the differentiation of Hittite and Mycenaean Greek: in all these cases, genetic factors can be reasonably excluded, and the vagaries of history can be assumed instead as the main cause of the changes, capable of producing profound linguistic upheavals in time intervals that are extremely brief compared to the rhythm of the genetic history of *Homo sapiens*.

Also, as we can see, the current idea of an original "rather uniform language" that gradually fragments, giving rise to new languages (Pievani 2011, p. 62) can only be supported if one limits one's focus to a chronologically and typologically limited written corpus. This intrinsic variability and instability of languages is what problematizes the analogy between languages and species, if we adhere to the belief that (Elredge & Gould, in Pievani 2011, p. 69) "for species, or more generally for a community, the norm is stability and not a process of continuous development". For languages, on the contrary, instability is the norm.[8]

To conclude, if we can reasonably assume, in the absence of contrary evidence, that the non-documented linguistic events that accompanied the long march of *Homines sapientes* towards the colonization of the planet were as random and unpredictable as the documented ones, then no inference or hypothesis on non-documented linguistic events belonging to the obscure periods of the human past can be reasonably made.

2.4. An insurmountable difference

Finally, to the differences between the dynamics of genetics and those of language mentioned by Pievani (2011, p. 73), and therefore to the prudence necessary in

7 Cavalli Sforza (1996, p. 244) does not consider Hittite, which would have undermined his coherent Neo-Schleicherian framework.

8 On irreversibility (Pievani 2011, p. 70), too, there would be much to say, since it does not seem to apply to languages: Latin *amabo* is a synthetic form, vulgar Latin *amare habeo* is an analytic one, Italian *amerò* is again a synthetic form; Germanic languages, according to the traditional reconstructions of the Indo-European verbal system, lose the Perfect / Imperfect opposition and the Present / Future opposition (as shown by the most ancient Germanic sources), but reintroduce them in periphrastic form; Indo-European had a synthetic middle-passive (surviving in Hittite, Latin and Greek); Germanic lost it, but its Northern branch reinstated it through the agglutination of a reflexive pronoun (Swedish *älska* "to love"/*älskas* "to be loved").

establishing correlations, I would add two other differences that might also have some weight, two aspects that differentiate the dynamics of genetics and language and make them incommensurable.

The first aspect is the fact that individual humans, whether one likes it or not, are the only real phenomenal form that combines both genetic characteristics and language in act. Now, in the course of their lives, individuals are genetically stable but linguistically unstable. Their languages change throughout their lives and, within them, different elements and systems coexist, which are also instable and constantly changing. These systems are held together only by social pressure (which does not always act in the same way) and by a shared world of experiences, but also, and perhaps mainly, by a reflexive metalinguistic capacity, which manifests itself whenever the speakers reflect on what they say, on how they say it and on what they listen to.

The second aspect, which I have already mentioned but is worth recalling, is that while genetic comparisons are based on discrete and well-defined entities (blood types, genes, etc.), linguistic comparisons are based on entities (languages and their components) whose boundaries and characteristics are uncertain and unstable, even synchronically, to the point that even in the case of well-known and studied areas, there is no agreement on how many languages are spoken, given the relative arbitrariness of the boundary between language and dialect[9]. Nor are the categories through which we describe languages (noun, verb, etc.) any more precise.

2.5. A significant similarity?

On the other hand, some similarities between genetic history and the history of languages do exist and need to be discussed. Pievani (2011, p. 71-72) lists their common traits: horizontal and/or vertical transmission, mutation, migration, drift, traces (linguistic and genetic) left by migratory waves. But even on this I would like to express a few reservations, based on what I have already said.

2.5.1. Genetic transmission and linguistic transmission

Genes and languages are transmitted vertically and, in the case of languages, also horizontally. But in what other way could a language ever be transmitted if not through the parents / children relation (vertical) and/or through the individual/world relation (horizontal)? What I mean is that to understand whether an analogy is significant (e.g., the form of transmission) one would need to know what other

9 As a example of classification uncertainties, we can consider the *Ethnologue* (Lewis 2009), a extremely authoritative source, which, in the list of Italo-Romance languages includes a Neapolitan-Calabrian language, a category which most experts would reject (http://www.ethnologue.com/show_language.asp?code=nap).

possible modalities have been excluded: but in the case of languages, as in the case of say exanthematous diseases, frankly I do not see any other possibility. In the absence of this condition, the analogy between the modes of transmission allows us only to postulate some sort of universal necessity, whose nature is neither linguistic, nor genetic.

