

how often one would expect English and Turkish synonyms to share some initial consonant just by chance. English *b* and Turkish *k* happen to be the second-commonest initial consonants in their respective languages, so that one would expect them to correspond frequently in English/Turkish synonyms even if the two languages were totally unrelated. From actual relative frequencies of English and Turkish initial consonants, Ringe's null model predicts an average of 1.7 *b/k* matches by chance in a 100-word list. Ringe calculates the probability of obtaining six by chance as only around 0.01.

At first, that suggests that the *b/k* correspondence is significant. But there is the issue of 'sample space'⁹ to be taken into account. If 100 consonant pairs are examined, one would expect to find approximately one example of a chance correspondence that would individually be unlikely at a probability of only around 0.01. From this perspective, it is unsurprising that Ringe's matrix of 153 comparisons for English/Turkish initial consonants produces two correspondences that would appear significant in isolation; one of those happens to be *b/k*. Considerations of English etymologies also make a historical interpretation of the *b/k* correspondences unlikely: the English *b* words entered the language too late to have been derived from a common ancestor shared with Altaic languages. Naturally, this does not disprove the hypothesis that the Indo-European and Altaic language families are distantly related. Rather Ringe's calculations fail to uncover support for it.

Ringe next considers several methods that linguists employ to increase the number of historically significant cognates or sound correspondences detected. Among them are increasing the number of word pairs compared; increasing the number of potentially related languages compared simultaneously (so-called multilateral comparison); relaxing the requirement that the word pairs (or sets) compared must be identical synonyms; and relaxing the requirement of exact sound correspondences. Such techniques do indeed serve to increase the detected number of historically derived sound correspondences. But Ringe shows that, by the same token, they also increase the number of chance correspondences. The net result, in Ringe's model calculations, is that the task of detecting historical relationships becomes no easier and may even become harder. That conclusion poses a paradox, however. Such methods have been employed since the beginning of modern linguistics, and have yielded conclusions that are universally accepted because of overwhelming evidence (for example that modern Indo-European languages are related).

So does Ringe's model omit any techniques that help linguists distinguish

historically derived sound correspondences from chance ones? It does omit some, of course, because simpler models are necessary stepping-stones to more complex ones. A consideration discussed by both Ringe⁶ and Greenberg⁷ is that certain sound shifts with time (hence certain sound correspondences between pairs of languages derived from the same ancestral language) are observed much more often than others. For example, *p* often changes to *f*, and *t* often changes to *d*. When linguists see such correspondences between pairs of languages, they know by experience that those correspondences are likely to be historically derived, and that sound changes that have been rare in the history of human speech require stronger evidence before an apparent case can be taken seriously. Ringe^{6,8} notes that this fact is nevertheless difficult to formulate in a null model. It probably helps explain why linguists are more successful than a first-generation computer model in distinguishing significant sound correspondences from chance ones.

As a final example, Greenberg and Ruhlen¹ note that words similar to *milq* and meaning *swallow* or else *throat* appear in languages from at least six of the 11 proposed subfamilies of the Amerind language family, which in Greenberg's view encompasses most American Indian languages². The authors calculate the chances of an accidental match for these three consecutive consonants in six languages as only 1 in 10,000,000,000. This calculation, too, is a stepping-stone to a more complex and realistic calculation, because it omits considerations of sample space⁹ (such as number of words tested or number of languages examined per subfamily). Interestingly, similar words with related meanings appear in several Old World language families, including Indo-European, Afro-Asiatic, Uralic and Dravidian.

Whether a refined statistical treatment would strengthen or demolish this hint of very ancient linguistic relationships remains to be seen. But collaborations between statisticians and linguists might prove decisive in tackling that and similar issues. □

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Internal medicine

"KEEP taking the tablets" says the doctor; but many of us lack the self-discipline to do so. A drug-implant, leaking the drug into the bloodstream all the time, avoids this problem. Daedalus is now taking this idea further.

He recalls that about a third of the human race are host to intestinal worms. Many of them don't even know it. Some tapeworms cause almost no symptoms, apart from reducing digestive efficiency. Tapeworm eggs have even been sold by unscrupulous vendors as slimming pills.

Even the simplest worms exude quite complicated molecules, such as the enzyme-inhibitors they use to prevent their host digesting them. (These also make it harder for the host to digest anything else: hence the slimming effect.) Many pharmaceuticals, of course, are simply enzyme-inhibitors. So, says Daedalus, it should be feasible to modify a worm to produce a specific pharmaceutical. Once installed in the gut, it would generate the drug automatically, steadily and indefinitely.

Many worms can be cultured *in vitro*, axenically. A DREADCO worm colony is now being mutated by irradiation, and genetically engineered more directly, to persuade the creatures to evolve or take up genes for the synthesis of various drugs. The end product should be a veritable stable of pharmaceutically accomplished intestinal worms.

Pharmacists will be delighted. One pill (a suitably coated worm egg) will now suffice for the most enduring symptoms. Worm therapy will be ideal for diseases such as schizophrenia and tuberculosis, whose long-term medication puts a heavy responsibility on the possibly unstable patient. And worm-borne contraception will free the most feckless teenager from the pregnancies that perpetuate her drab social position.

The technique might even be made quite automatic. Pinworms flourish and spread particularly well in insanitary, squalid, overcrowded urban conditions. Once introduced to such slums, contraceptive pinworms should spread widely, cutting back the local birthrate. When the population had fallen sufficiently, social regeneration would occur, sanitary standards would rise, the pinworms would be eliminated, and the inhabitants would regain their fertility.

This neat and simple piece of social engineering will, of course, bring down torrents of denunciation. Daedalus may be forced to substitute a strain of worm that has been sabotaged by deleting the digestion-inhibitors from its eggs. These will be digested by its host, preventing it from spreading through the community.

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