Talking about the genome

Biologists must take responsibility for the correct use of language in genetics.

Horace Freeland Judson

We think we think with words: too often, the words think us. Four centuries ago, Francis Bacon showed us how those who say they seek knowledge are prisoners of language. He proposed the doctrine of the four idols — objects of false worship that block our understanding.

Of these four Bacon wrote: "The Idols of the Tribe lie deep in human nature … The human understanding … readily supposes a greater order and uniformity in things than it finds … [it] is infused by desire and emotion, which give rise to 'wishful science'" and attachment to preconceived ideas. The Idols of the Cave are your particular set, or my different one, of preconceptions and prejudices. The Idols of the Theatre are those "which have crept into human minds from … faulty demonstrations" — experiments. They distort understanding because they take the representation for the reality. Then, worst, "There are also idols arising from the dealings or associations of men with one another, which I call Idols of the Marketplace". He had in mind, evidently, the *agora*, where in ancient Athens men met to talk. "For speech is the means of association among men," he wrote, "and in consequence, a wrong and inappropriate application of words obstructs the mind to a remarkable extent."

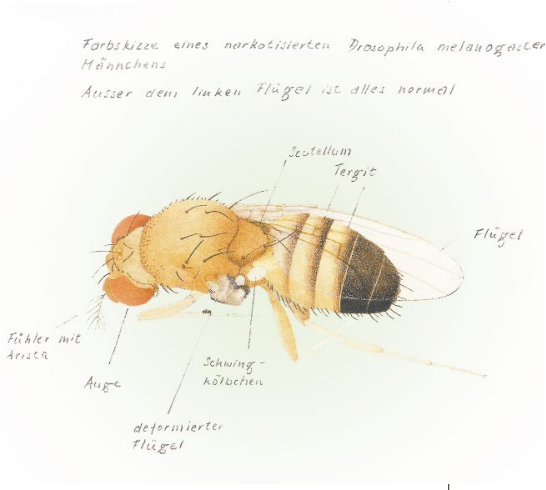
Bacon's terminology is unfamiliar, yet his formulations cut across recent fashions of thought and jolt us out of our preconceptions. The language we use about genetics and the genome project at times limits and distorts our own understanding, and the public understanding.

Look at the phrase — or marketing slogan — 'the human-genome project'. In reality, of course we have not just one human genome but billions. At the level of genes, the project promises a useful consensus, but at the level of sequences of nucleotides variability is great and important, and not just for uniquely identifying rapists and murderers. Clues to disorders, to talents and even to human origins may be buried there. Further, the genome project draws in various bacteria, yeast, nematode, fruitfly, zebrafish, mouse and chimpanzee. Comparisons are already forcing attention to features of the sequences previously unrecognized but so essential they have been conserved over hundreds of millions of years of evolution. Then, too, the entire phrase — the human-genome project: singular, definite, with a fixed endpoint, completed by 2000, packaged so it could be sold to legislative bodies, to the people, to venture capitalists. But we knew from the start the genome project would never be complete. The maps, or the sequences, are just the start of many lines of research, polyphiloprogenitive, multiply multiple genome projects.

This sloppy language is not merely shorthand, scientists talking among themselves. Scientists talk to the media, then the media talk to the public — and then scientists complain that the media get it wrong and that politicians and public are misinformed. What the media do is mediate. Public misinformation is largely and in origin the fault of scientists themselves. Bacon also said: "Words turn back and reflect their power upon the understanding."

The phrases current in genetics that most plainly do violence to understanding begin "the gene for": the gene for breast cancer, the gene for hypercholesterolaemia, the gene for schizophrenia, the gene for homosexuality, and so on. We know of course that there are no single genes for such things. We need to revive and put into public use the term 'allele'. Thus, "the gene for breast cancer" is rather the allele, the gene defect — one of several — that increases the odds that a woman will get breast cancer. "The gene for" does, of course, have a real meaning: the enzyme or control element that the unmutated gene, the wild-type allele, specifies. But often, as yet, we do not know what the normal gene is for.

Our thinking about genes in this way has a strong historical origin. In 1913, Alfred Sturtevant, a member of Thomas Hunt Morgan's fly group at Columbia University, drew the first genetic map — "The linear arrangement of six sex-linked factors in *Drosophila*, as shown by their mode of association". Ever since, the map of the genes has been, in fact, the map of gene defects. Only about fifteen years ago, when DNA sequencing and the art of locating genes on chromosomes began to be practical, were geneticists able to isolate a gene sequence and then reason forward to what it specifies.



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The fruitfly: *Drosophila* mutants are a cornerstone of the language used in genetics.

Morgan and his group themselves understood what the language meant. At that time, a number of scientists were still intensely sceptical of mendelism. They did not believe in genes. In 1917, Morgan published an extended reply to these foes. This was just seven years after he had announced the discovery of the first mutant fruitfly — a male with white eyes instead of the normal red — and with it had demonstrated what we now call sex-linked inheritance.

"There are several reasons why we need the conception of the gene," he wrote. In the first place, each gene has manifold effects. "If we take almost any mutant race" — or 'strain' as we would now say — "such as white eyes in *Drosophila*, we find that the white eye is only one of the characteristics that such a mutant race shows." Further, Morgan wrote, although traits may vary, "there is at present abundant evidence to show that much of this variability is due to the external conditions that the embryo encounters during its development. Such differences as these are not transmitted in kind — they remain only so long as the environment that produces them remains."

Pleiotropy. Polygeny. Perhaps these terms will not easily become common parlance; but the critical point never to omit is that genes act in concert with one another — collectively with the environment. Again, all this has long been understood by biologists, when they break free of habitual careless words. We will not abandon the reductionist mendelian programme for a hand-wringing holism: we cannot abandon the term gene and its allies. On the contrary, for ourselves, for the general public, what we require is to get more fully and precisely into the proper language of genetics. ■

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