

Heads and Reds

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18 November 2008

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* For helpful discussions, I thank Bert Van Landeghem, Steve Stillman, and Michael Wolf.

Evidence is vital

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The difficulty is this.

**Humans have a tendency to
see patterns in data when
there are none.**

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I want

- **To illustrate why**
- **To make suggestions about how I attempt to do persuasive empirical work**

Imagine I run a laboratory.

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My name is Andrew.

I have a collaborator

I have a collaborator

Amanda

We have a theory

**We call it Time of the Day
Effects.**

We think Isaac Newton was not quite correct on gravity.





**I am working on coin-tossing
-- heads and tails.**



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-- heads and tails.**

**I do so 6 times in the
morning, and 6 in the
afternoon – for 7 days**

**In the other experiment,
Amanda is spinning a
roulette wheel.**



She also does it 6 times in the morning, and 6 in the afternoon – for 7 days.

**Our total observations are
therefore 168.**

**We agree to collaborate and
to send a paper to the
Journal of Scientific
Discoveries.**

Our paper becomes famous

Our paper becomes famous

**“ Gravity Works Differently
on Wednesday Afternoons.”**



Stockholm beckons, we think?



But the key question



How likely are Andrew and Amanda to be able to write a paper (with random data) with a time-of-the-day effect that is statistically significant?

The answer is:

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Extremely likely.

**Say we are looking for a run
of six heads or tails ($p < 0.02$)
in a morning or afternoon.**

The probability of throwing a coin 6 times in a row and getting a head each time is one half to the power 6.

The probability of throwing a dice 6 times in a row and getting a head each time is one half to the power 6. Write this as $(0.5)^6 = 1/64$.

**The probability that EITHER
Amanda or I find a result is**

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***1 – probability there will neither
a Heads-or-Tails Run nor a
Red-or-Black Run.***

**The probability that there will
be neither is $(31/32)^{28} = 0.41$.**

So 59% of the time we will be able to write a paper proving, in a way that greatly exceeds the ninety-five confidence level, some version of “Heads come up on Wednesday afternoons”

In seminars

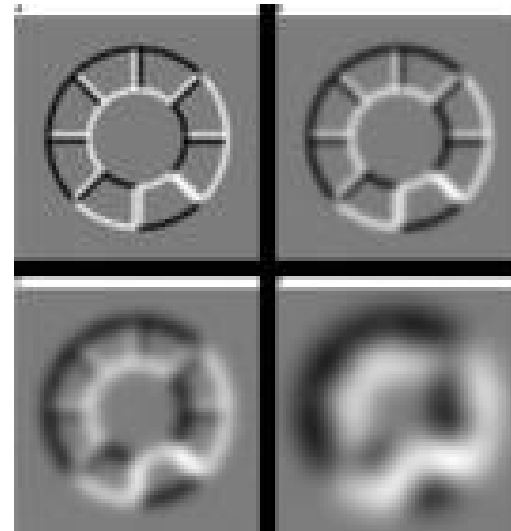
Amanda and I always say, correctly, to critics: “but our result is significant at the 0.02 level.”

Yet our paper is wrong.

***The pattern is an illusion
caused by too much
searching.***

In practice

How should we proceed in a world where the truth is blurry?



3 Suggestions



My personal checks

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- **Test for your key pattern in sub-samples.**

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- **Ask whether you made up your theory ex post.**

My personal checks

- **Test for your key pattern in sub-samples.**
- **Ask whether you made up your theory ex post.**
- **Ask: did you pre-search?**

**Replication is the best
check.**

The underlying point

Humans' minds work so flexibly that they can see convincing patterns when there aren't any.

**Thank you, and good luck
with your empirical work.**

Evidence matters.

Heads and Reds

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