Genes and genomes in science and society:

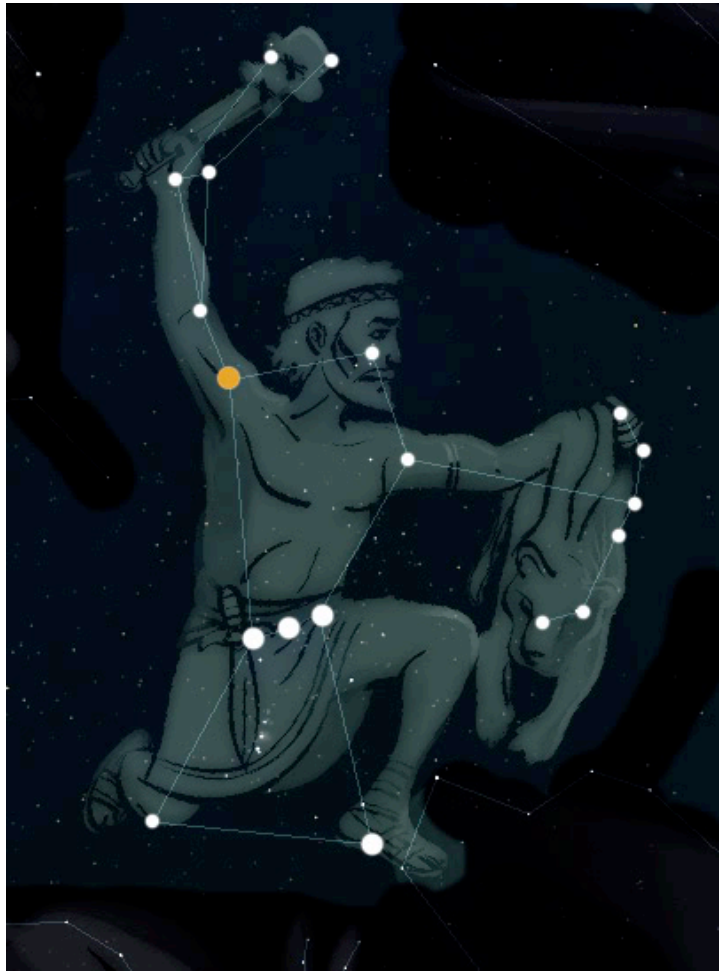
Do metaphors matter?

Brigitte Nerlich

University of Nottingham

@BNerlich

Connecting the dots



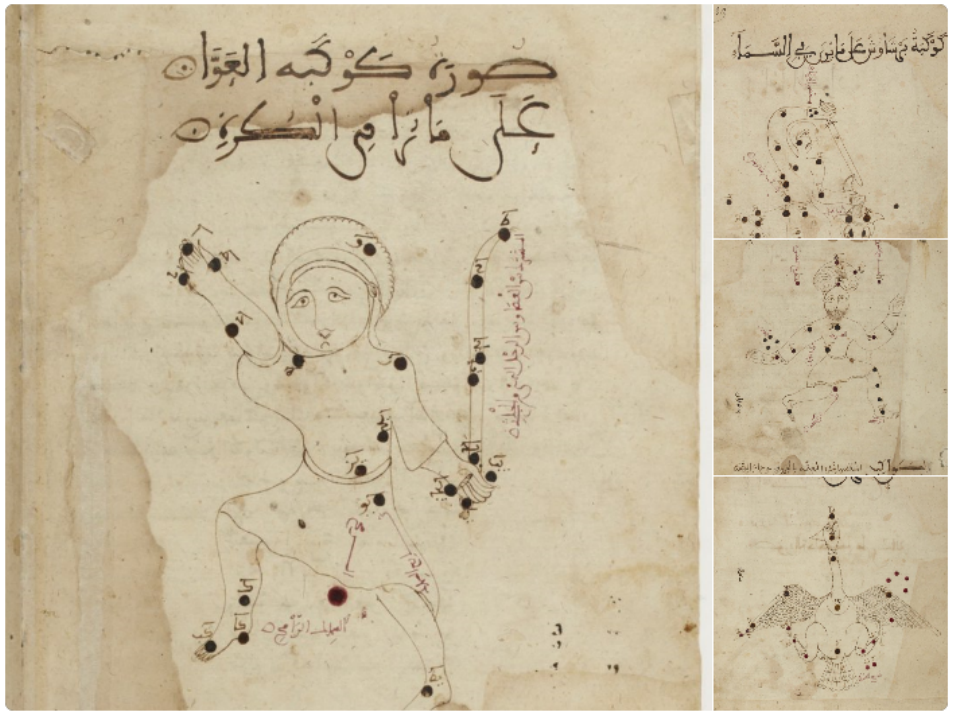
Connecting the dots

Emily Steiner
@PiersatPenn

Follow

Starry night

Book of Fixed Stars by ʿAbd al-Raḥmân ibn ʿOmar al-Ṣoûfî, الصور السمائية
BNF MS Arabe 2488 (14thc)



1:10 pm - 7 Oct 2017

The power of stories and metaphors

May 2016

March 2018

Musolff, A. (2015). Dehumanizing metaphors in UK immigrant debates in press and online media. *Journal of Language Aggression and Conflict*, *3*(1), 41-56.

Metaphors: ornaments, dangers, necessity

- decorative rhetorical devices
- “open defiance against reason” (Thomas Sprat, Royal Society, 1667)
- “perfect cheats” (John Locke, 1689)

- “Metaphors are necessary and not just nice” (Ortony, 1975)
  - Both to explain and communicate science and to *do* science
- “You need an ‘as if’ to look at the world; you need an ‘as if’ to explain the world.” (Rom Harré, p.c. 1990s)


THE
HISTORY
OF THE
Royal-Society
OF
LONDON,
For the Improving of
NATURAL KNOWLEDGE.
BY
THO. SPRAT.
LONDON,
Printed by T. R. for J. Martyn at the Bell without Temple-bar, and J. Allestry at the Rose and Crown in Duck-lane, Printers to the Royal Society.
MDCLXVII.

