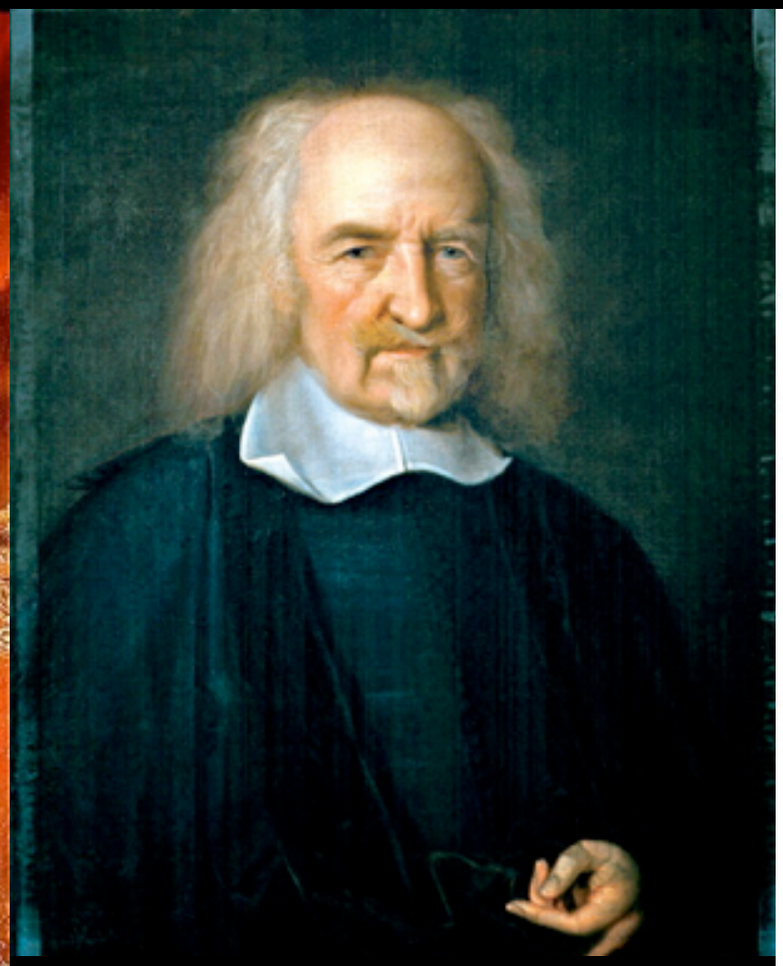
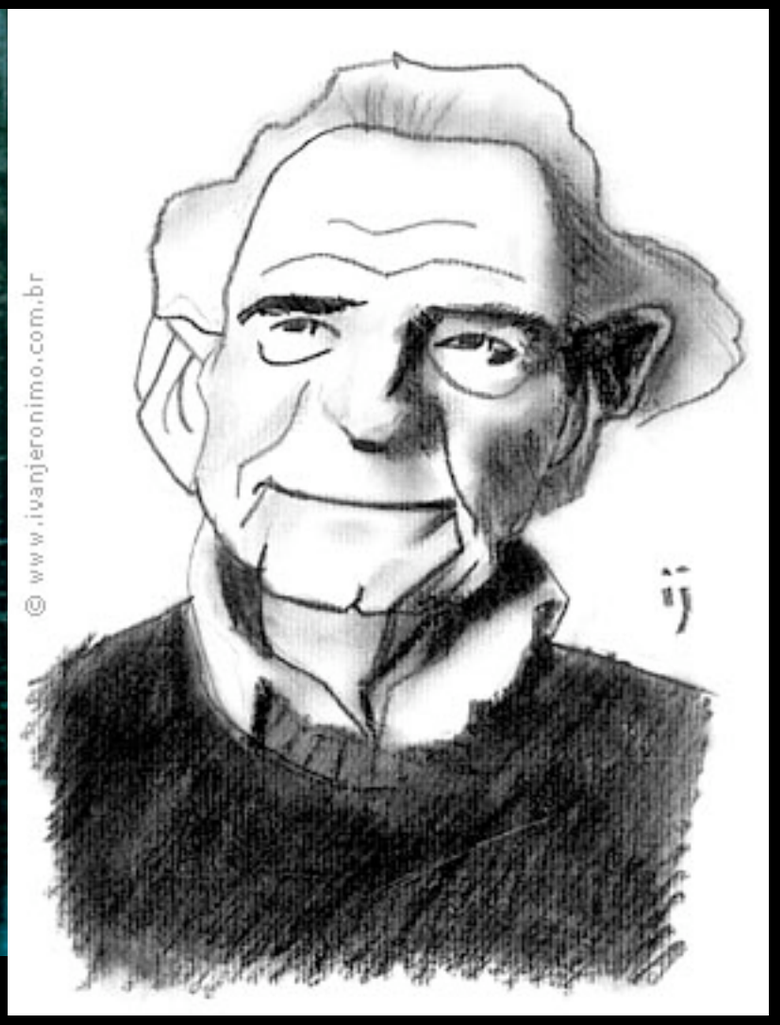
THE SCIENTIFIC METHOD

