WEBINAR

What does Null Hypothesis Testing Actually Achieve?

XLSTAT

ROGER WATT

BA, PhD FRSE Emeritus
Professor of Psychology
at University of Stirling

April 10

11 A.M EDT

Moderator

Thalia Anagnostou holds a Master's degree in Operational Research from the University of Edinburgh. After learning about the challenges and needs of data analysts in various industries and countries, Thalia has made it her mission to support data software users through webinar series, community events, and educational content. As a Customer Engagement and Enablement Manager at Lumivero, her goal is to support customers through webinar series and user group meetings focused on data science, qualitative research methods and scientific writing.

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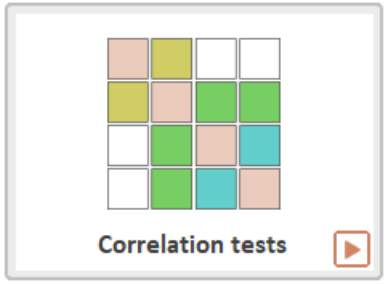

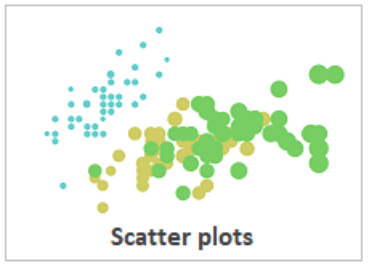

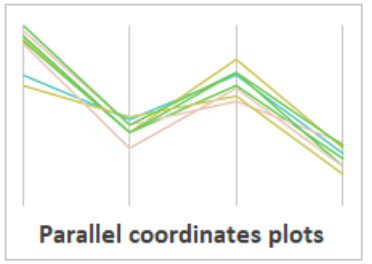

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Presenter

Prof. Roger Watt

Roger Watt did his BA at Cambridge (UK) where he became fascinated by the idea that maths could be used to explore human behavior and experience. He did his PhD at Keele (UK) in a department of engineers studying the senses of vision and hearing. He was appointed to a chair of Psychology at Stirling University in 1988, a post he held for 32 years until retirement. In 1995 he was elected Fellow of the Royal Society of Edinburgh. His research into human vision resulted in ~100 papers and 2 monographs. For many years, he taught statistics to (typically unwilling) Psychology students, continually refining how statistics was conceptualized presented.

Roger Watt BA, PhD, FRSE, Emeritus Professor of Psychology, University of Stirling

Outline

- **Two processes:**
  samples from population
  population from samples
- **Null hypothesis testing:**
  p-values
  possible inferential errors
- **NHST in action:**
  population effect sizes
  actual inferential errors
- **Possible improvements:**
  sample size
  alpha
  false hypotheses