Ortony, Andrew (1975). Why metaphors are necessary and not just nice. *Educational theory*, *25*(1), 45-53

Generative metaphors

- Metaphors in policy

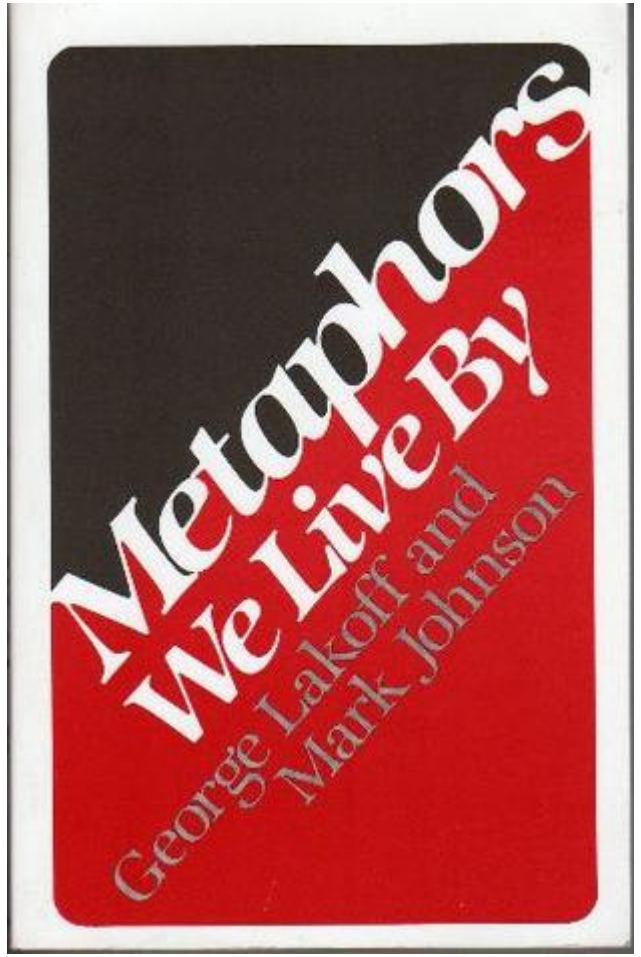
- Ways of seeing
- Ways of acting

  - scientific, financial, ethical, social, political….
  - *Responsible language use should be part of ELSA, RRI*

Schön, D. (1979). Generative Metaphors in the Setting of Social Policy Problems. *Metaphor and Thought*. Cambridge: CUP

Conceptual metaphors

- George Lakoff and Mark Johnson:
  - “Our ordinary conceptual system, in terms of which we both think and act, is fundamentally metaphorical in nature.”
  - "The essence of metaphor is understanding and experiencing one kind of thing in terms of another.”
  - Both in ordinary and scientific language
- Example: BACTERIA ARE COMMUNITIES
  - “Are microbial communities socialist or capitalist🤔?” (Victor de Lorenzo, tweet, 03/18)



Lakoff, G., & Johnson, M. (1980). *Metaphors we live by*. Chicago: University of Chicago Press.

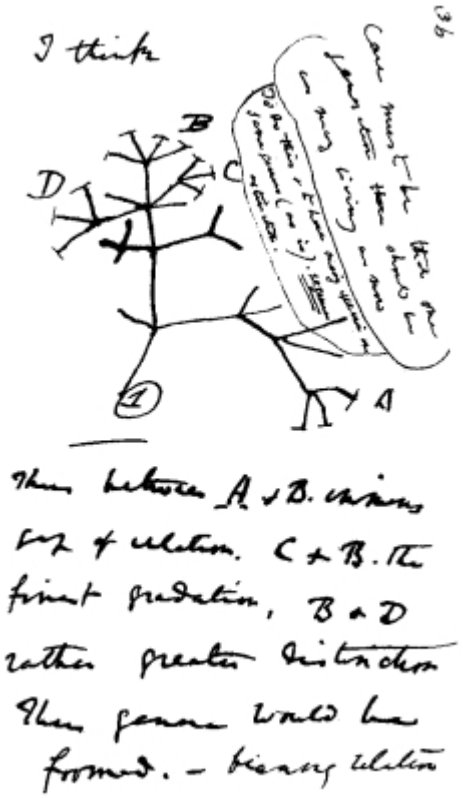
Metaphors and theories

- “There is here the possibility for a new kind of inquiry – an intellectual history which would consider not the manifest content of theories, but the development of their underlying metaphors” (Schön 1963:192).

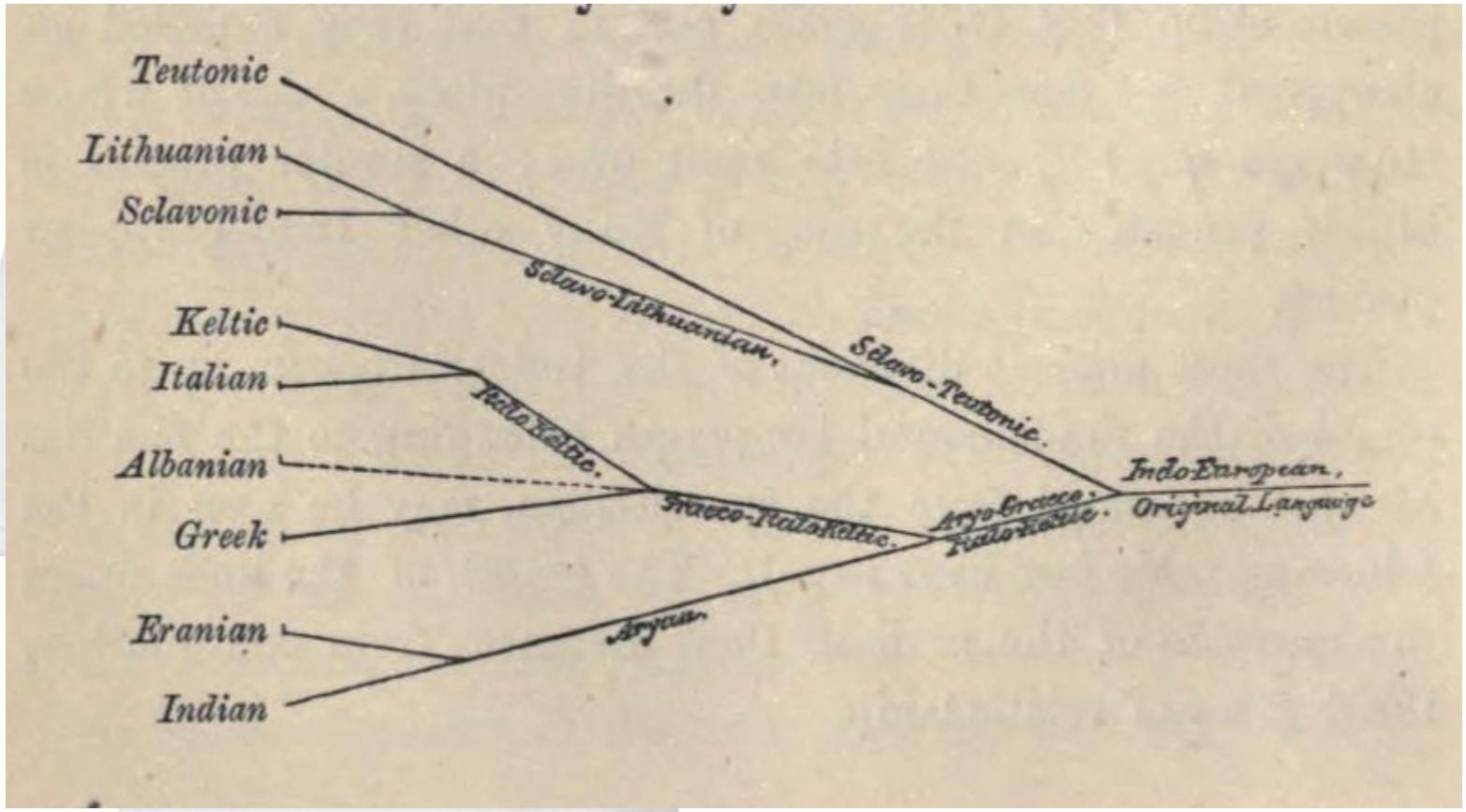
Schön, D. (1963). *Displacement of Concepts*. Tavistock Publications.