BACON



HOBBES

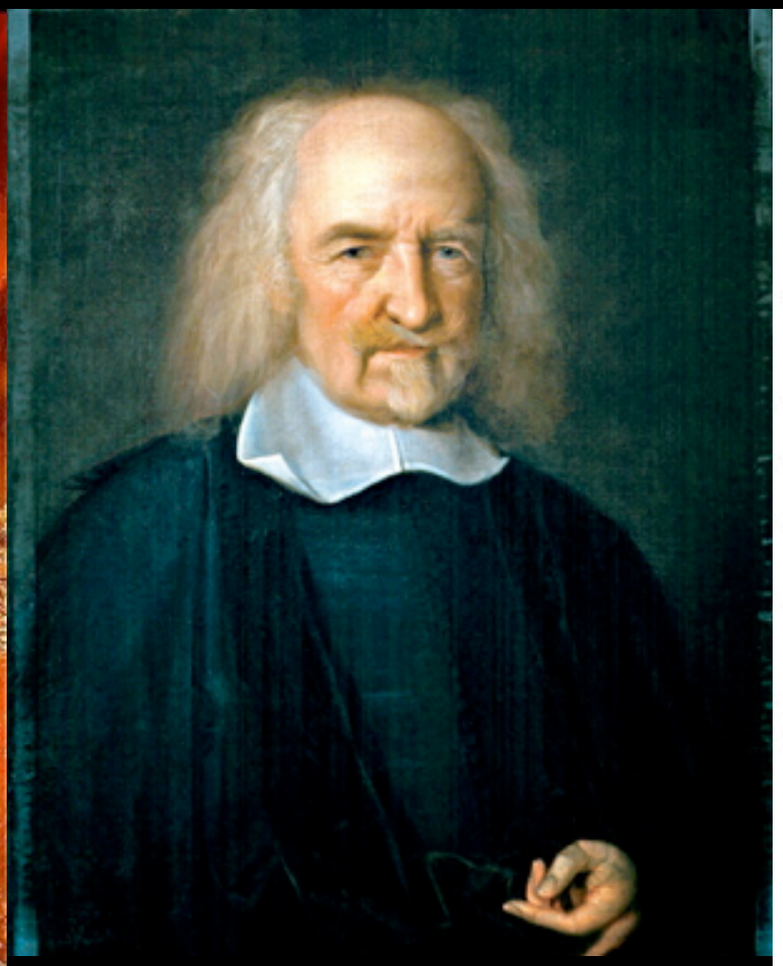


POPPER

THE SCIENTIFIC METHOD

"Words are but images of matter, to fall in love in them is to fall in love with a picture."