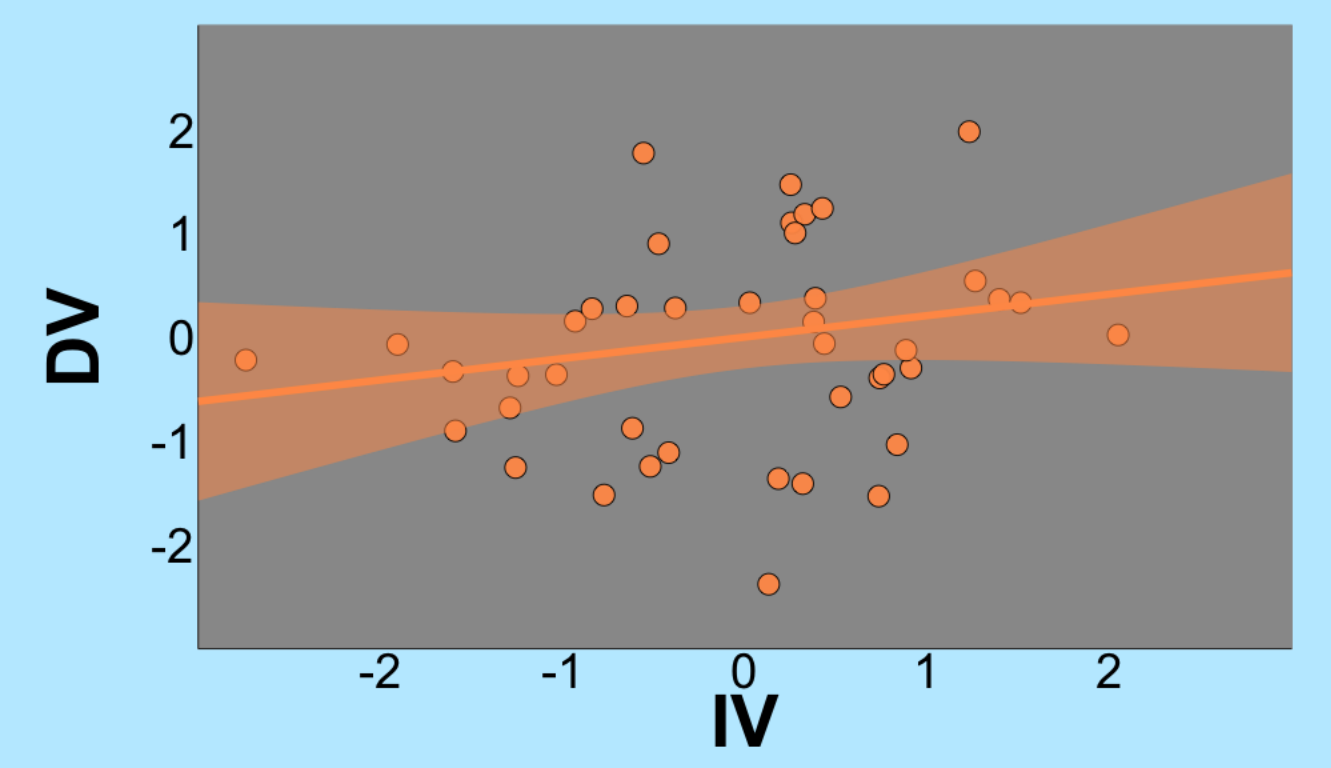
01 Two Processes

Sample vs population effect sizes

1. A typical sample

effect-size: how strongly one variable is related to another.
We will use r (aka correlation coefficient)

