

Why is There So Little Chemistry in Our Culture?

Michael Weisberg
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Philosophy of Science

general methodology

- ❖ nature of theories
- ❖ confirmation
- ❖ explanation
- ❖ modeling
- ❖ idealization

special sciences

- ❖ physics
- ❖ biology
- ❖ psychology
- ❖ economics
- ❖ chemistry!

Philosophy of Chemistry

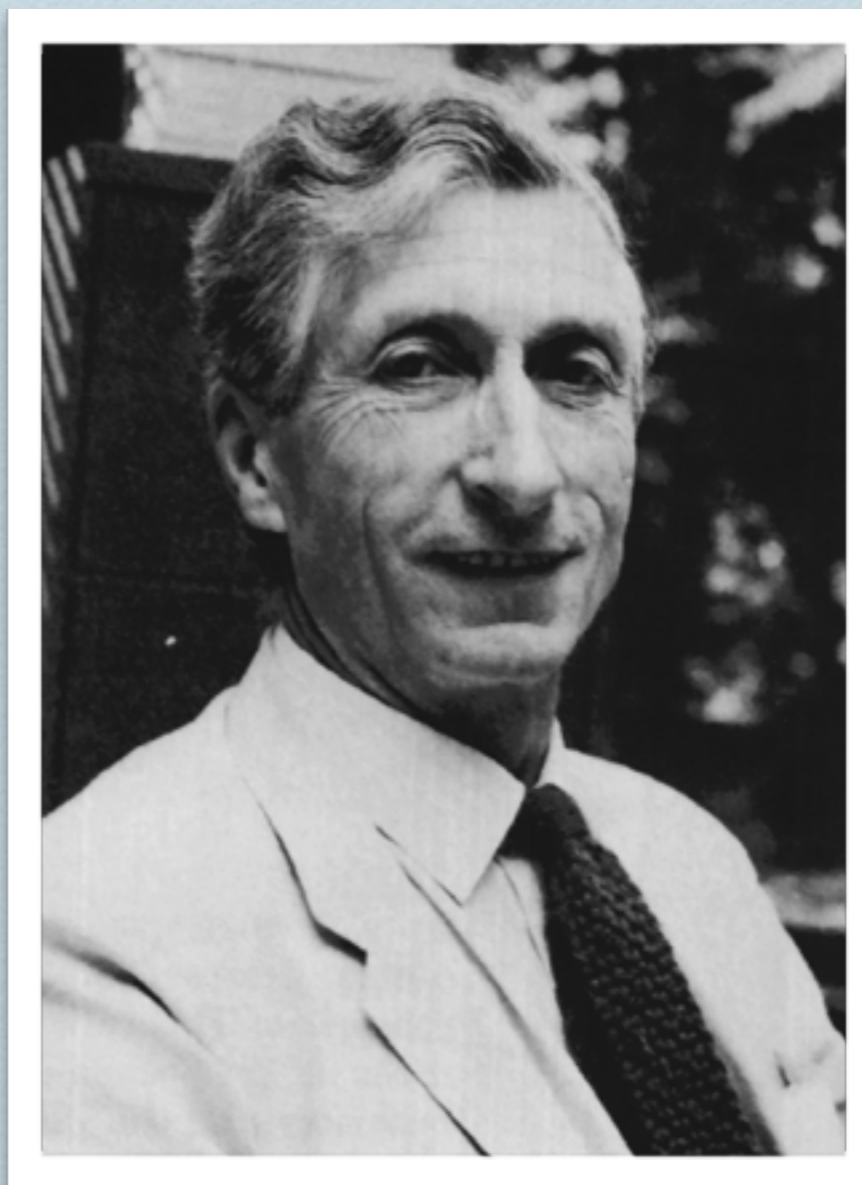
- ❖ nature of substances and their individuation criteria
- ❖ relationship between chemical and physical theories
- ❖ explanation in chemistry
- ❖ nature of the chemical bond

Are Chemical Bonds Real?

Sometimes it seems to me that a bond between two atoms has become so real, so tangible, so friendly that I can almost see it.

And then I awake with a little shock; for a chemical bond is not a real thing: it does not exist: no one has ever seen it, no one ever can. It is a figment of our own imagination.

Charles Coulson, 1951



Are Chemical Bonds Real?

Bonds are Not Real

- ❖ The structural concept of bonds is not robust across models of molecular structure.
- ❖ Models that produce better experimental fit to the data especially cast doubt on the concept.

Bonds are Real

- ❖ Chemistry is pragmatic: We have different bond concepts for different purposes.
- ❖ Highly successful practice is based on the structural concept. What better evidence is there that the concept refers?

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IUPAC Mission Statement

“In fulfilling this mission, IUPAC effectively contributes to the worldwide understanding and application of the chemical sciences, to the betterment of the human condition.”



Pennsylvania Science Standards for Grade 12

- Apply rules of systematic nomenclature and formula writing to chemical substances.
- Classify and describe, in equation form, types of chemical and nuclear reactions.
- Explain how radioactive isotopes that are subject to decay can be used to estimate the age of materials.
- Explain how the forces that bind solids, liquids and gases affect their properties.
- Characterize and identify important classes of compounds (e.g., acids, bases, salts)



Where does the mass
of the tree come from?

