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98% Alike? (What Our Similarity to Apes Tells Us About Our Understanding of Genetics)

By *JONATHAN MARKS*

It's not too hard to tell Jane Goodall from a chimpanzee. Goodall is the one with long legs and short arms, a prominent forehead, and whites in her eyes. She's the one with a significant amount of hair only on her head, not all over her body. She's the one who walks, talks, and wears clothing.

A few decades ago, however, the nascent field of molecular genetics recognized an apparent paradox: However easy it may be to tell Jane Goodall from a chimpanzee on the basis of physical characteristics, it is considerably harder to tell them apart according to their genes.

More recently, geneticists have been able to determine with precision that humans and chimpanzees are over 98 percent identical genetically, and that figure has become one of the most well-known factoids in the popular scientific literature. It has been invoked to argue that we are simply a third kind of chimpanzee, together with the common chimp and the rarer bonobo; to claim human rights for nonhuman apes; and to explain the roots of male aggression.

Using the figure in those ways, however, ignores the context necessary to make sense of it. Actually, our amazing genetic similarity to chimpanzees is a scientific fact constructed from two rather more mundane facts: our familiarity with the apes, and our unfamiliarity with genetic comparisons.

To begin with, it is unfair to juxtapose the differences between the bodies of people and apes with the similarities in their genes. After all, we have been comparing the bodies of humans and chimpanzees for 300 years, and we have been comparing DNA sequences for less

than 20 years.

Now that we are familiar with chimpanzees, we quickly see how different they look from us. But when the chimpanzee was a novelty, in the 18th century, scholars were struck by the overwhelming similarity of human and ape bodies. And why not? Bone for bone, muscle for muscle, organ for organ, the bodies of humans and apes differ only in subtle ways. And yet, it is impossible to say just how physically similar they are. Forty percent? Sixty percent? Ninety-eight percent? Three-dimensional beings that develop over their lifetimes don't lend themselves to a simple scale of similarity.

Genetics brings something different to the comparison. A DNA sequence is a one-dimensional entity, a long series of A, G, C, and T subunits. Align two sequences from different species and you can simply tabulate their similarities; if they match 98 out of 100 times, then the species are 98 percent genetically identical.

But is that more or less than their bodies match? We have no easy way to tell, for making sense of the question "How similar are a human and a chimp?" requires a frame of reference. In other words, we should be asking: "How similar are a human and a chimp, compared to what?"

Let's try and answer the question. How similar are a human and a chimp, compared to, say, a sea urchin? The human and chimpanzee have limbs, skeletons, bilateral symmetry, a central nervous system; each bone, muscle, and organ matches. For all intents and purposes, the human and chimpanzee aren't 98 percent identical, they're 100 percent identical.

On the other hand, when we compare the DNA of humans and chimps, what does the percentage of similarity mean? We conceptualize it on a linear scale, on which 100 percent is perfectly identical and 0 percent is totally different. But the structure of DNA gives the scale a statistical idiosyncrasy.

Because DNA is a linear array of those four bases -- A, G, C, and T -- only four possibilities exist at any specific point in a DNA sequence. The laws of chance tell us that two random sequences from species that have no ancestry in common will match at about one in every four sites.

Thus even two unrelated DNA sequences will be 25 percent identical, not 0 percent identical. (You can, of course, generate sequences more different than that, but greater differences would not occur randomly.) The most different two DNA sequences can be, then, is 75 percent different.

Now consider that all multicellular life on earth is related. A human, a chimpanzee, and the banana the chimpanzee is eating share a remote common ancestry, but a common ancestry nevertheless. Therefore, if we compare any particular DNA sequence in a human and a banana, the sequence would have to be more than 25 percent identical. For the sake of argument, let's say 35 percent. In other words, your DNA is over one-third the same as a banana's. Yet, of course, there are few ways other than genetically in which a human could be shown to be one-third identical to a banana.

That context may help us to assess the 98 percent DNA similarity of humans and chimpanzees. The fact that our DNA is 98 percent identical to that of a chimp is not a transcendent statement about our natures, but merely a decontextualized and culturally interpreted datum.

Moreover, the genetic comparison is misleading because it ignores qualitative differences among genomes. Genetic evolution involves much more than simply replacing one base with another. Thus, even among such close relatives as human and chimpanzee, we find that the chimp's genome is estimated to be about 10 percent larger than the human's; that one human chromosome contains a fusion of two small chimpanzee chromosomes; and that the tips of each chimpanzee chromosome contain a DNA sequence that is not present in humans.

In other words, the pattern we encounter genetically is actually quite close to the pattern we encounter anatomically. In spite of the shock the figure of 98 percent may give us, humans are obviously identifiably different from, as well as very similar to, chimpanzees. The apparent paradox is simply a result of how mundane the apes have become, and how exotic DNA still is.

Another way in which humans and apes are frequently conflated is phylogenetically. Humans, the argument runs, fall within a group that comprises chimpanzees, gorillas, and orangutans -- the great

apes. We are genetically more closely related to chimpanzees than they are to orangutans. Because we fall within the ape group, we are ourselves apes.

True, but again we need to look at the context.

Traditional zoological classifications incorporate two evolutionary processes: descent and divergence. The category of great apes is marked by the divergence of humans from it. It is, in taxonomic parlance, paraphyletic: The group is missing some close relatives that fall within it, and is an artificial amalgam of the species left behind.

Two other famous paraphyletic categories are invertebrates, a motley assortment of things that didn't evolve a backbone; and reptiles, the diverse scaly creatures that the birds left behind.

More to the point, consider the coelacanth, which by virtue of its limb structure is more closely related to tetrapods -- animals with four limbs -- than to other fish, such as trout. Therefore, fish are also a paraphyletic category, an assemblage of vertebrates that didn't evolve four limbs. Tetrapods are a phylogenetic subset of fish, although they have diverged extensively from their aquatic relatives.

Humans, of course, are tetrapods. Because of that fact, and because tetrapods share an ancestry with fish -- including both the closely related coelacanth and the distant trout -- the conclusion should be obvious: Humans are indeed apes, but only in precisely the same way that humans are fish. We simply fall within a diverse group of creatures with broad, general similarities to one another, from whom our ancestors radically diverged.

Our apeness, like our fishiness, is not a profound revelation about human nature, but merely an artifact of the way we classify things.

Genetics has the power to make a familiar fact seem unfamiliar, and to give biases and opinions the ring of scientific authority. Social and political activists have invoked genetics over the full course of the last century, and will undoubtedly continue to do so over the course of this one. It is thus of the utmost importance that we regard genetic data in a cultural and critical framework, and place them intellectually where the study of heredity intersects the study of human systems of meaning.

In a recent issue of *Anthropology Today*, Gisli Pálsson and Paul Rabinow analyzed the Iceland genome project and called for "a molecular anthropology that includes scientific, technological, political, cultural, and ethical dimensions." I agree that we need such a molecular anthropology, which should be informed by genetics and which should, at the same time, approach genetics with a critical, analytical, and ethnographic eye.

The time is ripe for such an interdisciplinary endeavor. Our place in nature is not determined by genetic data alone; it is a contested site on the boundary of godliness and animalness, between beast and angel. To make sense of the data requires both anthropological and biological knowledge.

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