Allow me another similar example, which is also a little mental experiment of sorts. Many linguists are familiar with Zipf's law, according to which the frequency of any word is inversely proportional to its rank in a frequency table, so that the product of frequency times rank remains constant (with an often conspicuous margin of error). Let us consider now a list of Italian cities ordered by number of inhabitants, high to low. The table lists the first 10 Italian cities by inhabitants and the first 10 words by frequency in the LIF corpus (Bortolini *et al.* 1971).

rank	city	inhabitants	rank x inhabitants	word	frequency	rank x frequency
1	Rome	2.761.477	2.761.477	il	54.752	54.752
2	Milan	1.324.110	2.648.220	di	25.401	50.802
3	Naples	959.574	2.878.722	egli	14.814	44.442
4	Turin	907.563	3.630.252	a	13.364	53.456
5	Palermo	655.875	3.279.375	essere	13.303	66.515
6	Genoa	607.906	3.647.436	e	12.733	76.398
7	Bologna	380.181	2.661.267	uno	10.821	75.747
8	Florence	371.282	2.970.256	in	8.851	70.808
9	Bari	320.475	2.884.275	non	8.733	78.597
10	Catania	293.458	2.934.580	io	7.824	78.240

As one can see, Zipf's Law roughly applies to both phenomena. Do we have to infer that there is a correlation between the two or that the study of one phenomenon will help us understand the other? I do not think so. The two series of events exhibit a similar distribution, but clearly this does not mean there is a relation between lexical distributions and urban demography (s. *infra* § 1.6). By the same principle, I do not think that the analogies between genetic propagation and language propagation mean that there is a significant relation between the two phenomena based on their intrinsic properties.[10]

10 After all, many of the characteristics of the dynamics of languages can be found also in other human activities: if we were to perform a philological study of human culinary habits, we would see that they too propagate, mix, juxtapose, become extinct, and vary in ways that are not too different from those of languages.

2.5.2. Genealogical trees

Many are impressed (some negatively so, see Vallini 1998) by the similarity between the genetic tree and the linguistic tree illustrated in Cavalli Sforza (1996, p. 214). It must be said in advance, however, that in the elder section of the two trees there is a significant difference. I am not able to say whether the Euro-Asiatic and the Nostratic families are genetically justified, but I assume they are. I am convinced, however, that from a linguistic point of view they are a figment of the imagination, as Cavalli Sforza too indirectly concedes (1996, p. 224), and therefore that it would be wise to exclude them from the comparison between the two trees.

On the other hand, the Indo-European family, among others, is not an invention and I will take it as an example. A rather significant methodological problem emerges, which can be condensed in the following question: do two or more human communities speak similar languages because they are genetically close or are they genetically close because speaking similar languages implies the existence of past contacts? For based on what we know of the history of these populations (which is a fair amount starting from the second millennium B.C. and quite a lot from the start of the first), why should we be surprised that their languages show strong affinities? It would rather be the contrary, an absence of affinities, that would need to be explained, as for example in the case of Hittite, which burst onto the stage, disrupting the reassuring pattern of Indo-European evolution elaborated by the Neogrammarians on a Sanskrit-Greek basis, a pattern that supported the illusion of a gradual progression from the complex to the simple, from the highly synthetic character of Indo-European to the highly analytic character of modern English. For this lack of affinity, no convincing explanation has yet been found, either in linguistics or genetics.

Now, if the relative linguistic closeness among Indo-European languages is the chance result of history, what can genetics add to what we already know, or think we know, about the linguistic proto-history of Indo-Europeans? Paradoxically, it seems to me that it is rather linguistics that can help genetic history by offering it a pattern, a more subtle order, which genetics seeks to verify, since population genetics never starts from the analysis of an indistinct group of humans, but from groups of humans that have already been somehow classified, often through purely linguistic criteria.

2.6. Independent or dependent variables?

This then seems to me the essential point of our discussion: genetic history and linguistic history can be viewed as two variables, but how are they related? There are three possible answers.

A. The two variables are independent and have a spurious relation[11], as in the case of demography and languages behaving according to Zipf's law.