Pure Appl. Chem., Vol. 80, No. 1, pp. 161–174, 2008.
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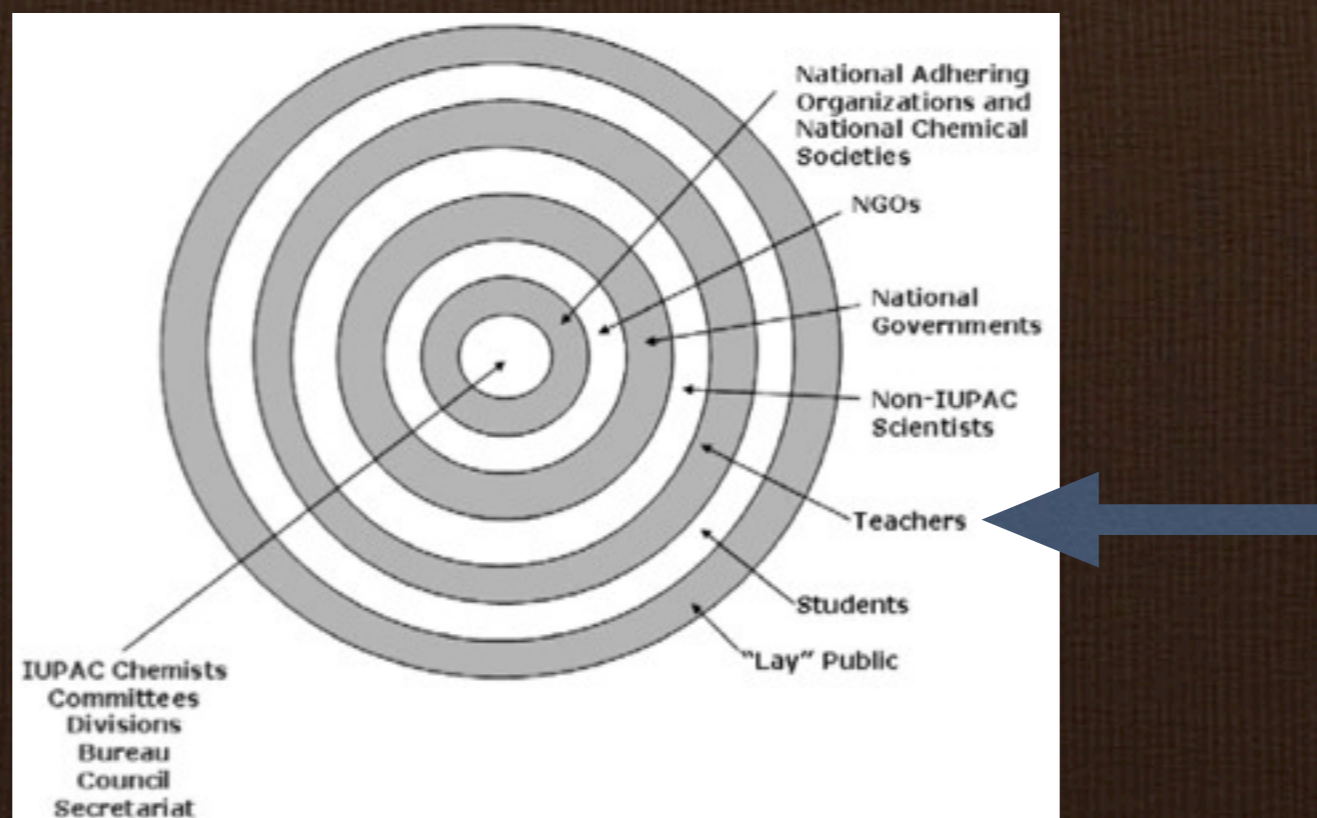
INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

COMMITTEE ON CHEMISTRY EDUCATION*,**

CHEMISTS AND “THE PUBLIC”: IUPAC’S ROLE IN ACHIEVING MUTUAL UNDERSTANDING

(IUPAC Technical Report)