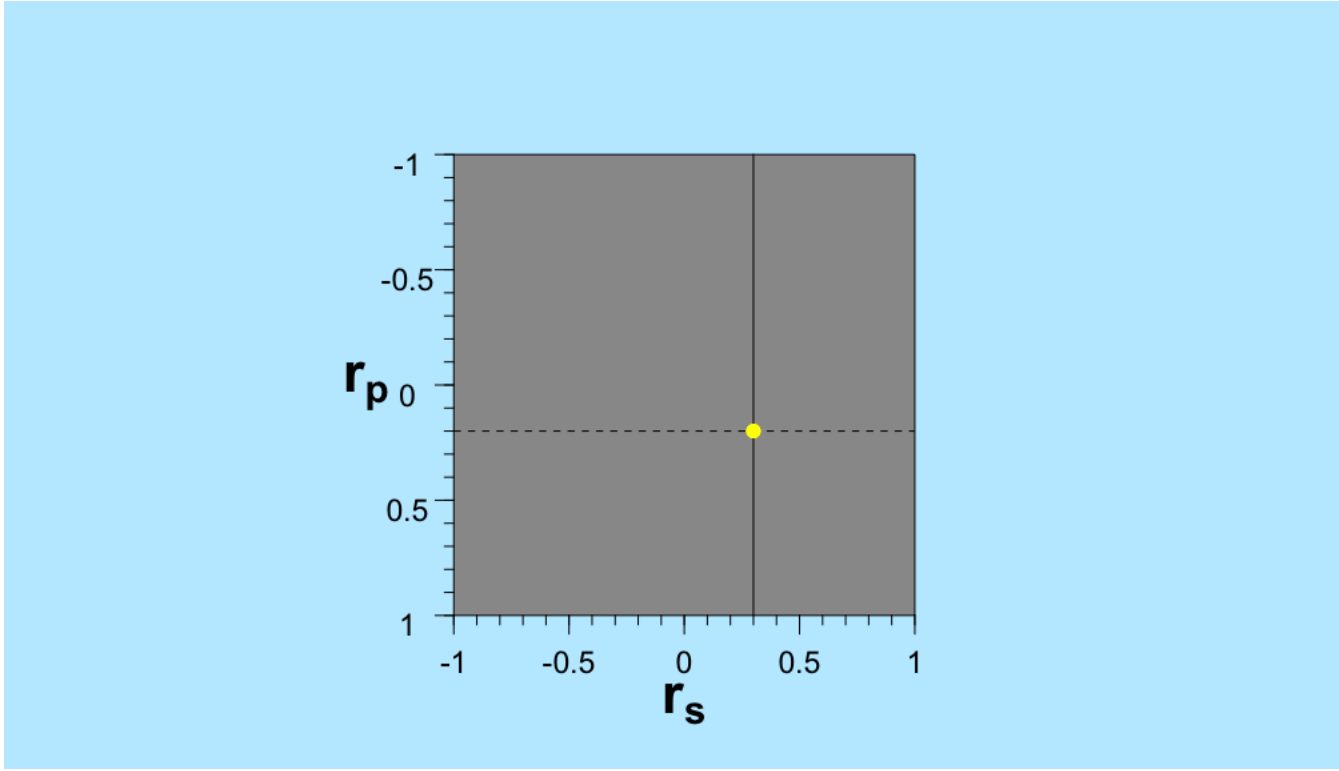
Here is a sample $r_s = 0.3$ $(n = 42)$



2. Another way of showing samples

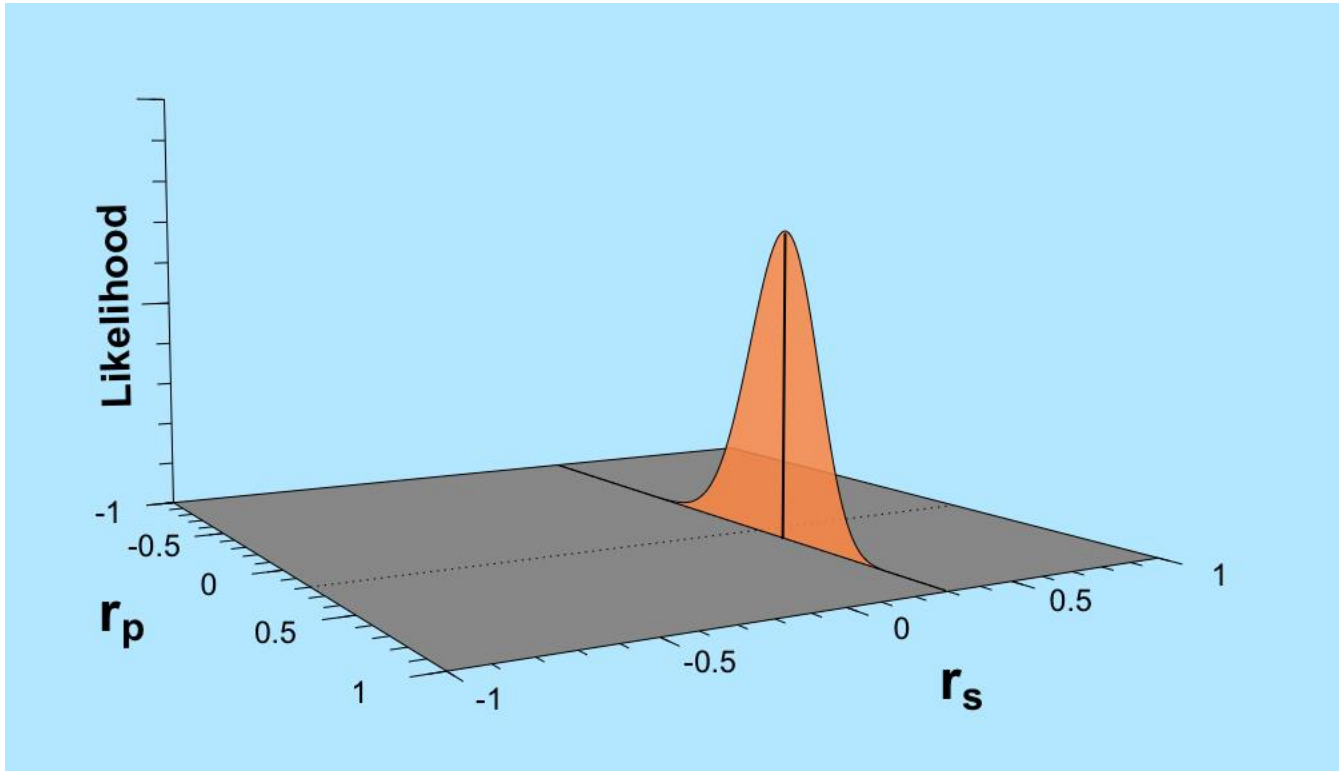
r_p population effect size (usually unknown)

r_s sample effect size (known)