BACON



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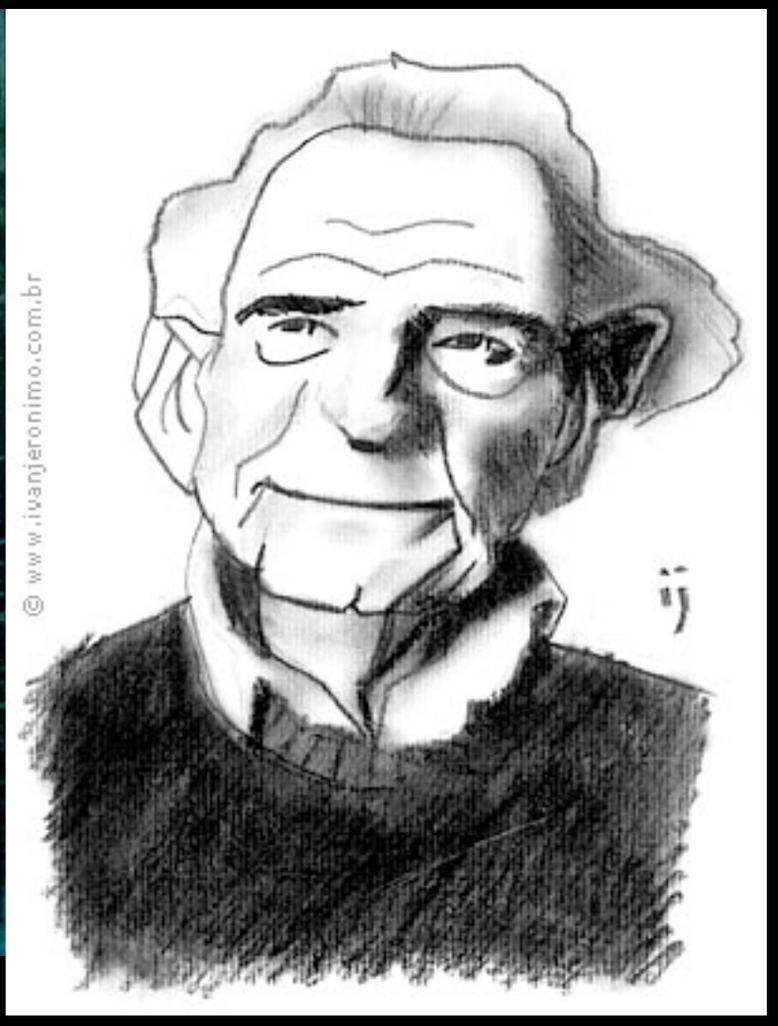
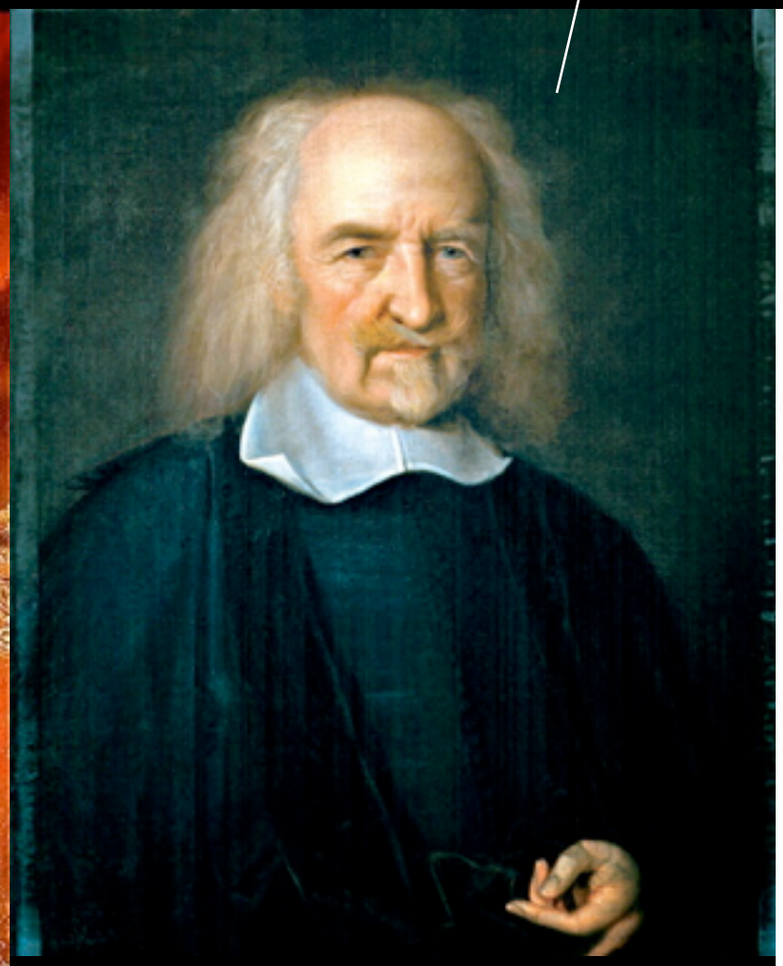


POPPER

THE SCIENTIFIC METHOD

"I am about to take my last voyage, a great leap in the dark."