Metaphors that made biology: Tree of life

and the interaction between biology and linguistics

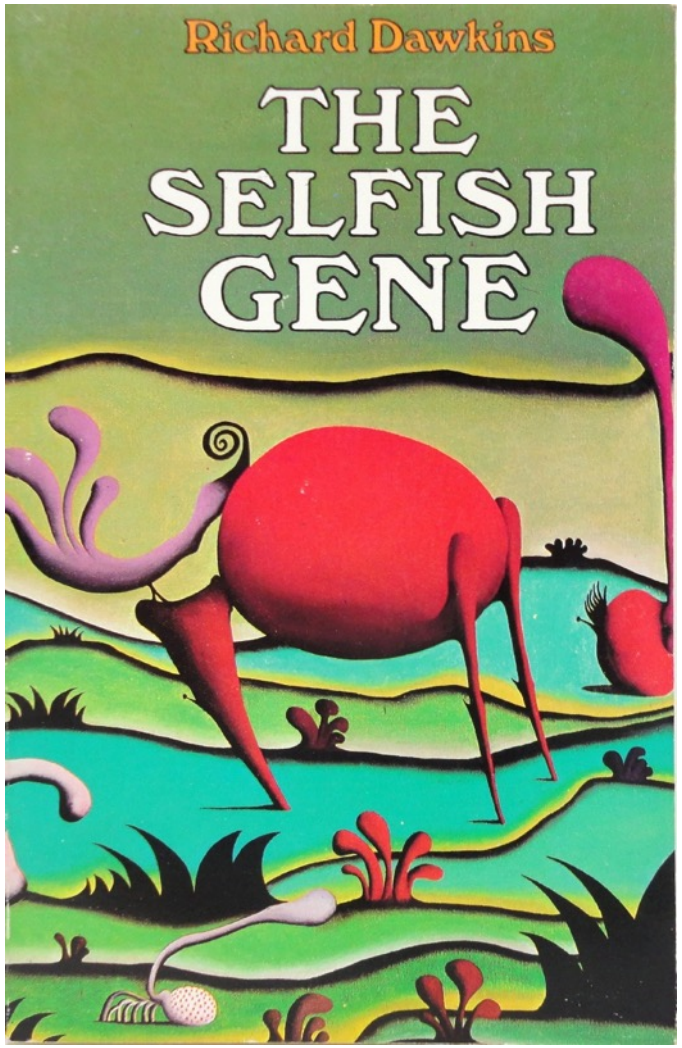


Darwin: 1837/1859



August Schleicher 1853/1861, Engl. Transl. 1874

Metaphors that changed biology: The selfish gene

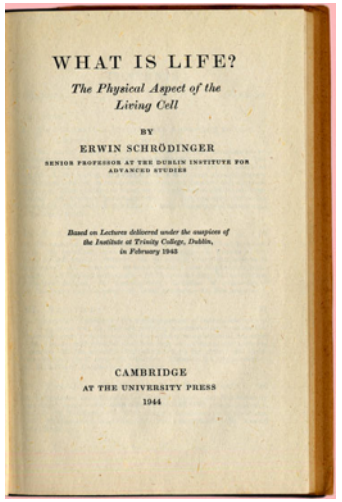


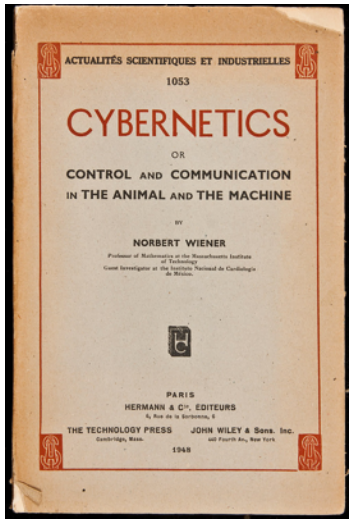
1976

"When I was an undergraduate, I recall a tutor rather shirtily suggesting that I should read some papers rather than “that book”, and *The Selfish Gene* has been attacked variously by philosophers, comedians, vicars and journalists too. Much of the enmity stems from people misunderstanding that selfishness is being used as a metaphor. The irony of these attacks is that the selfish gene metaphor actually explains altruism. We help others who are not directly related to us because we share similar versions of genes with them.” (Adam Rutherford, 2016)

Metaphors that made genomics: Information, regulation, control, code and text

- "In the 1950s molecular biology underwent a striking discursive shift: it began to represent itself as a communication science, allied to cybernetics, information theory, and computers. Through the introduction of terms such as information, feedback, messages, **codes**, alphabet, words, instructions, **texts**, and programs, molecular biologists came to view organisms and molecules as information storage and retrieval systems" (Kay, 1997)





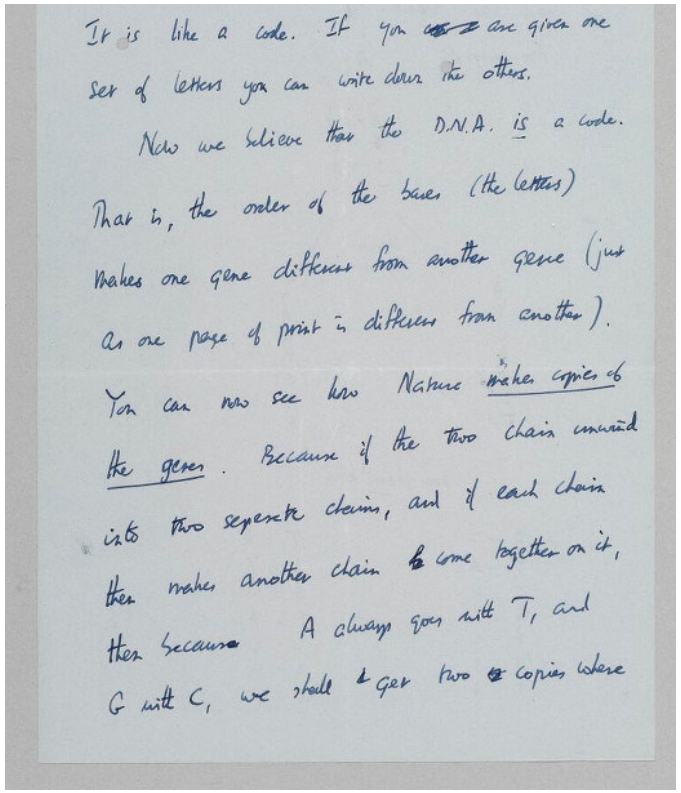
Kay, L. E. (1997). Cybernetics, information, life: The emergence of scriptural representations of heredity. *Configurations*, *5*(1), 23-91.