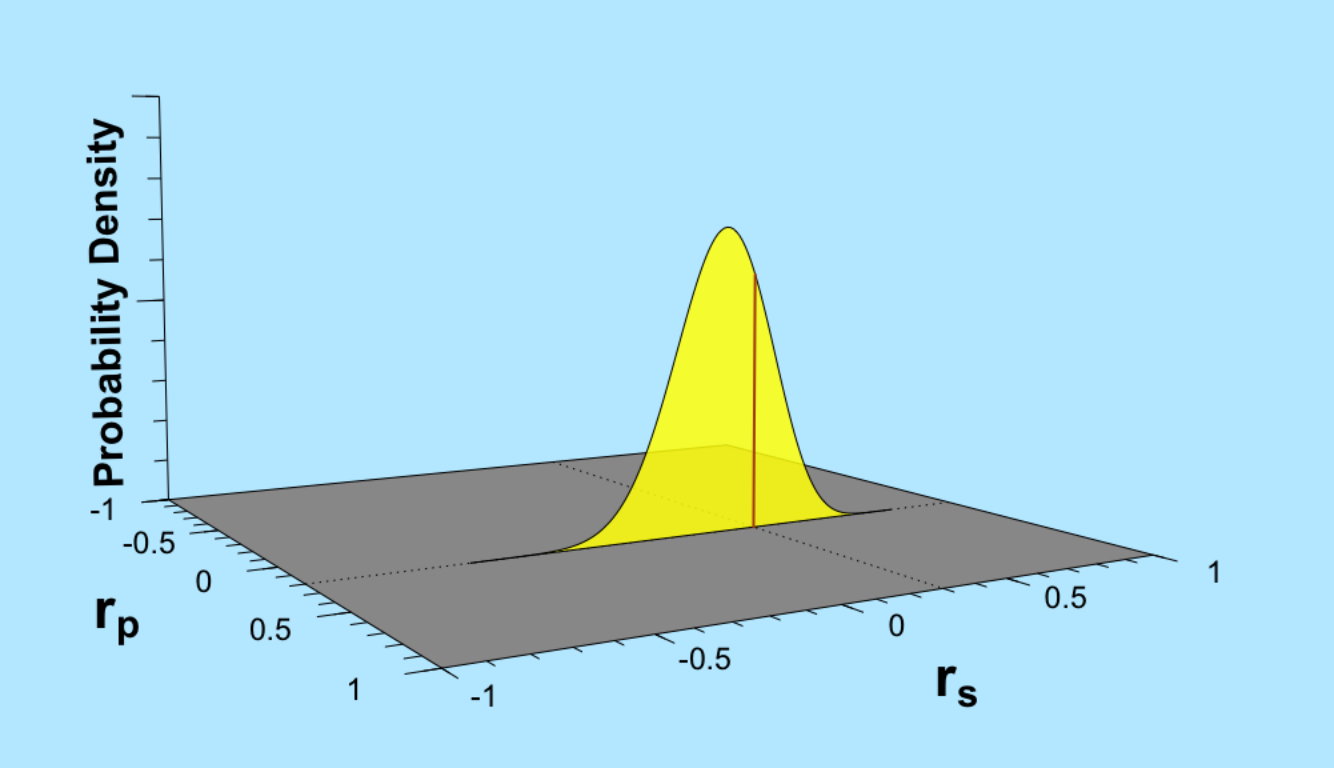
3. Likelihood function

What we want: population that produced our sample



4. Sampling distribution

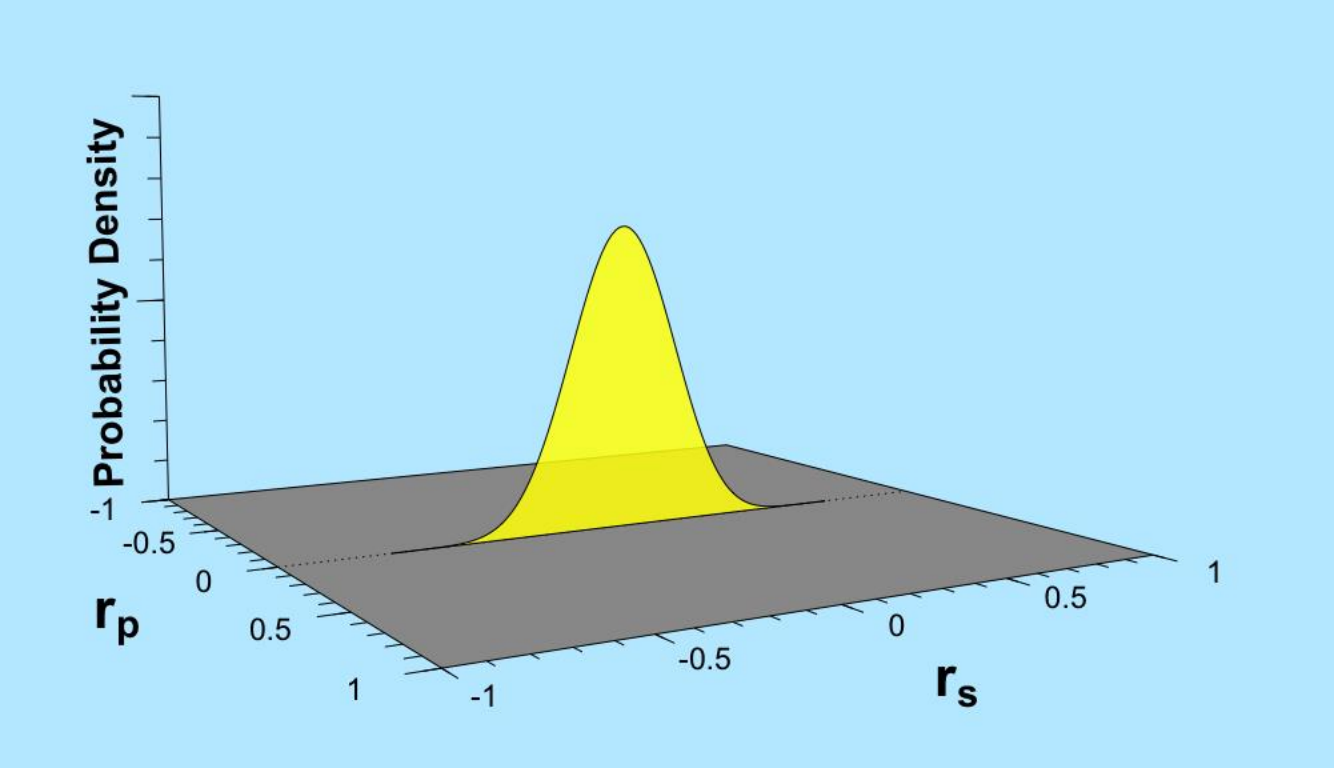