Prepared for publication by
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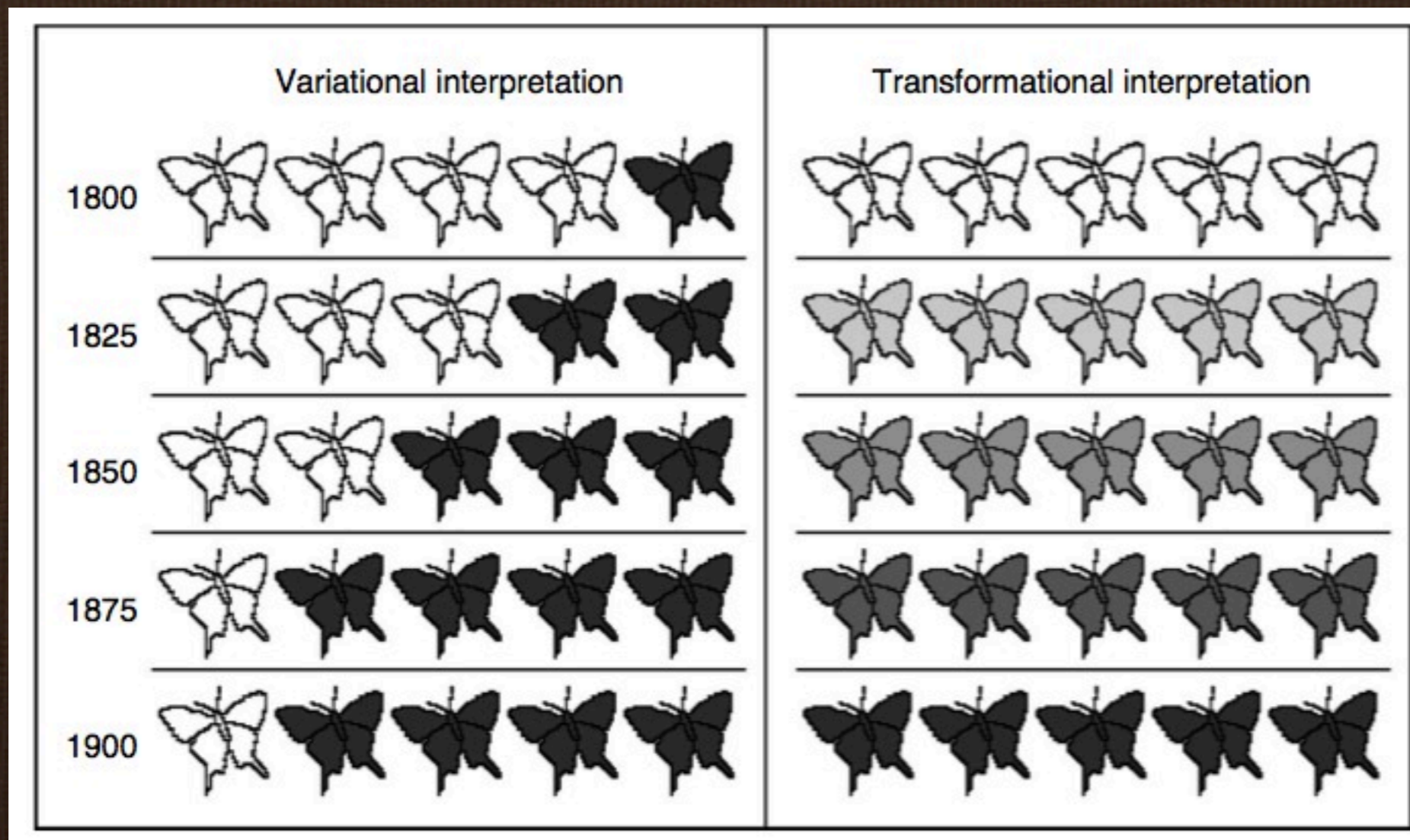


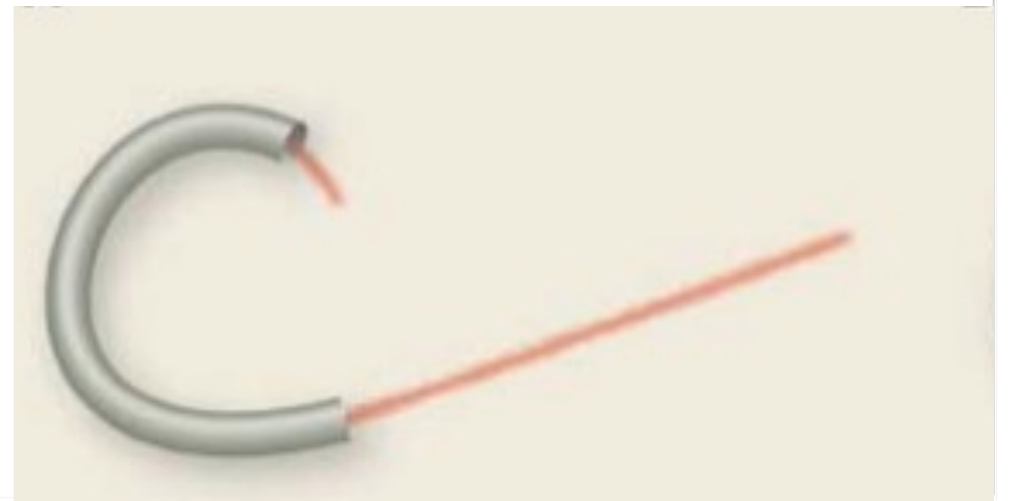
Lessons from Evolution Education?

“[Some] speculate that disbelief in evolution stems from a misunderstanding of Darwin’s theory, for anyone who grasps the explanatory power of natural selection cannot help but affirm its validity. However, studies that have measured both participants’ belief in natural selection and participants’ understanding of natural selection **have found no significant correlation between the two.**”

Shtulman, 2006

How did the moths change?