Metaphors that made genomics: Code

19 Portugal Place
Cambridge
19 March '53

My Dear Michael,

Jim Watson and I have probably made a most important discovery. We have built a model for the structure of des-oxy-ribose-nucleic-acid (read it carefully) called D.N.A. for short. You may remember that the genes of the chromosomes -- which carry the hereditary factors -- are made up of protein and D.N.A.



It is like a code. If you ~~are~~ are given one set of letters you can write down the others.

Now we believe that the D.N.A. is a code. That is, the order of the bases (the letters) makes one gene different from another gene (just as one page of print is different from another). You can now see how Nature makes copies of the genes. Because if the two chains unwind into two separate chains, and if each chain then makes another chain come together on it, then because A always goes with T, and G with C, we shall get two copies where we had one before.

It is like a code. If you are given one set of letters you can write down the orders.
Now we believe that the D.N.A. is a code. That is, the order of the bases (the letters) makes one gene different from another gene (just as one page of print is different from another). You can now see how Nature makes copies of the genes. Because if the two chains unwind into two separate chains, and if each chain then makes another chain come together on it, then because A always goes with T, and G with C, we shall get two copies where we had one before.
For example

A — T
T — A
C — G
A — T
G — C
T — A
T — A

Crick's letter to his 12 year old son

Metaphors that changed genomics: Language

and the interaction between genomics and linguistics

- Borek (1964/69): ***The code of life***
- Beadle and Beadle (1966): ***The language of life***
- Sinsheimer (1967): ***The book of life***
- ’Vivre et parler’. Un débat entre François Jacob, Roman Jakobson, Claude Lévi-Strauss et Philippe L'Héritier (1967)

Initiating the discussion with an examination of “Genetic Information and the Function of Language,” Jacob explained how “what we call genetic information . . . is genuinely inscribed in the chromosomes [via permutations of elements] . . . exactly like in a phrase in a text.” This view, he argued, had enormous consequences for the central problem of biology: organization.

“... the deciphering of the DNA code has revealed a language... as old as life itself, a language that is the most living language of all” (Beadle and Beadle, 1966)

“In this book are instructions, in a curious and wonderful code, for making a human being.” (Sinsheimer, 1967)

Genomics and politics: Speaking the language of God

"The two scientists stood shoulder to shoulder with President Bill Clinton in the East Room of the White House, the same room where the American explorers **Meriwether Lewis** and William Clark unfurled their **map** of the Northwest Territories for Thomas Jefferson." (Independent, 2013)

Map of Western North America, with annotations by Meriwether Lewis 1803.

"We are here to celebrate the completion of the first survey of the entire human genome. Without a doubt, this is the most important, **most wondrous map** ever produced by human kind. …[W]hen Galileo discovered he could use the tools of mathematics and mechanics to understand the motion of celestial bodies, he felt, in the words of one eminent researcher, that he had learned the language in which God created the universe. **Today we are learning the language in which God created life**. We are gaining ever more awe for the complexity, the beauty, the wonder of God's most divine and sacred gift." (Bill Clinton in the year 2000)

Nerlich, B., Dingwall, R., & Clarke, D. D. (2002). The book of life: How the completion of the Human Genome Project was revealed to the public. *Health* 6(4), 445-469.

Metaphors highlight and hide

- "Genome: Bought the book; hard to read. Said to have the answer to everything, absolutely everything. Diabetes, Asthma, Cancer, Evolution, Populations, Migrations, Life, Death, Taxes. Even the Boston Red Sox. The only problem is: there's no index."

Eric Lander, founder and director of the Whitehead Institute/MIT Center for Genome Research; director of the Broad Institute; one of the key pioneers in mapping and sequencing the entire human genome.
Photo: Margaret Hart.

Sticky metaphors

BOOK: The book of life / of human / of nature / of Genesis
Implies: One can read off genetic information unambiguously and straightforwardly, and correct genetic 'misprints'.

MAP: The map of life / physical map / searchable map
Implies: the possibility of finding precise locations (and possibly GOLD).

CODE: The code of life/ human software programme
Implies: Human genome provides the code for programming humans...

BLUEPRINT: Blueprint of life / of humanity / of heredity
Implies: Human genome is a simple set of instructions for building a human; prefigures/predetermines the object that is represented in detail.

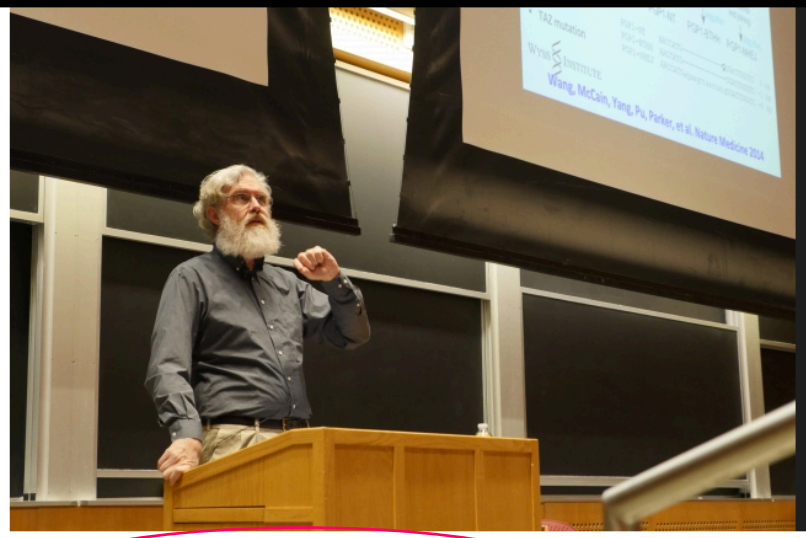
Books of life, junk DNA, DNA barcodes: all these images can and have distorted the picture, not least because scientists themselves sometimes forget that they are metaphors. And when the science moves on — when we discover that the genome is nothing like a book or blueprint — the metaphors tend, nonetheless, to stick. The more vivid the image, the more dangerously seductive and resistant to change it is.

Philip Ball, Nature, 2011

Sticky metaphors: Reading and writing

MIT News
ON CAMPUS AND AROUND THE WORLD

Browse or Search



FULL SCREEN

George Church gave the first lect
the Department of Biology's four-p
seminar series, Biology at Transfo
Frontiers.

Photo: Raleigh McElvery

Reading and writing DNA

Department of Biology kicks off IAP seminar series with a lecture by synthetic-biology visionary George Church.