BACON



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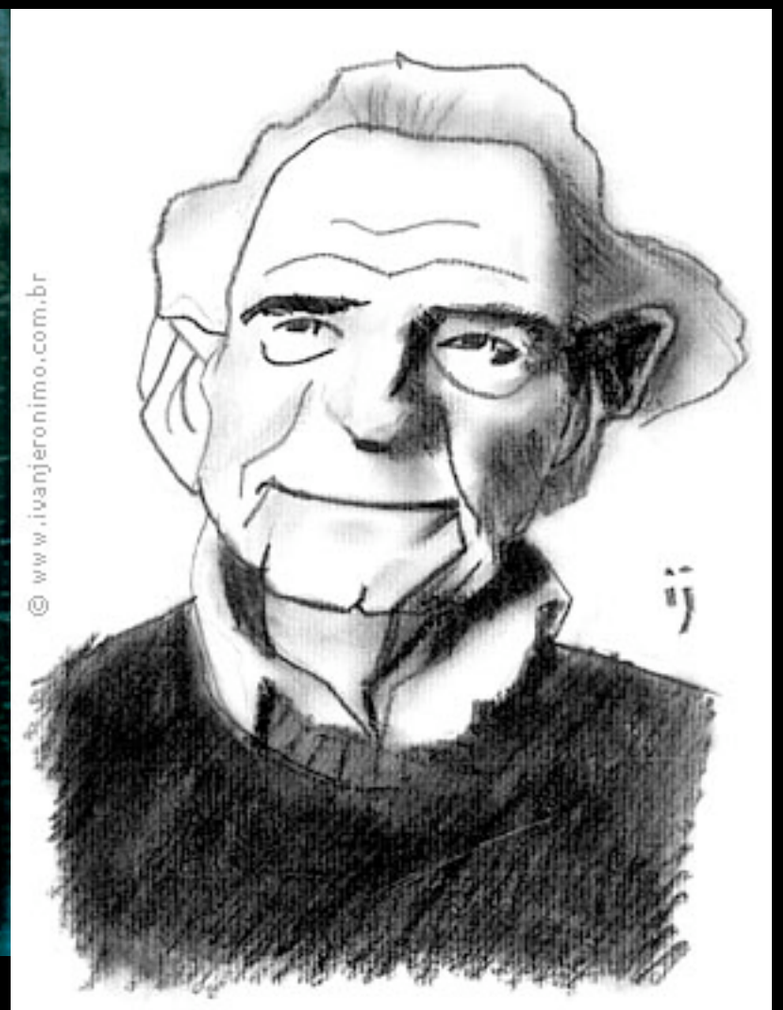
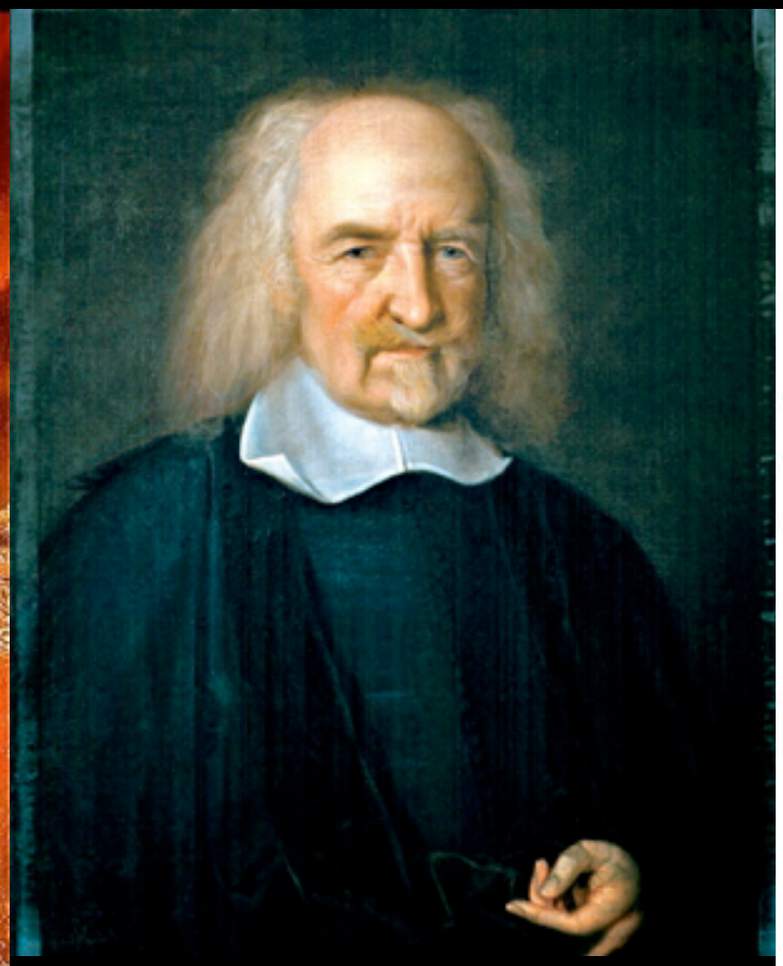


POPPER

THE SCIENTIFIC METHOD

"Science is perhaps the only human activity in which errors are systematically criticized and... in time corrected"

BACON



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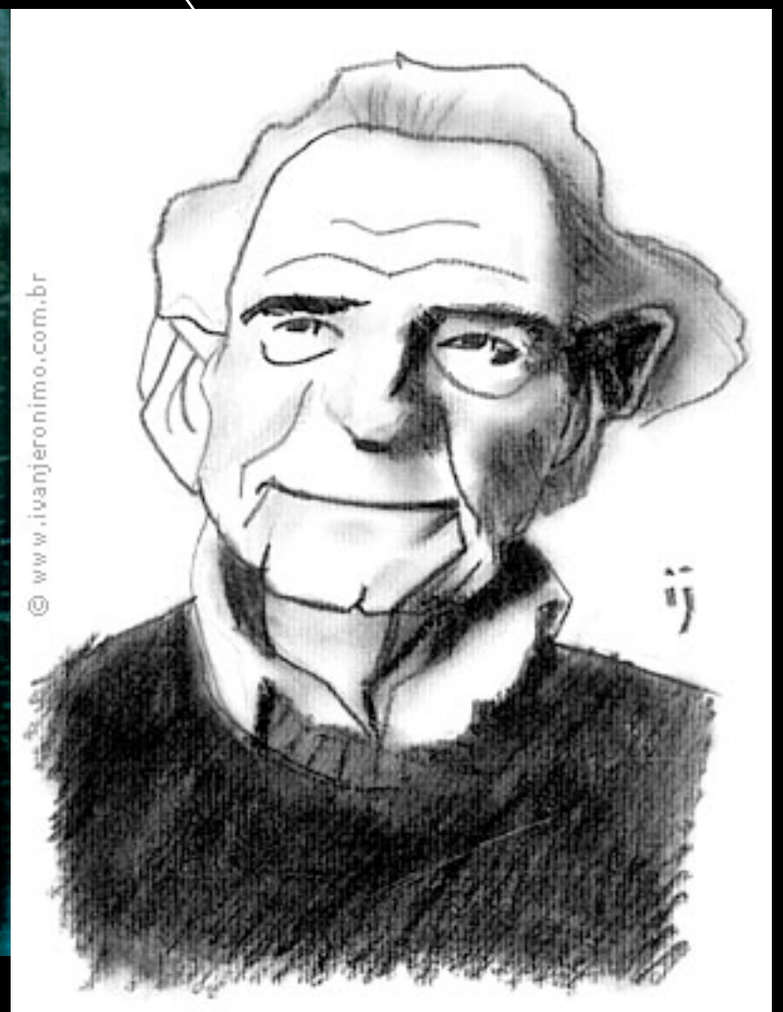