B. There is a causal relationship between the two variables and we must therefore ascertain which of the two is the independent variable and which is the dependent one. Based on our present knowledge, I do not think we have any way of settling the issue either way, although common sense and the contemporary tendency to interpret all mental activities in terms of naturalization would make it more likely to see genetics as the independent variable and linguistic relations as the dependent one.

Yet, on the basis of what argument beyond the similarity of the genealogical trees can this hypothesis be upheld? Also, this argument could be turned the other way, arguing, as I noted at the end of § 2.5.2, that the independent variable is the linguistic history of populations, occurring *iuxta propria principia*, and that genetic history is its consequence, in the sense that it would reflect the story of the populations that chance and history brought together and caused to elaborate common linguistic and genetic traits.

C. This last point generates a third answer: both variables (genetic and linguistic) depend from a third variable. In this case, the third variable can logically only be the degree of geographical proximity between groups of humans and the duration of this proximity, and therefore a casual factor.

3. GENES AND PHONEMES

And here I come to the main point of my discussion: is the survey of phonemic inventories of languages useful for outlining a linguistic proto-history of human communities, of their migrations and of their starting point?

In a recent article, Atkinson (2011) argues for a relation between the so-called serial founder effect and the phonemic richness of languages, stating that there is an inverse relation between the distance from the place of origin of *Homo sapiens* (Africa) and the phonemic diversity of a language, as a consequence of a series of divisions, each one of which would have provoked, along with a decrease in genetic diversity of the resulting populations, also a decrease in the phonemic diversity of their languages. By comparing simulations from different points of origin, the author finds a confirmation for the African origin of *Homo sapiens* as well as of his language.

> Under this model, during population expansion, small founder groups are expected to carry less phonemic diversity than their larger parent populations.

11 If two phenomena are statistically correlated, this does not necessarily imply the existence of a cause-effect relationship between the two, since the correlation could be the result of chance (spurious) or the result of a third variable causing both phenomena.

> A series of founder events should produce a gradient of decreasing phonemic diversity with increasing distance from the origin […] This approach does not attempt to infer particular phylogenetic relationships between languages, nor does it require that the probability of encountering a particular phoneme changes with distance from the origin (although it might), only that on average phonemic diversity in languages will decline (Atkinson 2011, Supporting Online Material, 4).

The article sparked a lively debate (Jaeger et. al. 2012; Wang et al. 2012; Cysouw et al. 2012; Hunley et al. 2012; Moran et al. 2012; Atkinson 2012) and in general attracted a lot of criticism, directed mostly at the statistical models used and only in two cases (Van Tuyl and Pereltsvaig 2012, Cysouw et al. 2012) at the appropriateness of the choice of phonemic diversity as an indicator. I cannot offer any informed judgment on the quality of the statistical elaboration of the data, for which I refer readers to the articles in *Science*. I will only note that for the scientific community, as represented by these articles, Atkinson's method is faulty but the linguistic object chosen for observation, i.e. the phoneme, is legitimate. I will instead offer a few observations on Atkinson's premises, on the specific model of linguistic change they rely on, and on one of the categories he adopts.

Atkinson's article is based on three premises, each one of which has a local value (i.e. internal to Atkinson's argument) and a general one (i.e. having to do with strategic choices within this field of study): a) phonemes exist as discrete and countable entities; b) there is a direct relationship between the phonemic diversity of a language and the size of the population that speaks it; c) the serial founder effect produces an impoverishment of both the genetic heritage and the phonemic one. The acceptance of the first premise is a necessary condition for the other two.

Following are my observations.

3.1. What do you count when you count phonemes?

According to Atkinson (and countless others), phonemes exist and are "perceptually distinct units of sound that differentiate words". The definition combines two criteria: a) a perceptually distinct unit; b) a unit that differentiates words. The first is an anatomo-physiological criterion that refers to the capacity of our apparatuses to produce, perceive and distinguish sounds. The second is a functional criterion that refers to the use of a hypothetical "unit of sound" to distinguish words.[12]

There are many definitions of the phoneme, as with all linguistic units, (and this fact alone is worrying from an epistemological standpoint), but the one adopted by Atkinson is ambiguous with respect to a question that is crucial for all phonemic models in general, and all the more so when working with phonemic statistics.

12 On the question of the theoretical status of the phoneme and of the phonemic models of languages, see Albano Leoni (2014).