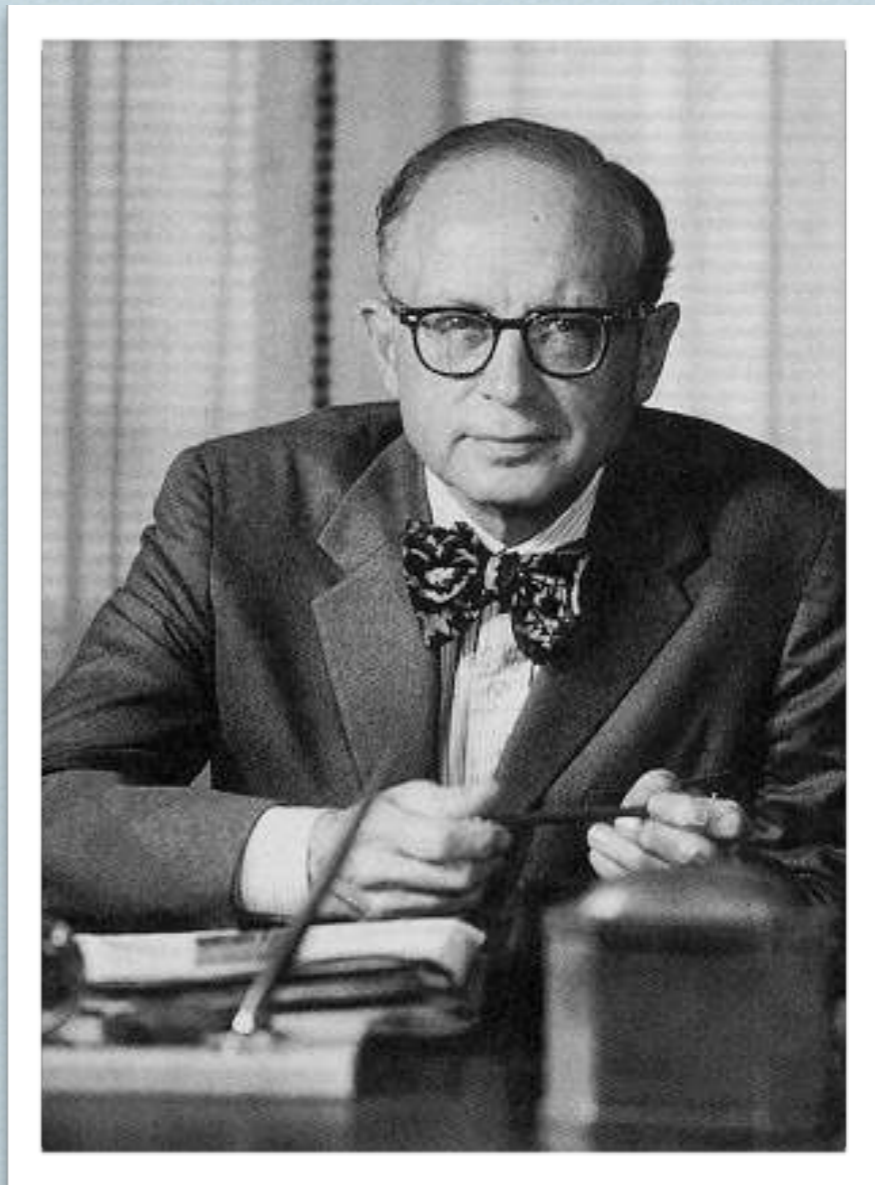


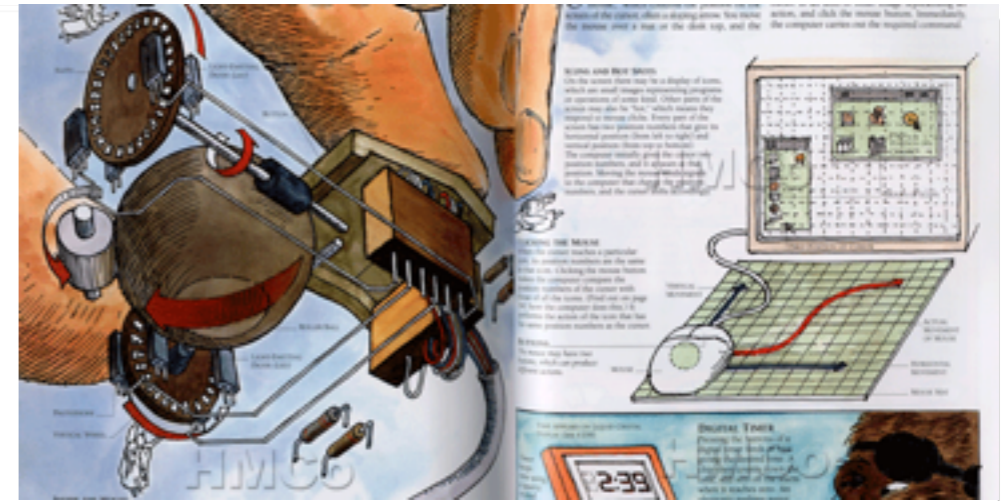