POPPER

1

See something.

2

Think of a reason why.

3

Figure out a way to check your reason.

4

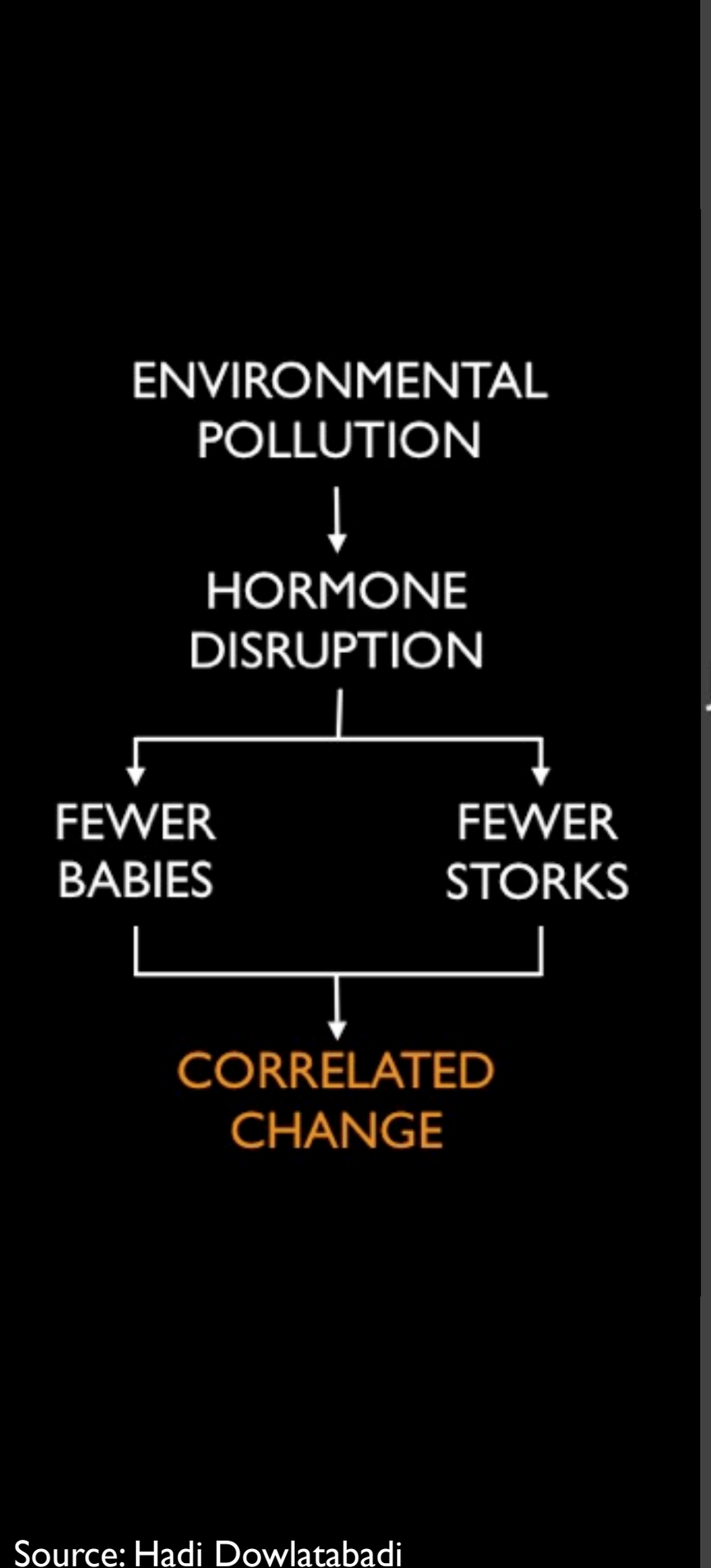
And?

