

# An Overview of Confirmation Bias in Science: Examples and Opportunities for Improvement

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# What is Confirmation Bias? Why is it a Problem in Science?

- The tendency to look for data that supports, rather than rejects, your hypothesis or preconceptions
- Typically done by interpreting evidence to confirm existing beliefs while rejecting/ignoring conflicting data
- It impact how we gather information, and influences how we interpret and recall information
- Effect stronger for emotionally charged issues and is reinforced with time
- Self-fulfilling prophecies in research can lead to distorted results, unnecessary costs, poor decision-making, statistical errors, and wrong conclusions



Pictures taken from How Confirmation Bias Works By Kendra Cherry; verywellmind 2/19/2020

# We are all subject to Confirmation Bias

- Consciously or unconsciously, cherry picking the selection of information we read in our choices of social media or published science literature
- Sometimes we even embrace it:
  - Political liberals have MSNBC
  - Political conservatives have Fox News
- Helpful quote from Warren Buffet:



“Human beings are best at interpreting all new information so that their prior conclusions remain intact”



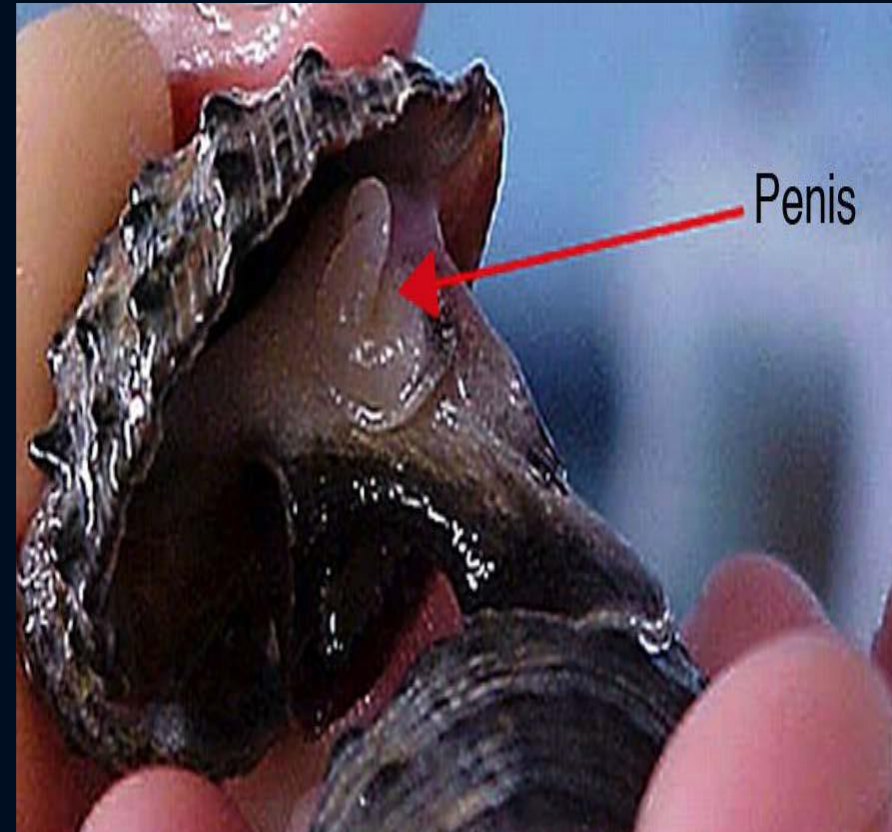
# A personal example of Confirmation Bias

- SETAC Pellston Workshop  
“Environmental Hazard and Risk Assessment Approaches for Endocrine-Active Substances” (held 31 January–5 February 2016 in Pensacola, Florida).
- 48 experts participated, bringing together scientists from around the globe representing a wide spectrum of scientific opinions.
- Overall workshop conclusion: If environmental exposure, effects on relevant taxa and life stages, and delayed effects and dose or concentration relationships are adequately characterized, then conducting environmental risk assessment of endocrine-disrupting substances (EDSs) is scientifically sound.