What we have: samples that a population will produce



NHST:
Null Hypothesis Testing

1. The Null Hypothesis

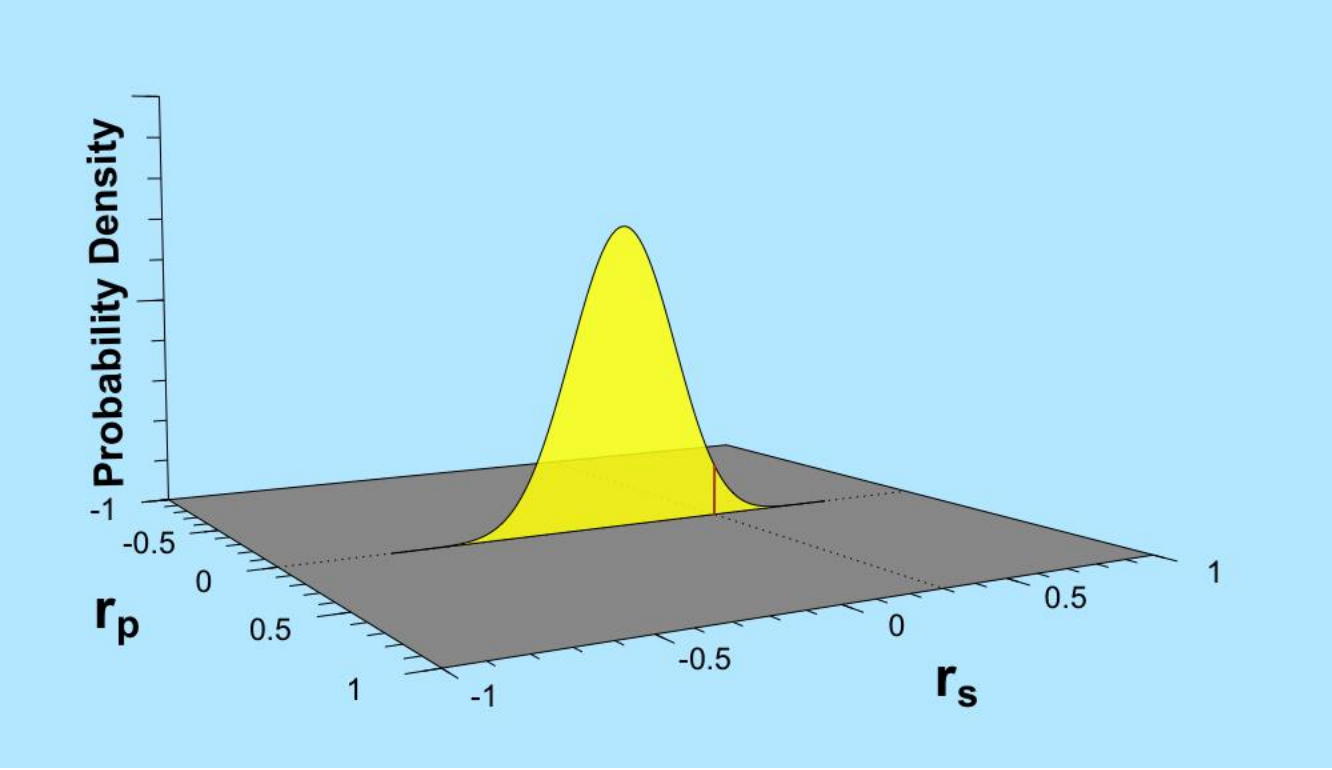
We know the expected samples from the null hypothesis…