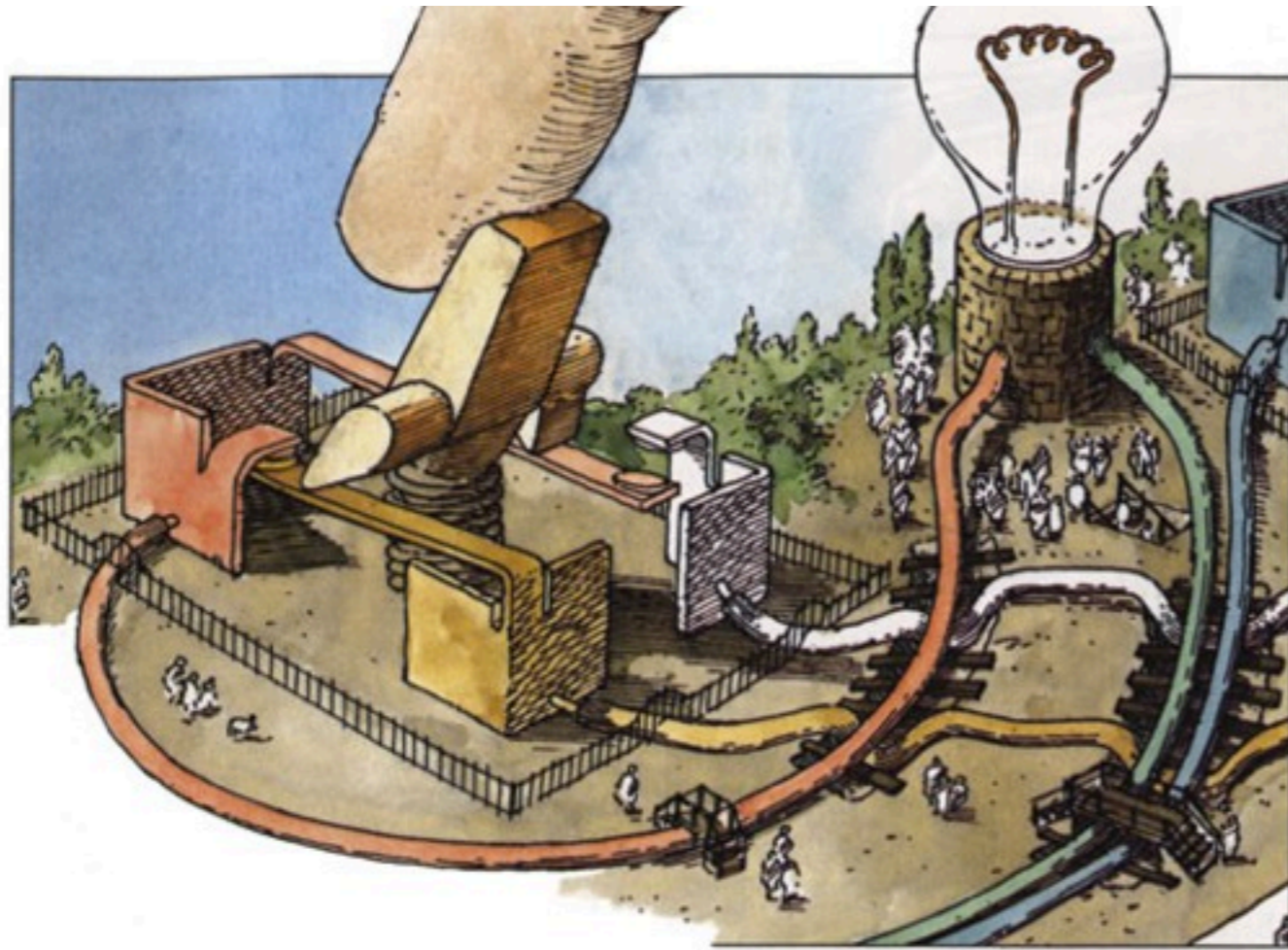
Childhood Origins

