Errors in statistical reasoning and judgement biases

Dr. Peter Howley

Professor of Behavioural Economics

Leeds University Business School

Web: https://business.leeds.ac.uk/divisions-economics/staff/126/dr-peter-howley

Things I want you to be able to do

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Understand the role that chance/luck plays in observational data

Awareness of the danger in extrapolating from small samples

Minimize instances of bad judgment and address weak spots in our reasoning

Be able to explain the following in your own words

1. Law of small numbers

2. Regression to the mean

3. Confirmation bias

1. Small samples – law of small numbers

- Small samples yield extreme results more often than large samples do

  - be careful to distinguish between **causal effects and pure luck**!

  - Random events do not lend themselves to explanation but **people are conditioned in trying to explain everything!**

  - Can lead to problems: Think through this exercise taken from *Thinking fast and slow* by Daniel Kahneman

  Imagine we are concerned with examining differences between rates of kidney cancer between urban and rural states in the US

  - *Can anybody think of a useful hypothesis to test*

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Imagine we are concerned with examining differences between rates of kidney cancer between urban and rural states in the US

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   1. We could hypothesis that rates will be lower due to 'clean living' or we could hypothesis that rates will be higher due to less medical care or income differences

Small samples – law of small numbers

- We could examine the data and find that rates are lower in rural areas and hey presto we have a ready made hypothesis to **explain** the pattern - The result (newspaper headline): *Incidence of kidney cancer are much higher in urban areas!*

- We could examine the data next year and find that rates are higher in rural areas and hey presto we again have a ready made hypothesis to **explain** the pattern!

- Either result could be an **accident of sampling**: Large samples are much more precise than small samples and small samples yield extreme results more often than large samples

Part of the problem is that we **focus on the story over reliability**, or, robustness, of the results.

Small samples can led researchers at the mercy of sampling luck

An illustration from our first lecture

- Take a set of six babies born at random at hospital. Which of the following sequences are most likely?

    - BBBGGG

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Because the events are independent and because the outcomes B and G are equally likely, then any possible sequence of six births is as likely as any other

People are somehow conditioned to like patterns (don't like to think of the world as an inherently random place)

Law of small numbers in action

- **Polish village hasn't seen a boy born in nearly 10 years!:** most recent 12 babies all having been girls.

- The mayor of the region is quoted in an article as saying there has been "scientific interest" – presumably from geneticists – in exploring what has led to this unusual sequence. He also discusses some glaringly unscientific advice the town has been given on how to conceive boys, ranging from changing mothers' diets to "keeping an ax(e) under your marital bed".

- What is the probability of having 12 girls born in a row in Miejsce Odrzanskie - $(½)^{12} = 1/4096$.

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- What is the probability of having 12 girls born in a row in Miejsce Odrzanskie - $(½)^{12} = 1/4096$.
- Wrong question – question should be what is the probability of having 12 girls born in a row in a village somewhere – given number of villages its quite high!

Take home message

- The law of large numbers describes the regular behaviour of chance behaviour in the <u>long run</u>

- Many people believe in the **law of small numbers**
- **we falsely expect even short sequences of random events to show the kind of average behaviours that in fact only appears in the long run**

In statistical speak: Dangerous to extrapolate from small sample sizes as the data might not be representative of the distribution

Note: the discussion in relation to power analysis as part of our Laboratory experiments lecture is helpful here

2. Regression to the mean

◆ The regression to the mean concept states that given a series of random, independent data observations, an unusual occurrence tends to be followed by a more ordinary event.

◆ Hence, chasing last year's winning mutual fund is likely to be a losing strategy, although many people do precisely this.

Medical intervention

Lets set up a medical experiment to test the hypothesis that hugs from cats can improve mental health

- Take a group of children identified as suffering from psychological distress (e.g. we select 100 children who all score below average on some metric of psychological well-being)

    - What would likely happen if they were 'treated' with hugs from cats over a 3 month period?

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  - What about treated with energy drinks for 3 months?

  - What about if they were kicked in the shins once a week for 3 months?

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V

V

Medical intervention

Lets set up a medical experiment to test the hypothesis that hugs from cats can improve mental health

- Take a group of children identified as suffering from depression

  - What would likely happen if they were 'treated' with hugs from cats over a 3 month period?

  - What about treated with energy drinks for 3 months?

  - What about if they were kicked in the shins once a week for 3 months?

- **Regression to the mean coupled with painting a picture**

- In any series with complex phenomena that are dependent on many variables, where chance is involved, **extreme outcomes tend to be followed by more moderate ones – regression to the mean!**

Further examples

- Think about investing in stocks

- What about sports performance

- Visit a herbalist and obtain a remedy for backache – what often happens?

- People do not recognize a probabilistic process, random fluctuations, or the presence of variations

- Policy makers often get overly-excited about minor changes in unemployment rates or GNP growth

- Overestimate the effect of policy interventions when chance alone causes changes (e.g. regression to the mean)

3. Confirmation bias

The human understanding when it has once adopted an opinion draws all things else to support and agree with it ......(Francis Bacon, 1620)