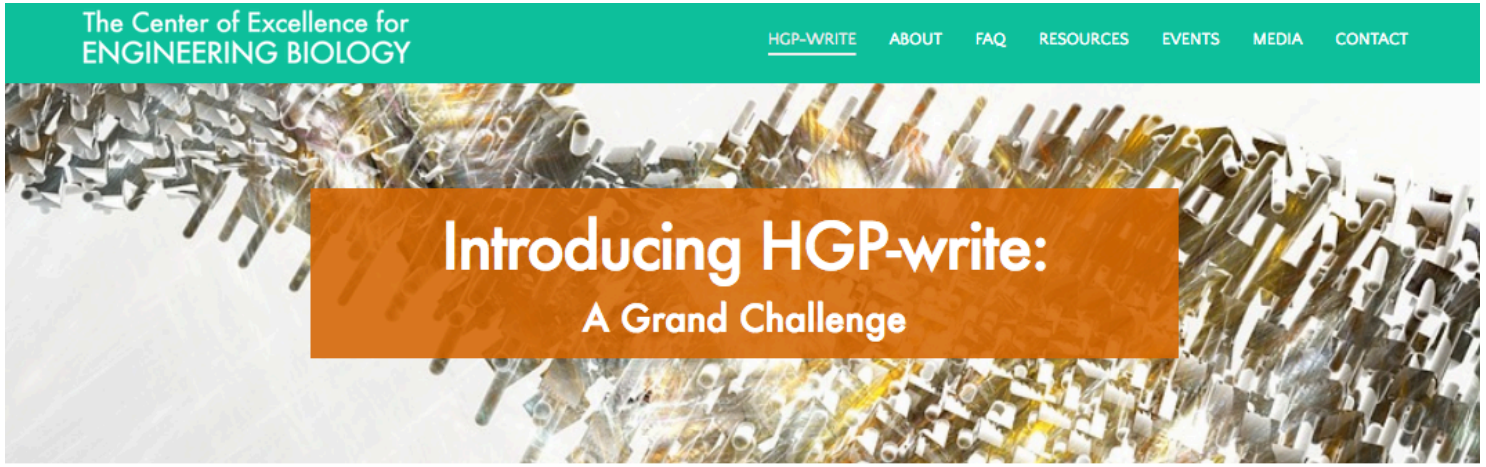
Raleigh McElvery | Department of Biology
January 31, 2018

Press Inquiries

RELATED

Thanks to the invention of genome sequencing technology more than three decades ago, we can now read the genetic blueprint of virtually any organism. After the ability to read came the ability to edit — adding, subtracting, and eventually altering DNA wherever we saw fit. And yet, for George Church, a professor at Harvard Medical School, associate member of the Broad Institute, and founding core faculty and lead for synthetic biology at the Wyss Institute — who co-pioneered direct genome sequencing in 1984 — the ultimate goal is not just to read and edit, but also to write.

Sticky metaphors: blueprint



The Genome Project-write (HGP-write) will be an open, international research project led by a multi-disciplinary group of scientific leaders who will oversee a reduction in the costs of engineering and testing large genomes in cell lines more than 1,000-fold within ten years.

This will include whole genome engineering of human cell lines and other organisms of agricultural and public health significance. Additionally, HGP-write will develop new technologies and an ethical framework for genome-scale engineering, as well as transformative medical applications.

The overarching goal of such an effort is to understand the blueprint for life provided by the Human Genome Project (HGP-read).

HGP-read aimed to "read" a human genome. Successfully completed in 2003, HGP-read is now widely recognized as one of the great feats of exploration, one that sparked a global revolution in science and medicine, particularly in genomic-based diagnostics and therapeutics.

Download the HGP-write White Paper (coming soon)

Learn How to Get Involved

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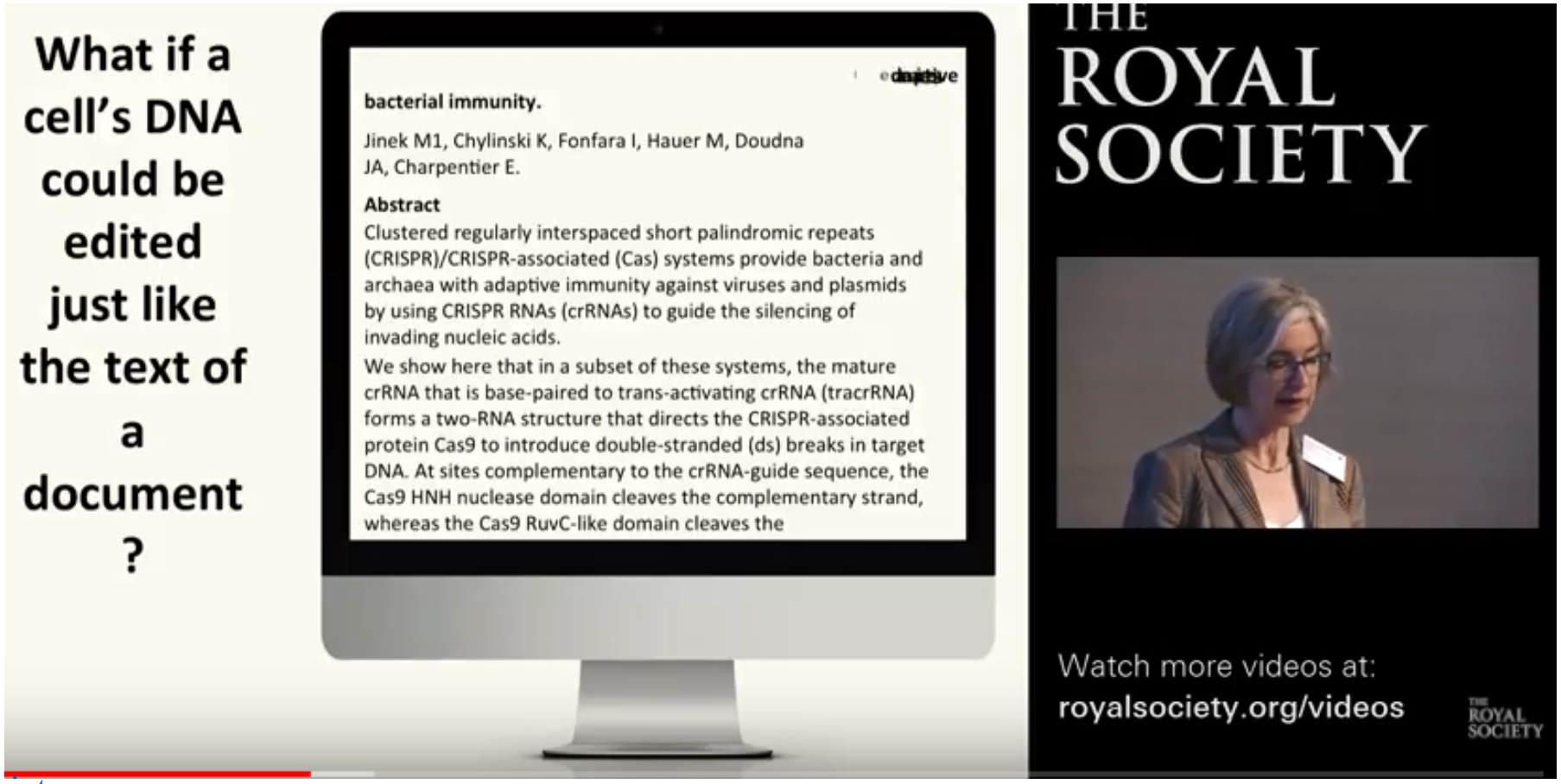
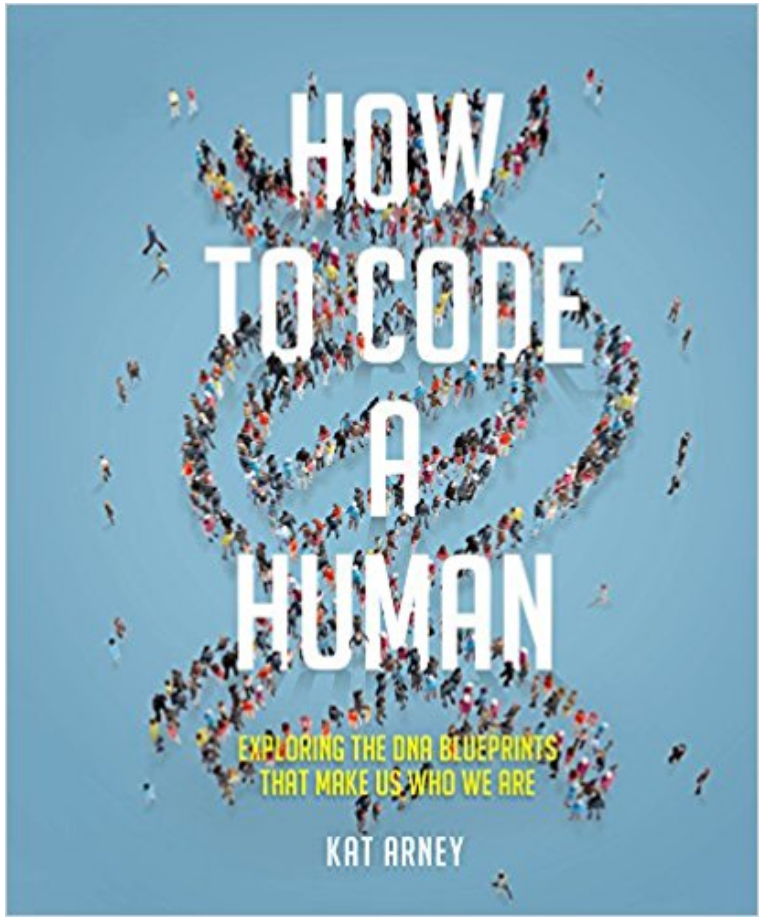
Sticky metaphors: Text/word processing