The question is the following: is this "unit of sound" a concrete object, a discrete piece of phonic material, or not?[13] In almost all phonemic models, whatever their terminological and conceptual differences (a phoneme can be a mental representation, or an abstract class, or a relational entity, or a binary matrix, or a family of similar sounds, etc.) phonemes are conceived as immaterial entities. If Atkinson agrees with this it is hard to see how he can treat phonemes as certain, discrete and countable entities. The point is that, whatever the definition, I think it must be acknowledged that phonemes are not natural objects, like genes or blood types, but a mental construct of Western (meta)linguistics and must therefore be dealt with prudently, keeping in mind that their identification is problematic and varies according to the adopted model. As a consequence, the size of the phonemic inventory of any given language can also vary significantly.

I will take Italian as an example, i.e. a well-known and much studied European language. Its phonemic inventory can oscillate between 56 units (as provocatively but legitimately demonstrated by Albano Leoni and Clemente 2005) and 30 units (Basile et al. 2010, p. 129), or even 23, with a few adjustments. These significant variations depend on one's position with respect to a number of controversial theoretical issues in Italian phonology: a) long consonants (do we consider them as one long phoneme, like long vowels in German, or as the repetition of a single short phoneme?); b) affricate consonants (one phoneme or two?); c) diphthongs (one phoneme or two?); d) semivowels or glides (independent phonemes or combinatory variants?).

If such a disagreement characterizes Italian, which has been a frequent object of study, at least since the fifteenth century (and the object of modern phonemic descriptions at least since 1938), one cannot be faulted for being somewhat suspicious of the data on much less known and studied languages like !Xóõ which, according to Maddieson (in Bright 1992, p. 193-194) oscillates between 116 and 55 consonantal phonemes. While I have no doubt that an experienced phonetician using a narrow-band spectrogram might have detected 116 or 55 distinct consonants, I wonder through what procedures these have been translated into 116 or 55 phonemes (whatever definition was adopted)[14]. It is for this reason that I believe

13 As an example of the uncertainty that governs this area of linguistics, compare wals (Haspelmath et al. 2011 [2008]) with upsid (Maddieson & Precoda 1990). WALS does not use the term phoneme and speaks only of *sounds*, but the chapter on consonants (http://wals.info/chapter/1), written by Maddieson, is a perfect example of distributionalist phonology *à la* Bloomfield and therefore the concept of phoneme is implicit (*the same sound*). UPSID speaks of *segments*, in the sense of *phones*, and in one of its shorter versions (http://web.phonetik.uni-frankfurt.de/upsid_info.html), indicates which segments (in a list of 919 units) are found in which languages. A similar confusion characterizes Ladefoged & Maddieson (1996, p. 1-3).

14 Even Ladefoged has some reservations (1997, p. 591): "In fact, it may be that certain languages (e.g. !Xóõ, according to Traill 1985) have little or no phonology – i.e. few alternations explicable in terms of rules – although they obviously have lexical items that have to

that the immaterial units called *phonemes* do not lend themselves to rigorous statistical analyses.

On the other hand, going back to Atkinson's definition, if this "unit of sound" is a material object then it must coincide with what phonologies call *phone*. The phones of a language, when they are not masked as pseudo-phonemes (in the sense that through the assignment of a symbol of the phonetic alphabet they are basically turned into abstract classes, resulting from the conventions of the IPA), are hard to count. For example, in any language, vocalic phones distribute themselves in a continuous range throughout the entire anatomically possible vocalic space. The space between two vowels is neither empty nor discontinuous, being rather occupied by many intermediate phones, as is known by all those who have spent some time doing phonetic analysis in the field. And all these phones, even though very different from what phonologists would like them to be, effectively contribute to the phonic configuration of words.

Aside from these rather conspicuous theoretical problems, the fact remains that the plurality of possible solutions significantly affects the reliability of any estimate of the size of inventories and consequently any statistical analysis based on them.

The uncertainty of theoretical definitions and the resulting uncertainty concerning the actual size of the phoneme inventories of the various languages is the first problem with studies like Atkinson's.[15]

3.2. Few speakers, few phonemes?

Atkinson derives from an article by Hay & Bauer (2007) the premise of a direct relation between the phonemic diversity of a language and the number of its speakers. Hay & Bauer (2007) stated that they had noted this correlation almost by chance and had been studying it more extensively based on the empirical data of what they described as a forthcoming study, which I have unfortunately been unable to find.[16]

be given distinct representations"; id. (1997, p. 617): "There are also constraints built in as a result of using multi-valued features. About half of the terminal features that have been described are multi-valued. If we had used binary features, additional combinations of terms, such as *[+high, +low], would have been ruled out as definitionally impossible". This statement confirms the fact that there is something wrong with these overinflated inventories and that accepting them is problematic.