5

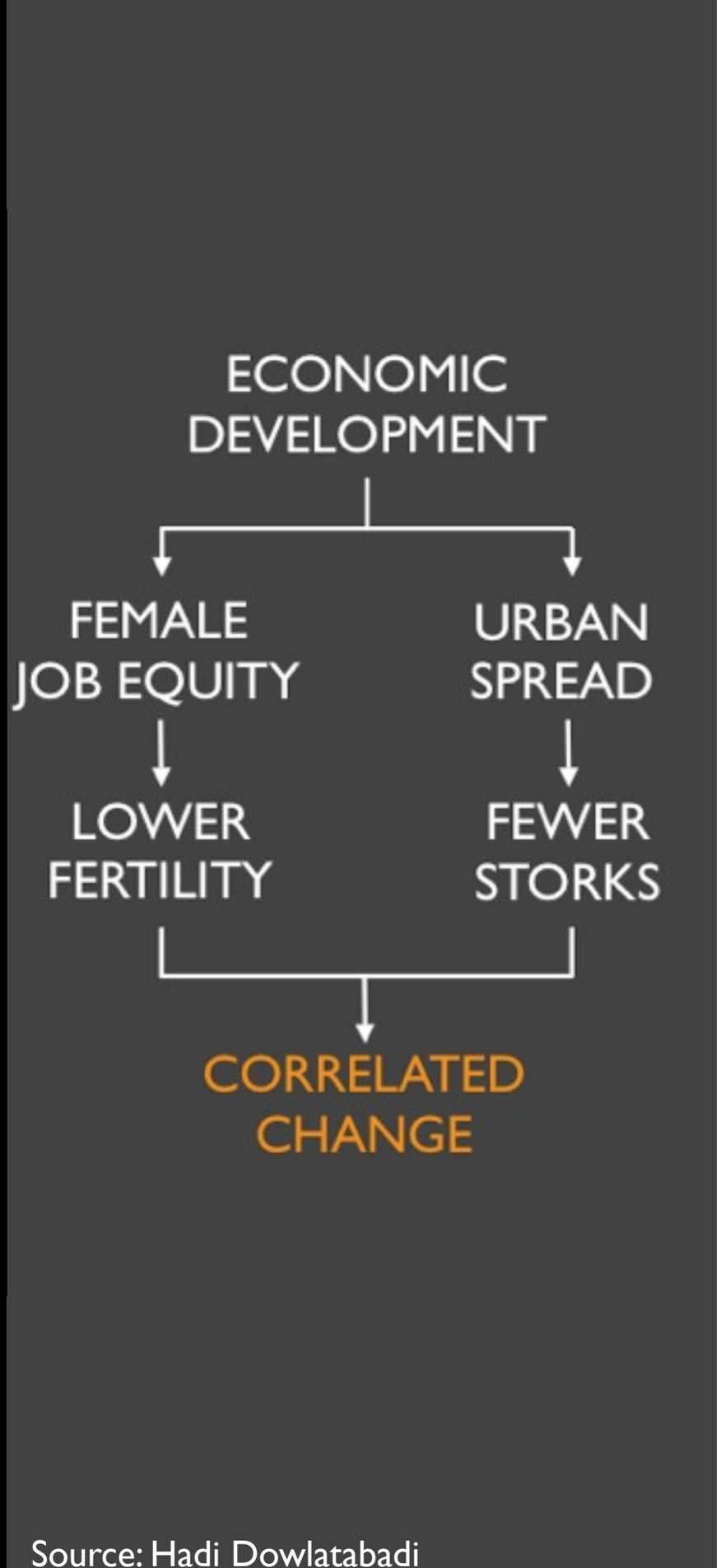
Now, everyone gets to dump on you.