1. The Null Hypothesis

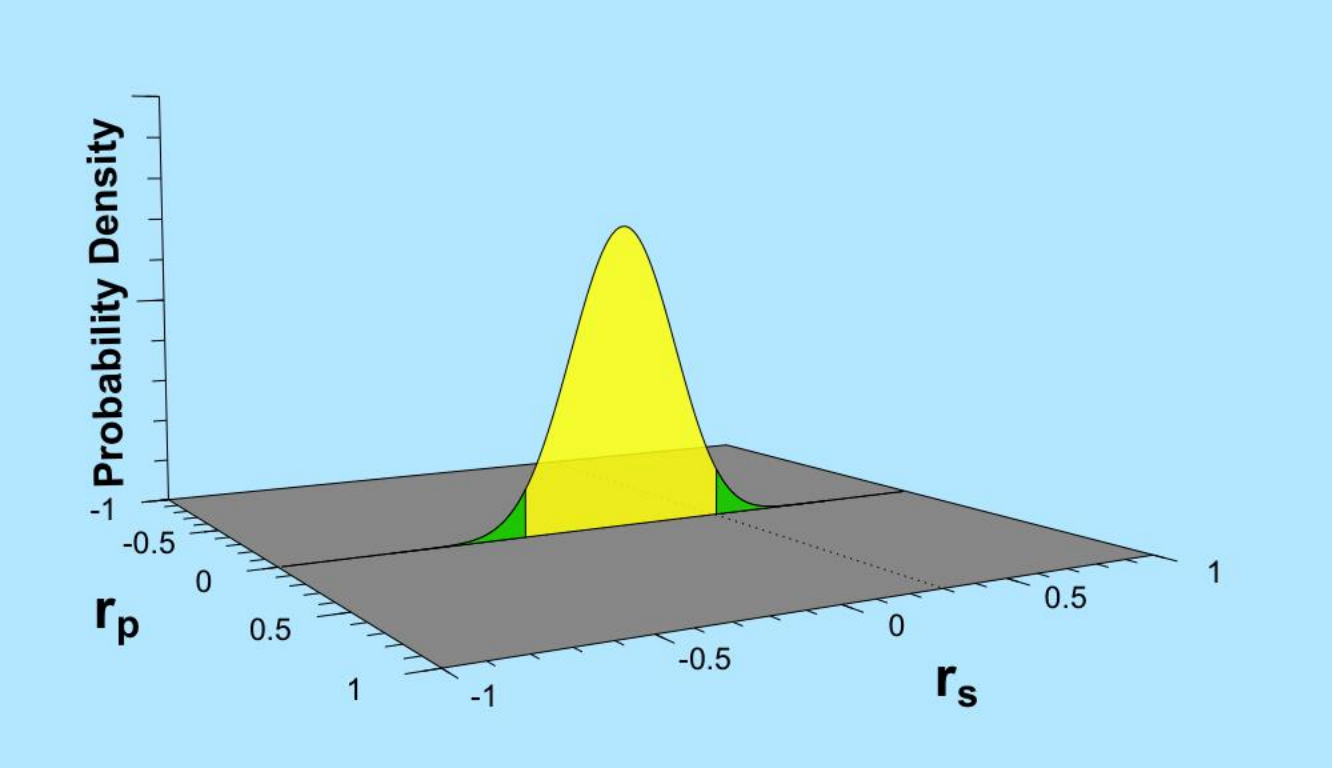
We know the expected samples from the null hypothesis…

…we can compare our sample with it.