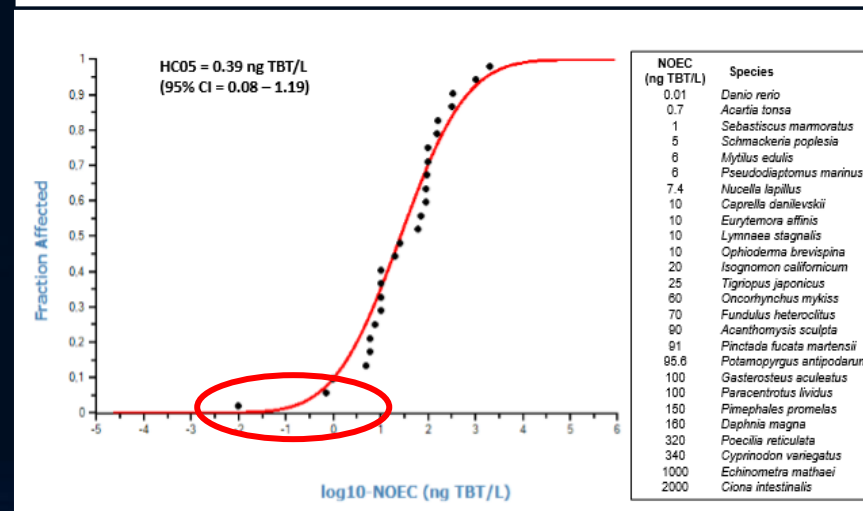
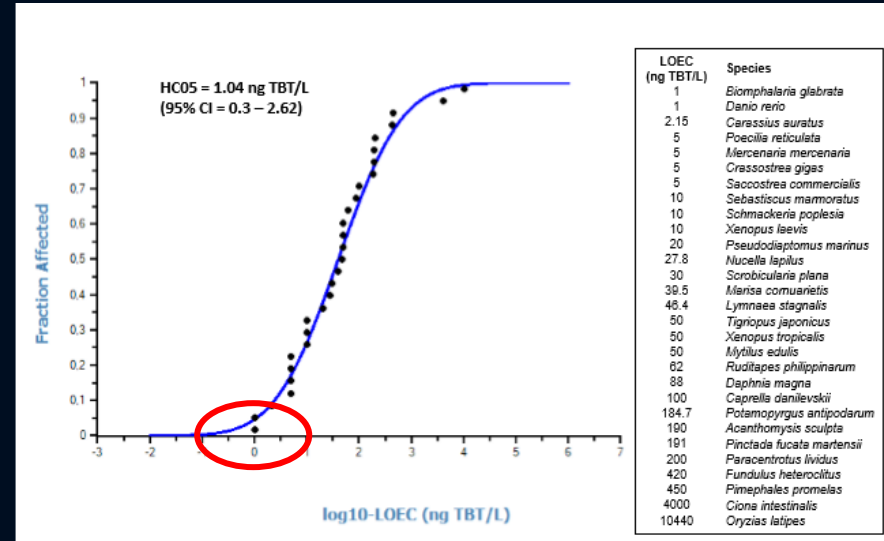
# Tributyltin (TBT) one of eight case studies

- Molluscs have long been recognized as uniquely sensitive to TBT (imposex)
- Our group was affectionately referred to as much as the mollusc group as it was the TBT case study
- Reviewed 160 studies on the MoA and effects of TBT in molluscs and other invertebrates, fish, amphibians, birds and mammals according to the OECD Conceptual Framework
- Information evaluated for reliability relevance (Klimisch scores) of biological effects in populations of aquatic animals and was used to construct Species Sensitivity Distributions (SSDs) based on NOECs and LOECs



# Big Surprise! Confirmation Bias Fooled us!

- TBT is highly toxic to a variety of aquatic taxa
- TBT is not a classic endocrine disruptor; it impacts reproductive and metabolic pathways primarily through interaction with the retinoid X receptor (RXR) and peroxisome proliferator-activated receptor (PPAR $\gamma$ ) nuclear receptors
- **Fish are even more sensitive than molluscs when based on water exposure**





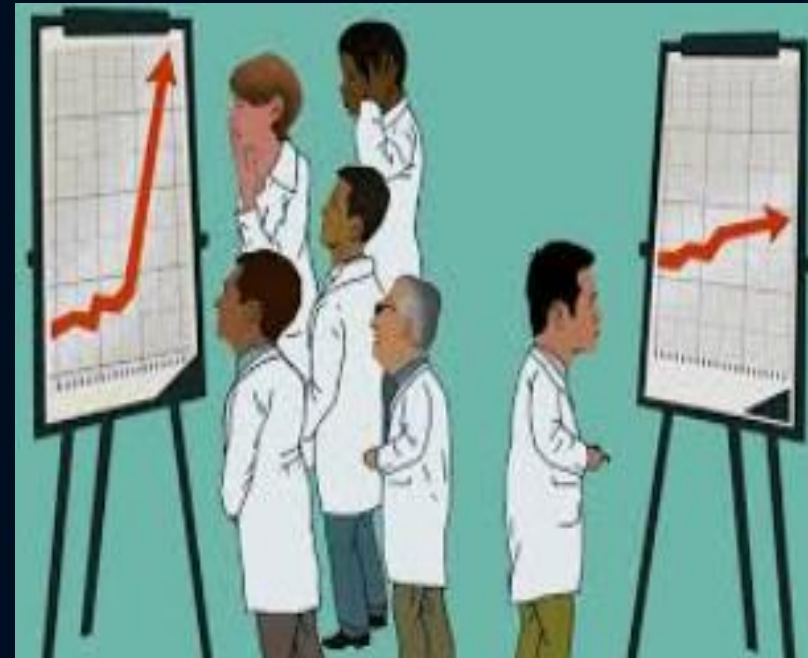
# Given the same set of climate change evidence, why are some people concerned while others remain unconvinced?