Illusion of Explanatory Depth

“The great obstacle to progress is not ignorance but the illusion of knowledge.”

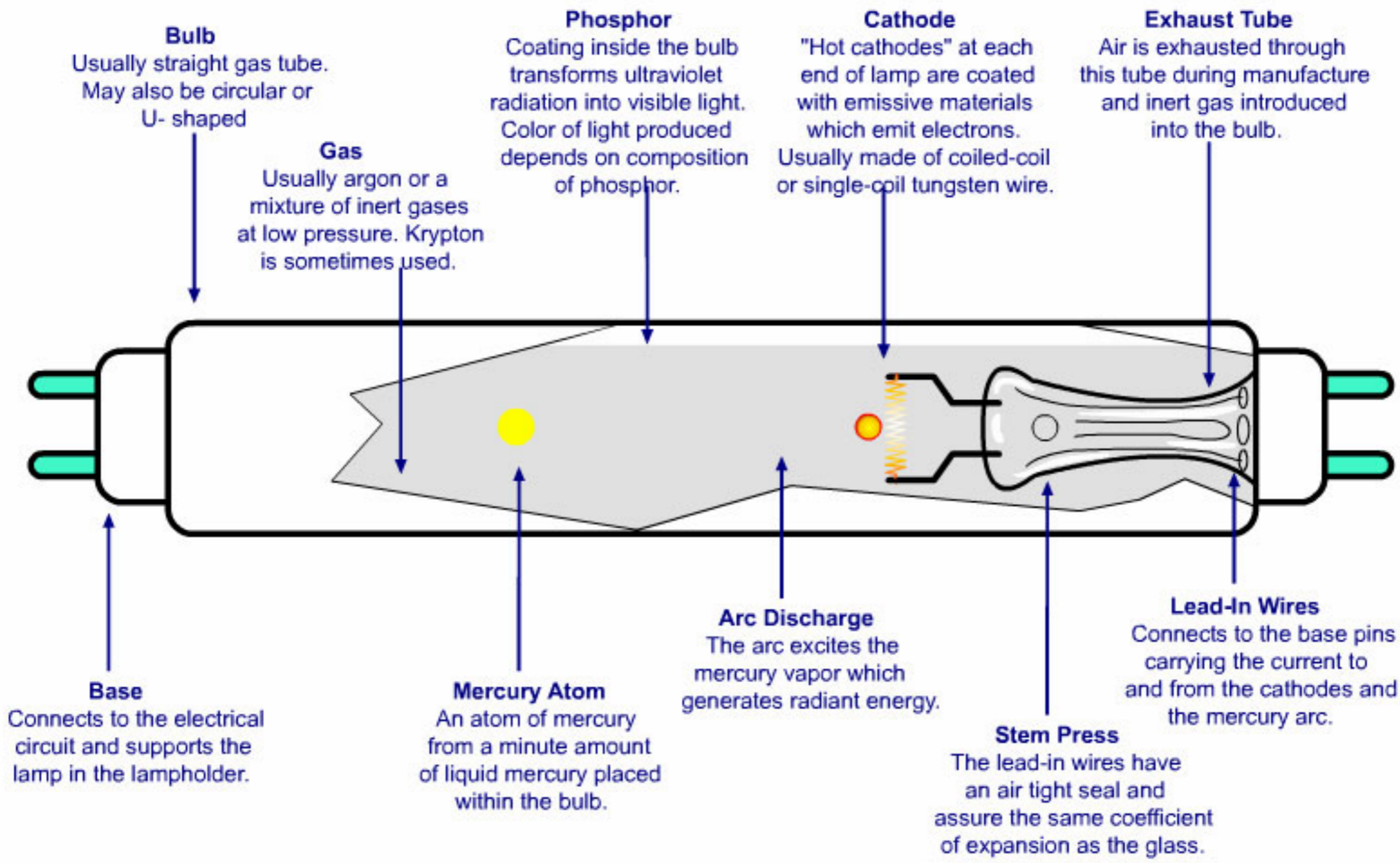
Daniel Boorstin
12th Librarian of Congress