6

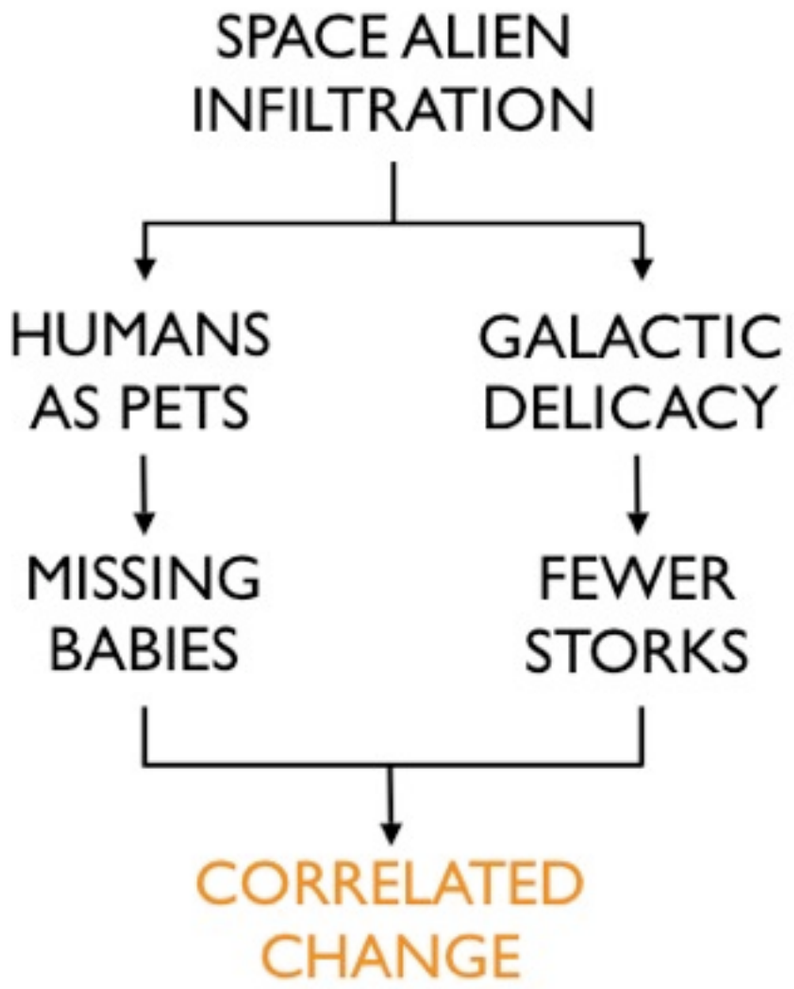
Repeat until consensus formed.



