Bullshit Bingo

an incomplete collection of logical fallacies and other science crimes

Post hoc ergo propter hoc fallacy	Non-falsifiable claims	Circular reasoning	Equating correlation with causation
No randomization	Overlooking law of large numbers	Fail to apply Occam's razor	Biased sample
Sample size too small (anecdote as data)	Over-extrapolation of results	Not blind	No (good) control
Base rate fallacy	Not replicable	Finding hypothesis in the results	Extraordinary claim without extraordinary evidence

OCCAM'S BEARD — 1 FEBRUARY 2014

This Bullshit Bingo card contains (an incomplete selection of) painfully common errors in science and science communication. You can play Bullshit Bingo in journal clubs, conferences, or while reading the latest science digest in your local paper. But for the love of Occam, don't make these mistakes yourself!

Post hoc ergo propter hoc translates to: "after it, therefore because of it". If every time I have dinner I eat bacalhau first, and chocolate mousse later, this does not mean that eating bacalhau causes me to eat chocolate mousse.

Non-falsifiable claims are useless in science. If there is no scenario imaginable that would disprove the claim or theory, we can never be certain that it is true, and there is nothing to learn from it.

Circular reasoning can be well hidden in an argument. If an assumption is repeated as a conclusion, this is a red flag: "If we assume that Lisbon is in Portugal, we can conclude that Lisbon is in Portugal" is meaningless.

Equating correlation with causation happens all too often, particularly in science journalism. Per country, the size of the stork population correlates significantly with the number of annual births. Does this mean that storks bring babies?

Using proper **randomization** when dividing test subjects into control and test groups is vitally important. Without this, the composition of these groups could be biased, invalidating the experimental results.

The law of large numbers states that with an increase in sample size, the observed effect will become less extreme. When a comparison is made between the 'before' and 'after' of an intervention, the resulting difference may simply be a consequence of an increasingly large sample on one side of the equation.

Where would we be **without Occam's razor**? This principle states that the simplest explanation is often the best: beware of overcomplicating factors that add nothing, and are simply unnecessary to explain the data.

Understand the properties of the sample used in the experiment: how were they chosen? If the **sample is biased** from the get go, this restricts the conclusions that can be drawn from the experiment.

An anecdote is not data. However shocking an observation may be, **a small sample** cannot prove a hypothesis.

Over-extrapolating results can turn a valid experiment into a wild story. The data and the story may be consistent with each other, but this does not mean the data is evidence that the story is true. Speculation is not the same as a conclusion.

Scientists are human, and human expectations may confound their observations. Ensuring that observations and measurements **are made blind** (without knowledge of the test category) is therefore important to ensure accurate results.

Controls are incredibly important: any data linked to a treatment cannot be valued unless it is compared to data in the absence of this treatment. Beware of the pseudo control: a good control group undergoes exactly the same process as the test group, except for one crucial ingredient.

The **base rate** of an observation (the frequency with which it occurs) is highly relevant in determining the accuracy of a detection method. For example, if 1 in 10 000 people have a disease, and the test for it is 99% accurate (1 in 100 will be a false positive) a positive result is 100x more likely to be false positive than real.

Experiments should be **replicable**, and preferably replicated. If something only worked 'that one time' under very specific conditions, the result is likely a fluke.

Don't look for a **hypothesis in the results**: a large enough data set is bound to have some significant correlations that don't mean anything. See xkcd.com/882 for a great example.

Extraordinary claims require extraordinary evidence. Outlandish statements that go against prevailing theory may be true, but they do need to bring a lot of high quality evidence to the table to be considered. Prevailing theory is prevailing for a reason.