The Royal Society
Uploaded on Mar 27, 2018
Professor Jennifer Doudna ForMemRS, Professor and HHMI Investigator at UC Berkeley, and co-discoverer of CRISPR-Cas9, delivers the keynote address CRISPR systems: Nature's toolkit for genome editing.

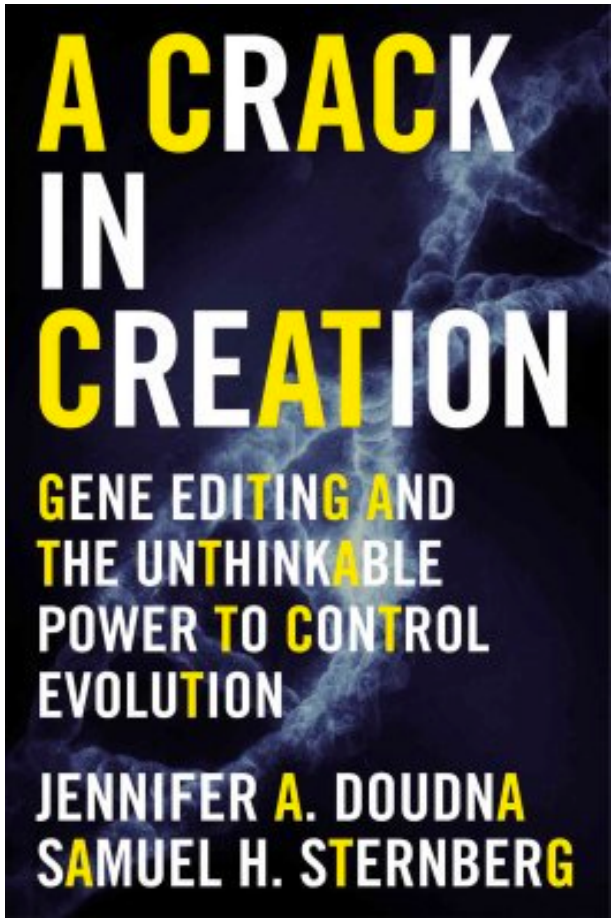
Sticky metaphors: Code



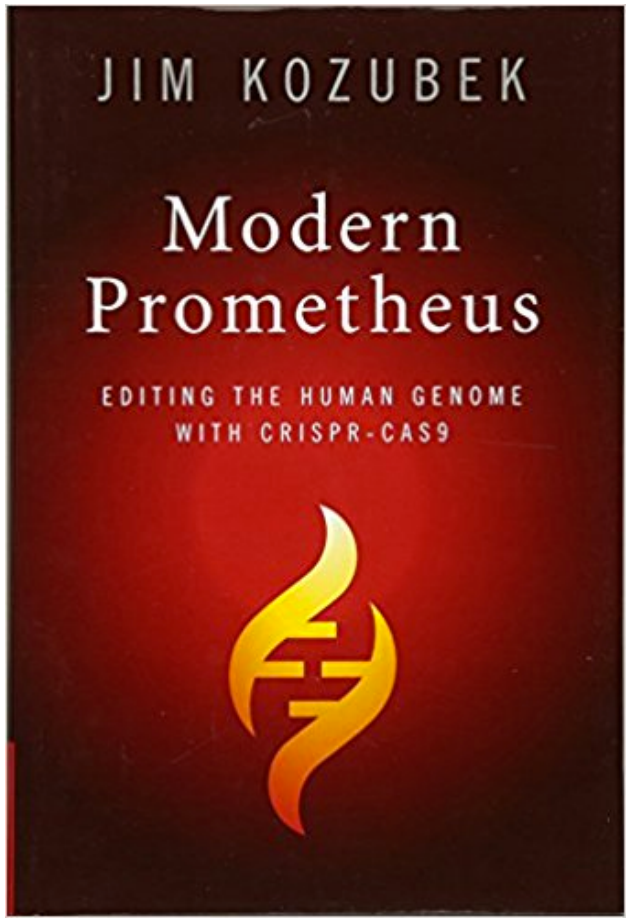
How to Code a Human:
Exploring the DNA Blueprints That Make Us Who We Are