- Socio-political motivations may shape visual attention (bias) to climate evidence, altering perceptions of the evidence and subsequent actions to mitigate climate change
- 97% of actively publishing climate scientists agree that human activities are causing global warming (Cook et al., 2013, 2016)
- In the United States, public views on climate change tend to polarize along party lines
  - 86% of democrats vs. 42% of republicans agree most scientists believe global warming is occurring;
  - 4% of democrats vs. 69% of republicans think the seriousness of global warming is exaggerated;
  - 89% of democrats vs. 35% of republicans believe global warming is caused by human activities;
  - 91% of democrats vs. 33% of republicans worry about global warming



# What are the explanations for this polarization of opinions on climate change?

- It's likely not a lack of knowledge or understanding or insufficient awareness about the issue
- Increasing volume of data and evidence on climate change has been presented to the public regularly
- Individuals with high science literacy and technical reasoning skills not the most concerned about climate change, but rather they are the ones among whom polarization is the greatest
- People form perceptions of risks/controversial topics in ways that match the group value characteristic of groups which they identify
- Maybe not publication bias but stylistic biases in how climate change articles are written; the most prominent effects often reported in the abstract while lesser effects tend to be buried within the technical results sections



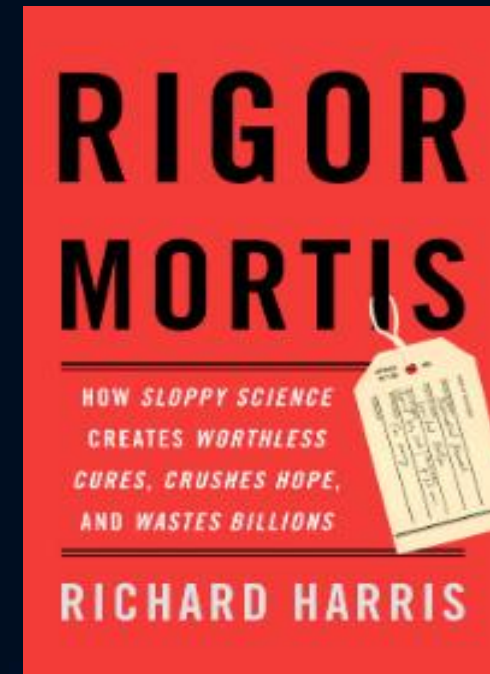


# Best practices for taking Confirmation Bias out of your experimental results

- Ensure an open and transparent research atmosphere where data and experimental design are examined and evaluated by everyone, especially those not working directly on the project.
- Encourage and carefully consider critical views on the working hypothesis.
- Confirm that all stakeholders examine the primary data. Do not rely on analysis and summary from a single individual or summaries of secondary literature.
- Design experiments to test the hypothesis honestly. Potential outcomes of an experiment should include the possibility to both prove and disprove the working hypothesis.
- Use blind studies and blind data analysis
- During experimental design, set the standard for what results support the hypothesis, what results disprove the hypothesis, and what results fail to provide useful information.

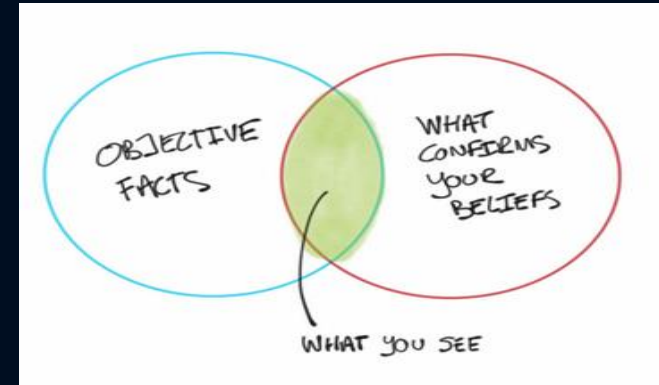
Adapted and expanded from Charles Rock and Jiangwei Yao January 17, 2018  
Research post: [Ways to take bias out of investigational results](#)

For more on the challenges in experimental science, read:



# Mitigating Confirmation Bias on a Personal Level

- Start questioning your research methods and sources to obtain information in a very deliberate and conscious manner
- Consider the possibility of beliefs and hypotheses other than your own which can help you gather information in a more dynamic manner (rather than one-sided)
- Try to be more aware of your own ideas and concepts and truly examine the basis upon which they are founded



Is your perspective balanced?