15 The existence of a long and authoritative Western tradition of representing languages as a linear succession of certain and discrete elements leads everyone, specialists and laymen, to deal with phonic matters through the reassuring phoneme, systematically neglecting the role of intonation. But this question is beyond the scope of the present paper. I also must renounce discussing the way in which WALS (Atkinson's source) organizes the data used for the statistics.

16 Incidentally, this article too has been criticized (e.g. by Moran et al. 2012); a remarkable contribution is the anonymous Wintz (http://www.gnxp.com/wp/2010/08/30/phoneme-inventory-size-and-demography/, Posted by Wintz on August 30, 2010). One could object that

This premise too is somewhat questionable. When studying languages in order to establish different degrees of complexity (complexity that is also a measure of the diversity of languages), it is very reductive, if not downright wrong, to use as the only or main parameter the presumed number of phonemes, and to correlate it to the size of the population.

This on account of two reasons. The first is of a more general nature. Gnerre (2011), based on his survey of an extensive bibliography and on his equally vast field work in ethno-linguistics, proposes a divergent and much more convincing theory: the conditions in which human communities elaborate high levels of linguistic complexity (of which phonetic diversity is one of the indicators) are the following (p. 133): a) low population size (hunters-gatherers); b) low density of social networks; c) almost complete absence of socio-economic stratification; d) almost complete absence of differences in social prestige; e) almost complete absence of socio-political control; f) almost complete absence of writing. [17]

As regards population size, then, the current position of ethno-linguists is the opposite of Atkinson's (and of his sources). As for the other parameters, these are not taken into account by Atkinson.

A second objection is more trivial. Even a cursory examination of WALS data (which, independently of its reliability, remains the only source of the above studies) reveals a number of cases that appear to contradict Atkinson's premise: both Swedish and Irish have a greater consonantal diversity than German, though the latter has a much greater number of speakers; Lithuanian and Latvian have the same number of speakers yet Lithuanian has greater diversity, and so on.

3.3. Does every division lead to a decrease in phonemic diversity?

For Atkinson, the serial founder effect influences phoneme dynamics in the same way that it influences genetic dynamics. The idea is that whenever a population splits, the resulting populations are less numerous, at least at first, and genetically less diverse.

> If phoneme distinctions are more likely to be lost in small founder populations, then a succession of founder events during range expansion should progressively

Hay and Bauer's work (like Atkinson's) is based on the application of algorithms that calculate the probability that the correlation between two series (in this case phonemic diversity and population size) is causal, and in the case cited this probability is less than 0,0001. But, apart from the already discussed fact that when one changes the principles for identifying phonemes the number of phonemes also changes, the fact remains that the dependence of one variable on the other must be plausible (see above, § 1.6.1-3).

17 This model is indirectly confirmed by Wray & Grace (2007) in an article (on whose glottogenetic assumptions I have some reservations) in which they study the characteristics of 'esoteric' communities, characterized by the absence or scarcity of exchanges (linguistic and non-linguistic) with other communities, therefore isolated and small, whose languages show a high degree of complexity.

> reduce phonemic diversity with increasing distance from the point of origin, paralleling the serial founder effect observed in population genetics (Atkinson 2011).

Atkinson's study therefore combines the founder effect model with one that assumes a relationship between population size and phoneme diversity, as embodied in the premise discussed in § 2.2. The corollary is obvious: the further we move away from the starting point (Africa, in line with a common opinion), the greater the number of founder events and, therefore, the lower the number of phonemes.

Even if one were to accept the first two premises (without which the third would be impossible), the strength of this hypothesis remains doubtful. To the objections in 2.2, another three can be added.

The first is based on the many documented cases of population separation that have occurred in historical times. A classic example of a founder event is offered by the history of Icelandic: between 870 and 930, a Norwegian community colonized uninhabited Iceland; starting from the twelfth-thirteenth century, contacts with the motherland decreased until they almost ceased. I know nothing about the genetics of Icelanders, but it is a known fact that eleven centuries after the separation, the phonemic diversity of Icelandic is not inferior to that of Norwegian. Similarly, Greek colonies in Italy did not seem to suffer from phoneme impoverishment. Nor did this occur with the colonization of Little Italy by the peasants from Southern Italy or of New England by the Founding Fathers.