THE **NEW** WAY THINGS WORK

Illusion of Explanatory Depth



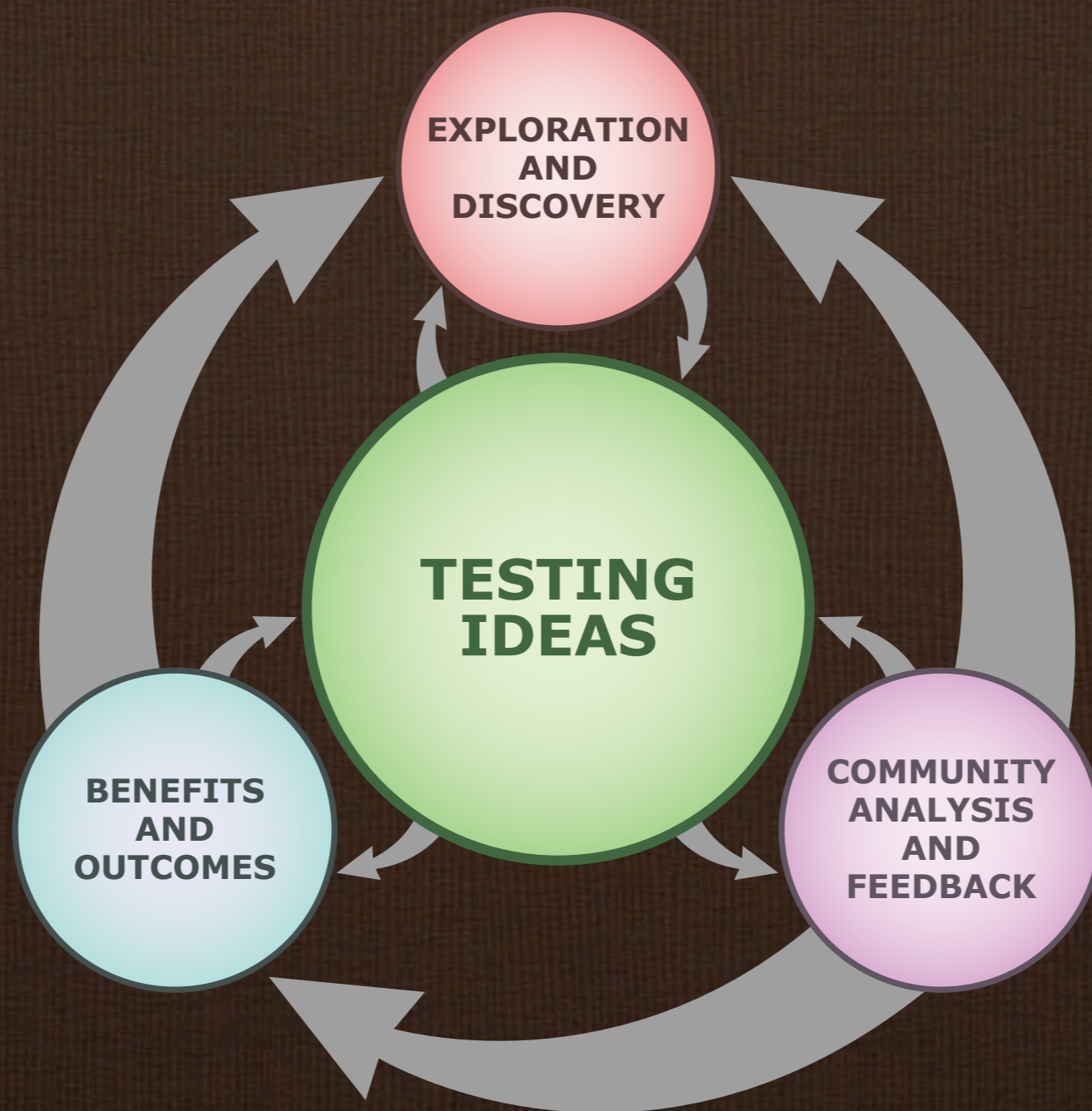
Illusion of Explanatory Depth

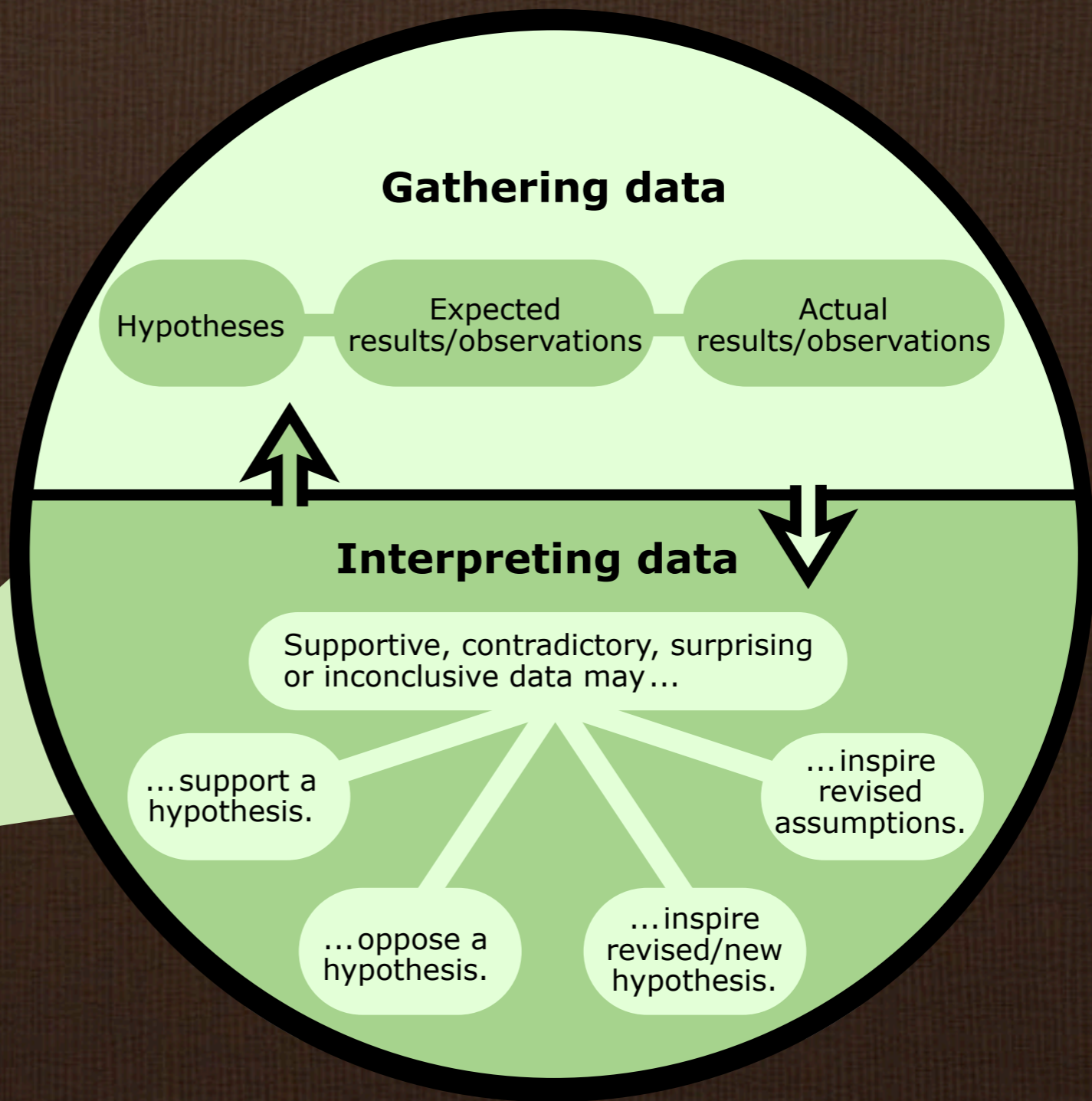
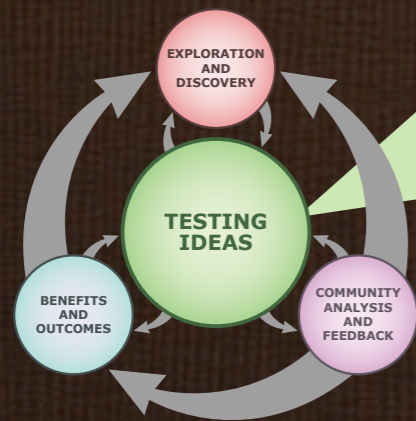
“Most people feel they understand the world with far greater detail, coherence, and depth than they really do ... laypeople, unlike some scientists, usually remain unaware of the incompleteness of their theories.”