The confirmation bias is the tendency to find and interpret information to confirm existing beliefs.
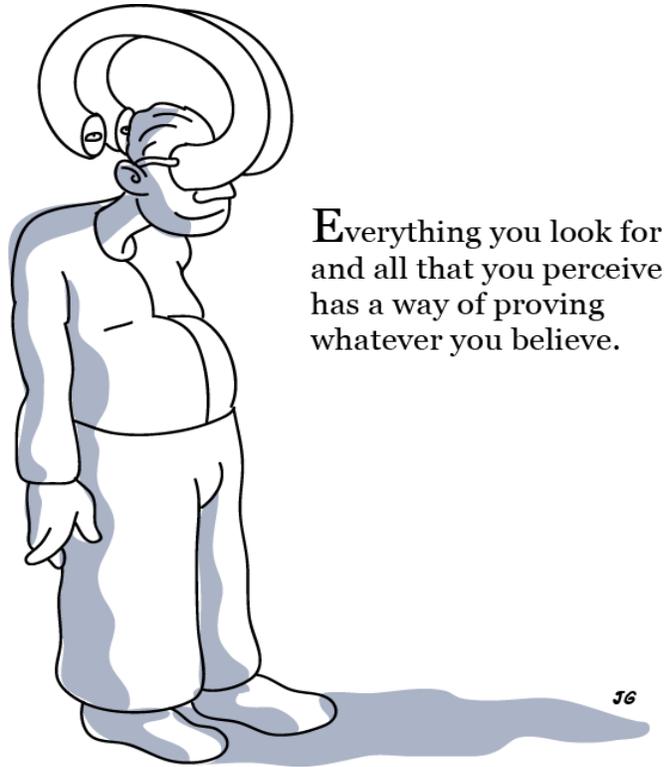
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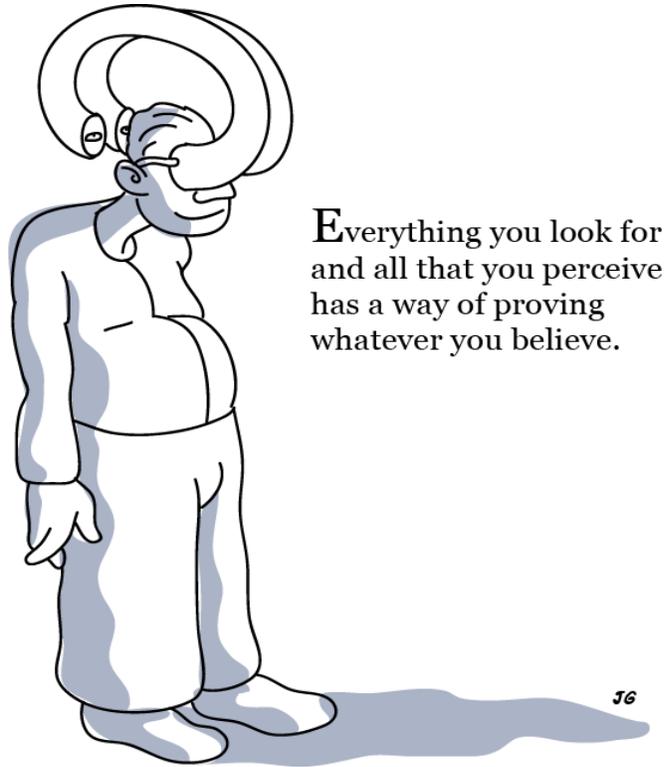
The confirmation bias leads people to…

…Seek information that confirms expectations (seeing what one is looking for)

….Once one has taken a position on an issue, one's primary purpose because that of defending/justifying it

Can anybody think of any examples:

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Everything you look for and all that you perceive has a way of proving whatever you believe.

The confirmation bias leads people to…

…Seek information that confirms expectations (seeing what one is looking for)

….Once one has taken a position on an issue, one's primary purpose because that of defending/justifying it

Can anybody think of any examples: Provides an explanation for why people can believe in clairvoyants, mind readers and Brexit often with very little evidence
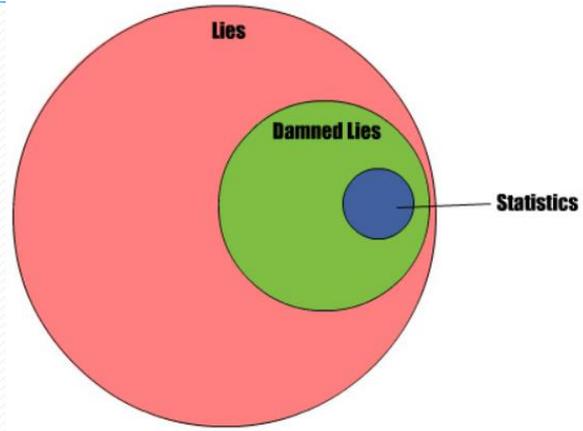
Confirmation bias

- How do you think clairvoyants get away with this?
    -pretty easy to demonstrate proof, e.g. set up an experimental trial

- But they play on people's judgement biases
    When they say it only works when you believe!

- *What they are really saying is* - it only works if you suspend rational thought and only seek out evidence in support of the existence of an a priori belief that I can talk to the dead

- **We tend to cherry pick information that conforms to our existing beliefs**: **Biased assimilation and attitude polarization** – Lord et al., (1979): *Journal of Personality and Social Psychology*.

Extra reading

- Regression to the mean: https://fs.blog/2015/07/regression-to-the-mean/

- Regression to the mean delusion: https://www.youtube.com/watch?v=jyfNZ_vSCLc

- The small sample fallacy: https://www.youtube.com/watch?v=sgZQMJQRwRM

- Another interesting discussion piece: https://theconversation.com/how-to-increase-your-lottery-winnings-and-succeed-in-business-by-being-contrary-108784

- Confirmation bias: **Biased assimilation and attitude polarization** – Lord et al., (1979): *Journal of Personality and Social Psychology*.