Originally published: **3 April 2018**

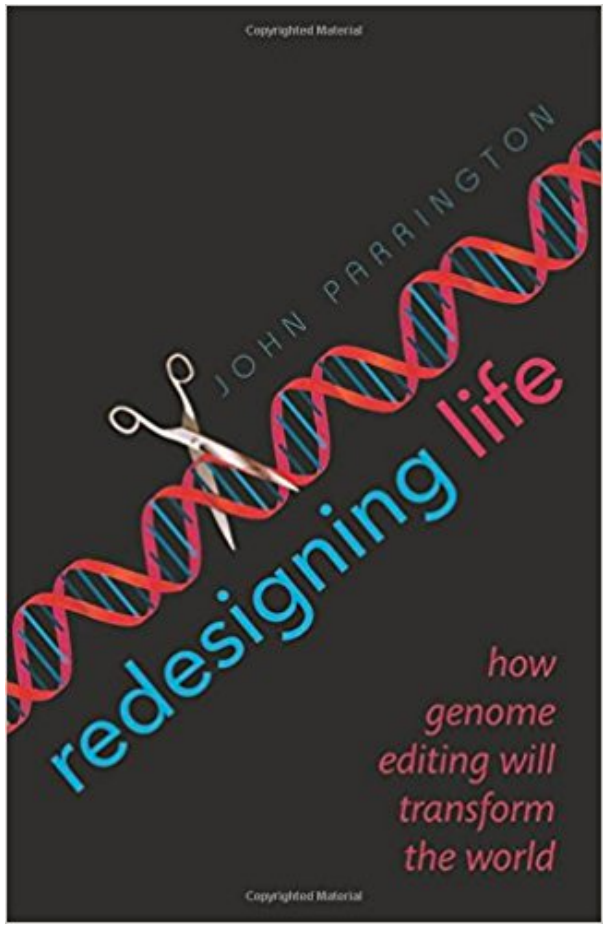
Genome *editing*:
Metaphors become reality and old stories die hard



2017



2016



2016

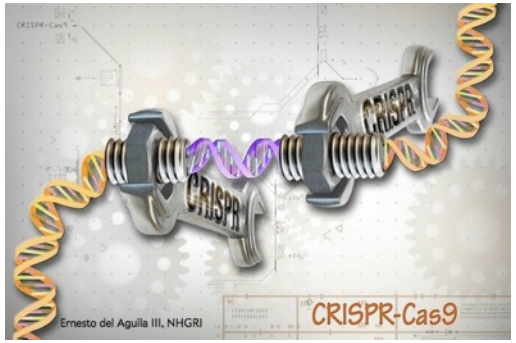
Playing God;
Dr Frankenstein

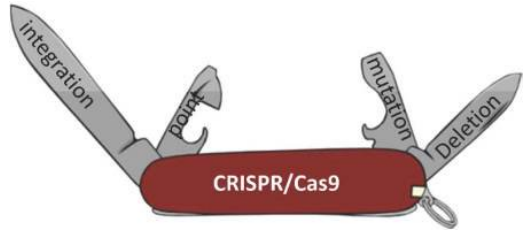
Mary Shelley, 1818: Frankenstein
The Modern Prometheus

Engineering life

Genome editing: In search of new metaphors

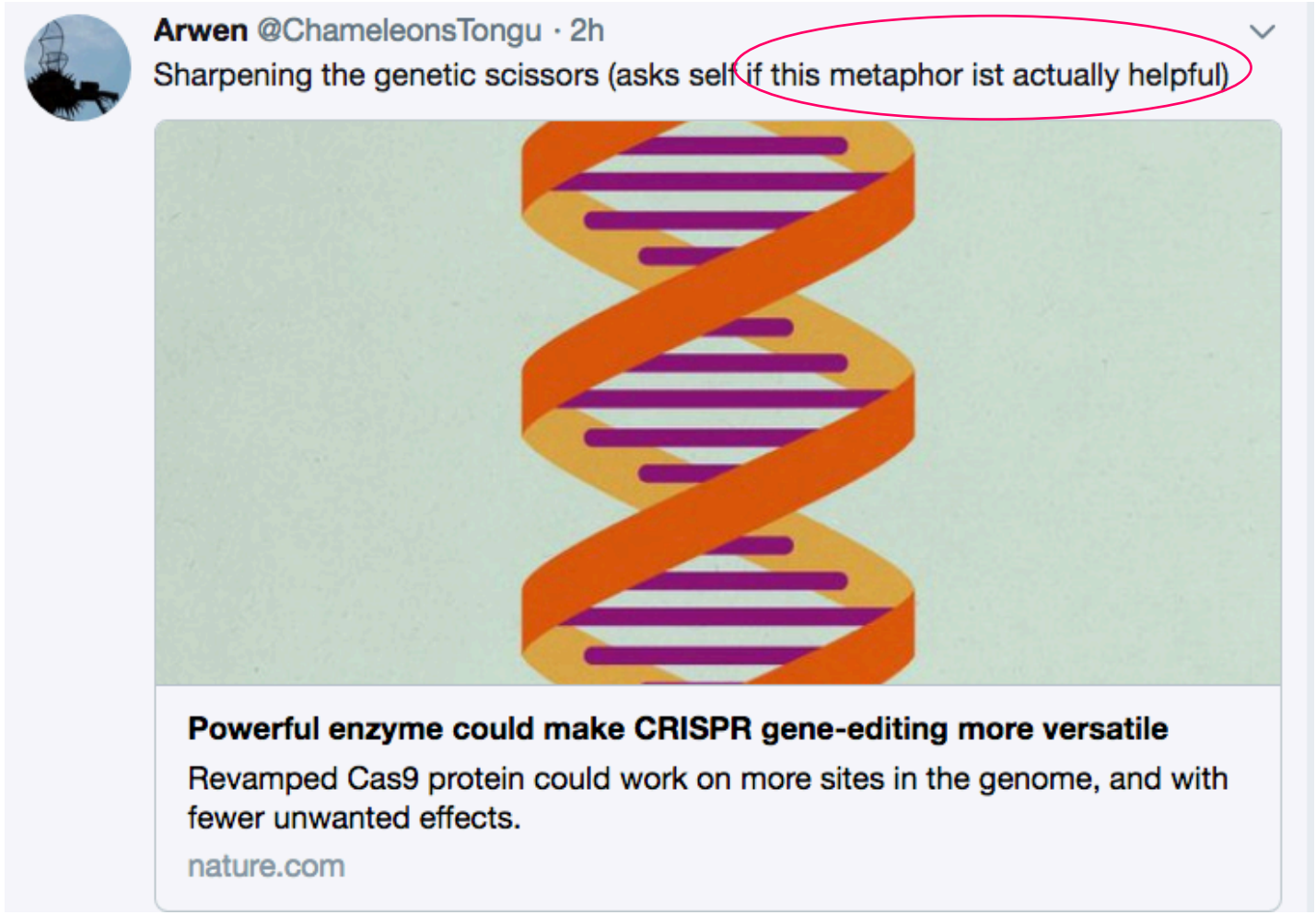
- A knock-out punch
- The hand of God
- A bomb-removal squad
- A handy-man at work
- An eraser
- A surgeon's scalpel
- A pair of scissors
- Search and replace
- Photoshop
- A Swiss army knife
- Plus: invisible mending