Are these time intervals too short? Perhaps, but certainly we have no proof that this is the case since no one has established what length of time is required for the presumed linguistic effect of the serial founder effect to manifest itself. Have neither Icelandic, nor Faroese, nor the Greek of Magna Grecia or the Italian of Little Italy followed the above rule by pure coincidence? Or did the decrease in diversity not occur because relations were maintained with the motherland? Perhaps. But these events have all been documented and, if one is to accept Atkinson's hypothesis, one should first explain why they are not relevant. After all, no one can say what happened in the case of population divisions in undocumented periods: no one knows if and for how long they remained in contact with the parent population, and with what other populations and languages they came into contact. And what about the cases of *Sprachbünde* (to which I have referred in relation to the lingua franca, see above), in which different populations, due to a common cult, or contact through trade, or geographical closeness, elaborate common linguistic innovations? Did they occur only in historical times?

The second observation is a result of plain common sense. Imagine a community that splits in two. I can understand why the size of the genetic heritage of each of the two communities (consisting in the sum of the DNA of each member) would

decrease after the split. But I cannot fathom why each of the two communities would maintain only part of the phonemes of the community of origin. It makes much more sense to believe that they would bring with them the entire heritage, after which (unless one shares, and I do not, the premise discussed in § 2.2) the linguistic inventory of each community would be subject to the vagaries of chance and history.

Finally, if Atkinson's hypothesis is not coupled with a model for a possible increase in phonemic diversity (which I have not found either in Atkinson or elsewhere), it would follow that the phonemic history of humanity should be one of gradual decline. Yet, this does not seem to be the case.

In other words, as noted also by Van Tuyl and Pereltsvaig, in the absence of reliable data:

> Whatever the locations and phoneme inventories were for African languages in antiquity, the situation is surely different today, some 50,000 years after the modern human exodus. Migrations, conquests, and borrowings—many of which occurred long after the era of the founder effect—can explain the present state of African languages more credibly than simple diffusion of small founder groups. (Van Tuyl and Pereltsvaig 2012)

4. CONCLUSION

On a semi-facetious note, I could conclude with 'he who lives by the sword, dies by the sword'. Wang et al., provoked by Atkinson, have checked his math (apparently, personally counting the phonemes of the observed languages, including Italian, which turns out to have 8 vowel phonemes, and this too is a surprising discovery)[18] and reached the following conclusion:

> Thus, we demonstrated that WALS's data simplification has distorted Atkinsons results. Apparently, the results without simplification should be more reliable. Therefore, Asia (where the Babel was supposed to be) might be a more appropriate best-fit origin for modern languages if modern languages have a common origin. (Wang et al. 2012)

But in reality, I believe there is a more fundamental problem beyond the counting of the phonemes, the statistical algorithms adopted or the size of the studied populations. Specifically, I think it would be useful to have an open discussion on the two points I have tried to put into perspective in the present paper, renouncing any *idées reçues*, whether ancient, recent, or even very recent.

In a brief article on the contribution that linguists could offer to the study of the evolution of language, Carstairs-McCarthy (2007), after citing the famous ban by the Paris *Société* on this topic, the historical diffidence towards it by linguists,

18 The editors and peer reviewers of *Science* are known and feared for their rigor, but in this case appear to have been somewhat absent-minded.

and the tendency to take it up again in recent times by specialists from other fields, raises the following question:

> But scholars in other disciplines (notably psychologists, anthropologists and philosophers) have never been so abstemious. This has left linguists with a dilemma. Should they join in, with their customary plaintive admonition 'But language isn't as simple as that!'? Or should they stay on the sidelines while psychologists, anthropologists and others eagerly discuss such evidence as there is? (Carstairs-McCarthy 2007, p. 503-504)

The question is obviously only rhetorical and the expected, scientifically correct attitude for linguists would be, according to Carstairs-McCarthy, to join the fray, rather than to stick to their true but ultimately useless admonishment on the complexity of languages.

It is my belief instead that the admonishment is not useless at all. Indeed, this, for me, is the final conclusion of the considerations made in the present paper: an invitation to consider carefully all facts and all options, avoiding all shortcuts, even when these facts and options appear to contradict the dominant theory.

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