Source: Hadi Dowlatabadi

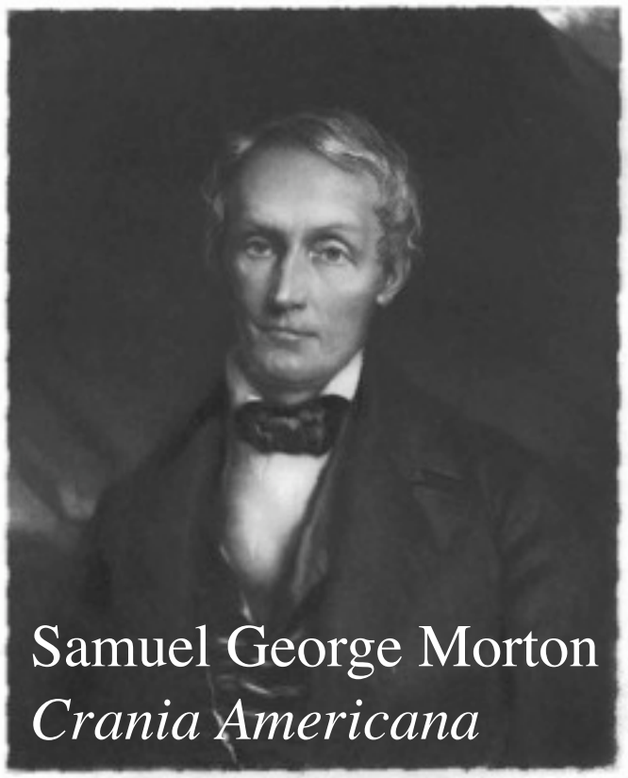


Source: Hadi Dowlatabadi

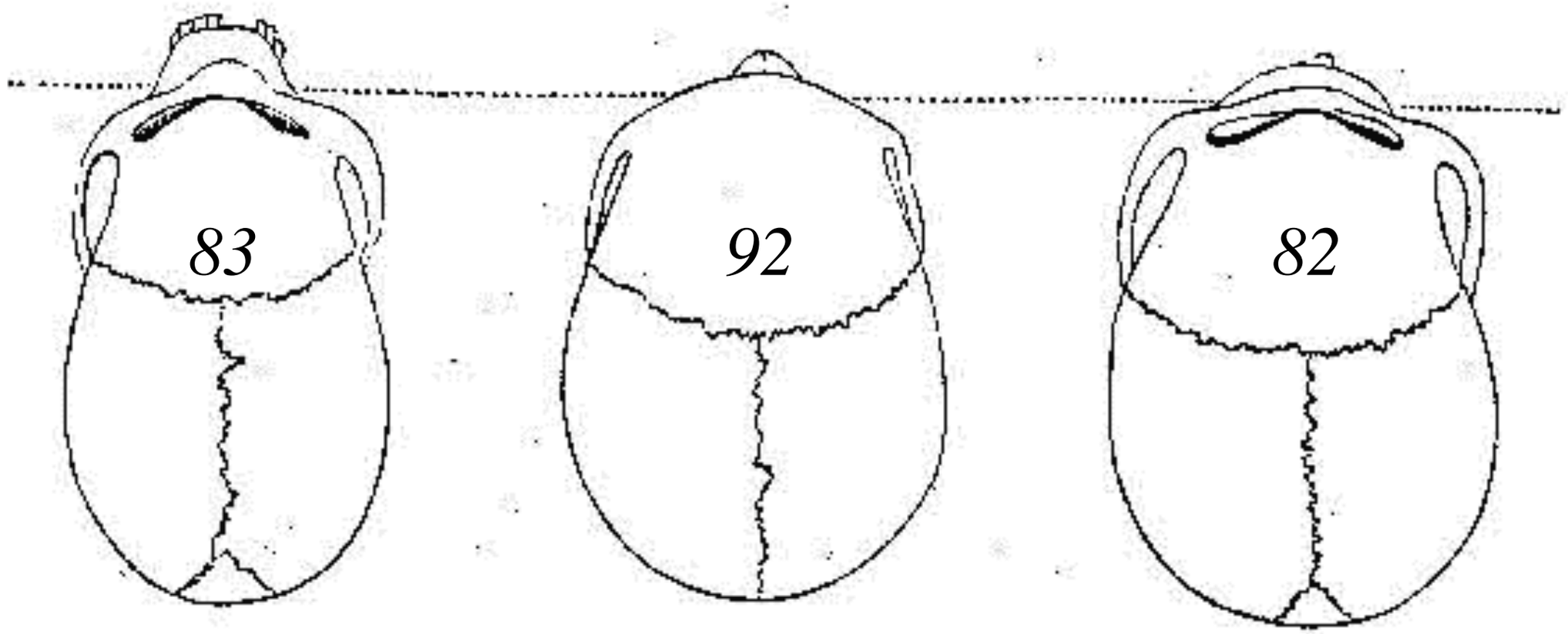


Source: David Ng

Methodology & Objectivity



Samuel George Morton
Crania Americana



Essay

Why Most Published Research Findings Are False

John P. A. Ioannidis

"I've just completed Mike's nature trick of adding in the real temps to each series for the last 20 years (i.e. from 1981 onwards) and from 1961 for Keith's to hide the decline."

~Phil Jones, Director, Climate Research

"The fact is we can't account for the lack of warming at the moment and it is a travesty that we can't."

~Kevin Trenberth, National Center for Atmospheric Research

Summary

There is increasing concern that most current published research findings are false. The probability that a research claim is true may depend on study power and bias, the number of other studies on the same question, and, importantly, the ratio of true to no relationships among the relationships probed in each scientific field. In this framework, a research finding is less likely to be true when the studies conducted in a field are smaller; when effect sizes are smaller; when there is a greater number and lesser preselection of tested relationships; where there is greater flexibility in designs, definitions, outcomes, and analytical modes; when there is greater financial and other interest and prejudice; and when more teams are involved in a scientific field in chase of statistical significance. Simulations show that for most study designs and settings, it is more likely for a research claim to be false than true. Moreover, for many current scientific fields, claimed research findings may

factors that influence this problem and some corollaries thereof.

Modeling the Framework for False Positive Findings

Several methodologists have pointed out [9–11] that the high rate of nonreplication (lack of confirmation) of research discoveries is a consequence of the convenient, yet ill-founded strategy of claiming conclusive research findings solely on the basis of a single study assessed by formal statistical significance, typically for a p-value less than 0.05. Research is not most appropriately represented and summarized by p-values, but, unfortunately, there is a widespread notion that medical research articles

It can be proven that most claimed research findings are false.

should be interpreted based only on p-values. Research findings are defined

is characteristic of the field and can vary a lot depending on whether the field targets highly likely relationships or searches for only one or a few true relationships among thousands and millions of hypotheses that may be postulated. Let us also consider, for computational simplicity, circumscribed fields where either there is only one true relationship (among many that can be hypothesized) or the power is similar to find any of the several existing true relationships. The pre-study probability of a relationship being true is $R/(R + 1)$. The probability of a study finding a true relationship reflects the power $1 - \beta$ (one minus the Type II error rate). The probability of claiming a relationship when none truly exists reflects the Type I error rate, α. Assuming that c relationships are being probed in the field, the expected values of the 2×2 table are given in Table 1. After a research finding has been claimed based on achieving formal statistical significance, the post-study probability that it is true is the positive predictive value, PPV

EXPERT PEER REVIEW

“We are skeptical of claims for the ability of random mutation and natural selection to account for the complexity of life. Careful examination of the evidence for Darwinian theory should be encouraged.”

“Evolution is a vital, well-supported, unifying principle of the biological sciences, and the scientific evidence is overwhelmingly in favor of the idea that all living things share a common ancestry. Although there are legitimate debates about the patterns and processes of evolution, there is no serious scientific doubt that evolution occurred or that natural selection is a major mechanism in its occurrence. It is scientifically inappropriate and pedagogically irresponsible for creationist pseudoscience, including but not limited to “intelligent design,” to be introduced into the science curricula of our nation’s public schools.”

Spoiler Alert