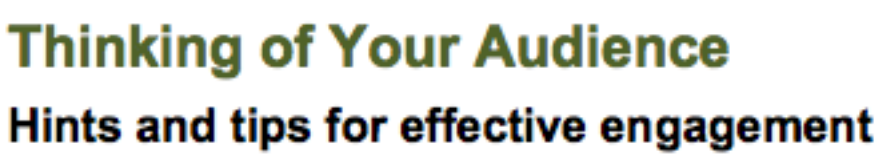
https://www.statnews.com/2017/12/08/crispr-analogies-ranked/

Mind the metaphor



Nature, 2013

Metaphors and public engagement



WELLCOME GENOME CAMPUS | PUBLIC ENGAGEMENT

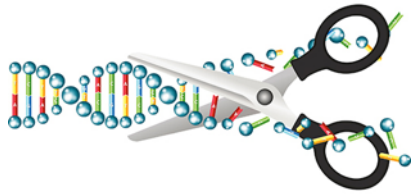
- “Help get across concepts or scales using comparisons or metaphors. A comparison might be ‘if you stretched out all the DNA in all your cells it would easily span the solar system’. Metaphors would include terms like ‘blueprint’ in the context of the genome or ‘genetic scissors’ in the context of genome editing.”
- Are these good metaphors??

Ask the people

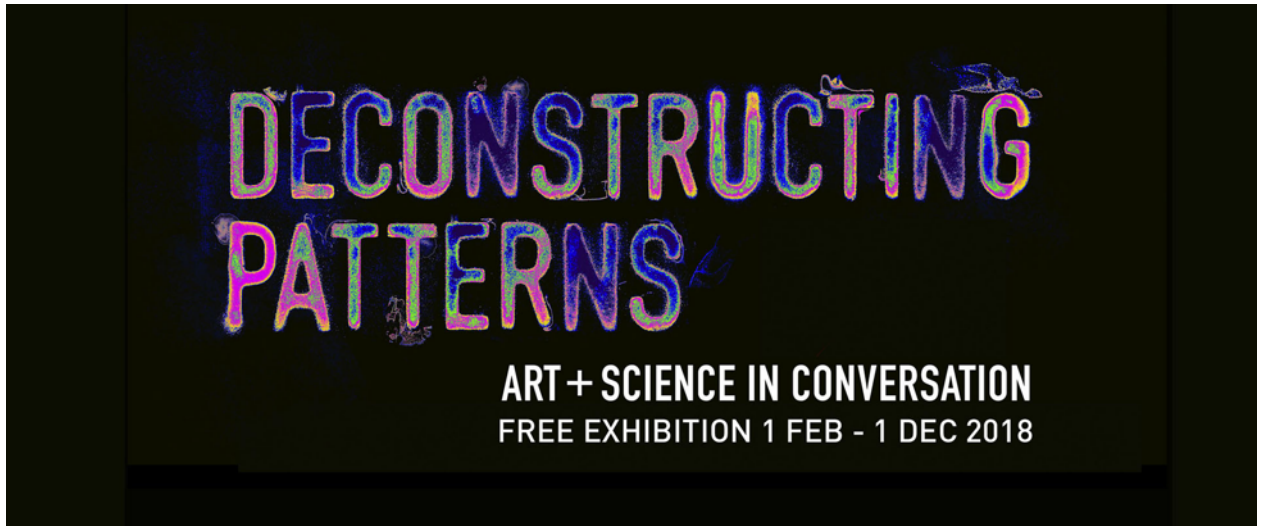
“Basic understanding of genome editing”

(Genetic Alliance and the Progress Educational Trust, 2017)

- The **genome**: people use term but cannot explain it
  - Metaphors: **book** (text, letter, script), recipe, roadmap, shopping list
  - **blueprint** was regarded as outdated
- **Genome editing**: people liked the term but not genome engineering and genetic modification
  - Metaphors: Word processing (find and replace, copy and paste, cut and paste)
  - Combination of ‘**satnav**’ and ‘**scissors**’
- **CRISPR**: people did not understand the term



The problem of dynamics and complexity



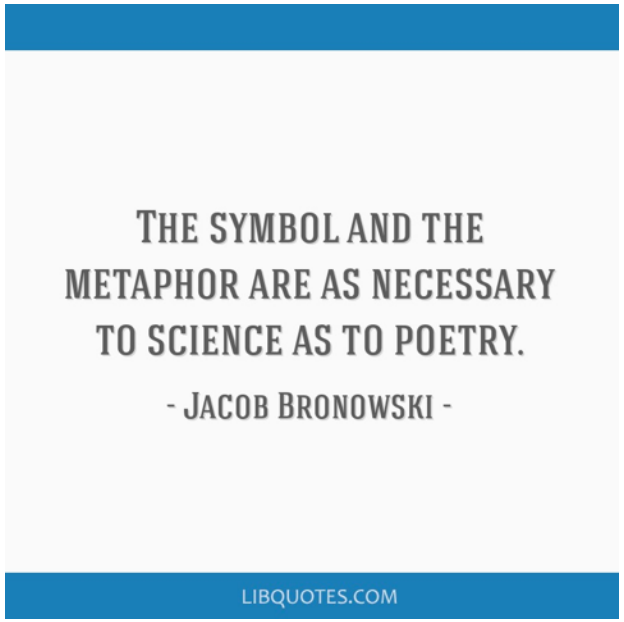
The Francis Crick Institute

- "Alphabet of us, cipher deciding the exact moment genes flip on and where", Howe's poem begins. The words, fugitive in Shewring's soundscape, suggest that representations of the genome are moving beyond the static, deterministic metaphors of a 'book of life'. Shewring was keen to keep interpretation open and uncertain, aptly reflecting the dance between prescriptiveness and contingency in the dynamic unfolding of genetic information." (Philip Ball, *Nature* 554, 298-299, 2018)

Metaphors: Awareness and beware

- Jacob Bronowski: *Science and Human Values* (1956:41) 41)
  - "All science is the search for unity in hidden likenesses….." – and so is art and poetry
- Care needs to be taken when exploiting likeness in science, art, politics, public engagement and public dialogue
- Sarah Bakewell (*The Guardian*, 2013):
  - "Metaphors can persuade us to war or bring us back from the brink. We must try to be more aware of them".

- **RRI and public engagement need reflection on creative and responsible language use**



Thank you!

- **Blog**: http://blogs.nottingham.ac.uk/makingsciencepublic/
- **Twitter**: @BNerlich