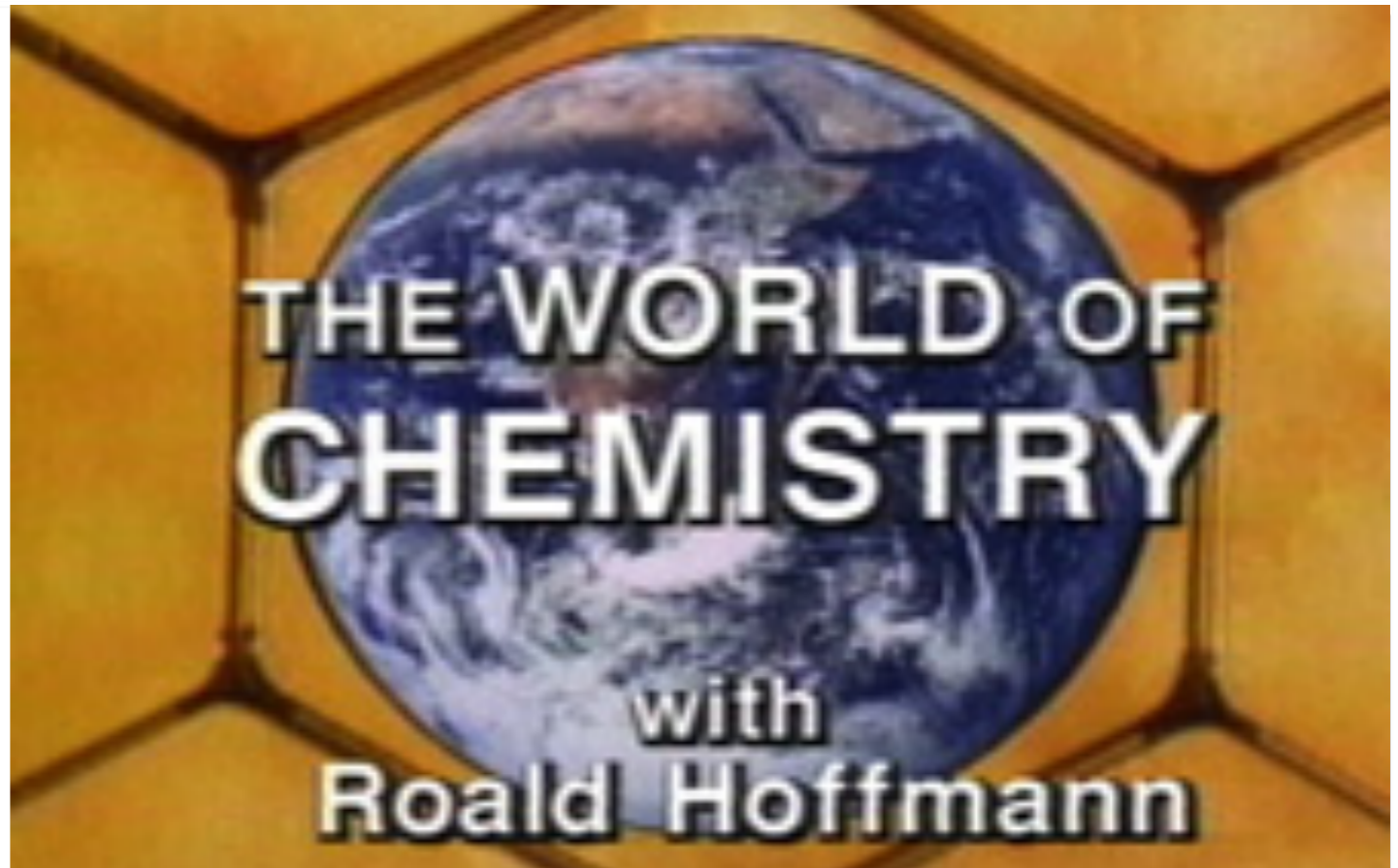
“Laypeople rarely have to offer full explanations for most of the phenomena that they think they understand. Unlike many teachers, writers, and other professional ‘explainers,’ laypeople rarely have cause to doubt their naïve intuitions.”

Rozenblit and Keil, 2002









27 Cobalt

I'M NOT SURE HOW common this element is, but for years cobalt was an element that made me feel nervous. Its main association in my mind, and doubtless in that of many others, was with nuclear fallout. But that's just a particular isotope, ⁶⁰Co. Although this isotope is indeed highly radioactive, and was a deadly component of the fallout from atmospheric nuclear bomb tests in the 1950s, ordinary cobalt is not radioactive at all.

In fact, cobalt is a quite ordinary metal, similar in appearance to nickel (Ni), and used, like many of the other elements in this neighborhood of the periodic table, as a component in steel alloys. Cobalt steel is one of the hardest and toughest alloys used for drills and milling machine bits.

Nickelodes of glass triskelons will know the deep blue color of cobalt glass, used in everything from bottles to electrical insulators. For some reason, glass insulators from old telephone wires, power lines, and railroad signals are rarely collected, commanding shockingly high prices on eBay.

The blue comes from a trace of cobalt compounds added to the glass, and actually has a more serious application beyond cheap bottles and suspended antique insulators. When the very strong yellow emission lines from sodium (Na) interfere with spectroscopic measurements, cobalt-blue filters are used to block it out selectively, allowing other colors of light through.

Cobalt and its neighbor, nickel, are chemically quite similar, but nickel has a far higher public profile, primarily due to its frequent presence in American pocket.

- ▲ Cobalt blue triskelion vials, built up by extended electrolysis.
- ▲ Cobalt aluminum oxide has been an important pigment for centuries.
- ▲ Cobalt steel is widely used for milling bits.
- ▲ Rarely, cobalt blue glass insulator.
- ▲ Cobalt glass triskelion vials are insulators.
- ▲ Cobalt electrolysis vial.

Elemental

Atomic Weight	58.9332
Density	8.9
Atomic Radius	125pm
Crystal Structure	

Electron Configuration: [Ar] 3d⁷ 4s²

Atomic Emission Spectrum

73

fin