2. The p-value

We ask how often the null hypothesis would produce a sample effect size at least as large as ours: $|r_0| \geq r_s$



3. The test

The convention is this:
If the p-value is less than 5%,
the NH will not often produce this sample
then we say that
the NH did not likely produce this sample.

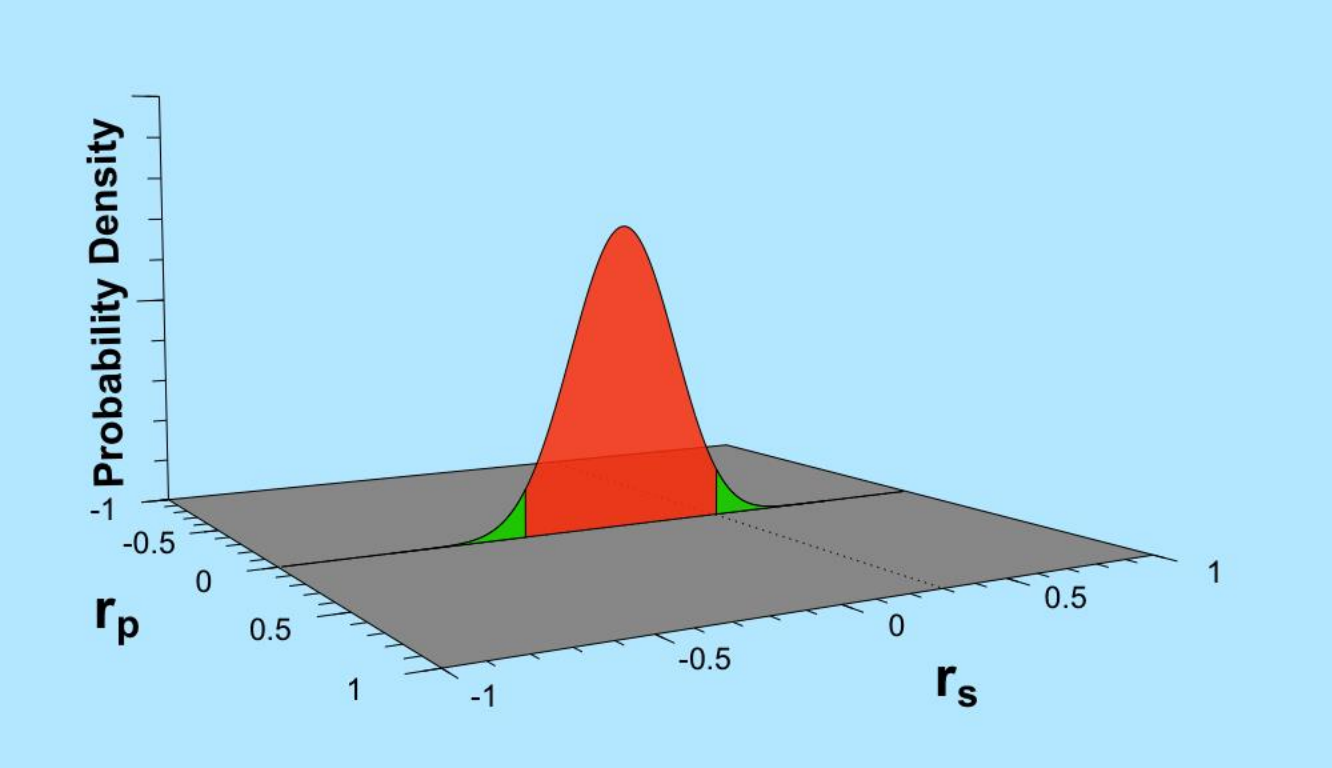
And we must accept that:
- we have only tested the NH
- so can only reach in inference about the NH

We either reject the NH or we infer nothing.

Notice the change in tense.
This tells us that something is not quite right.

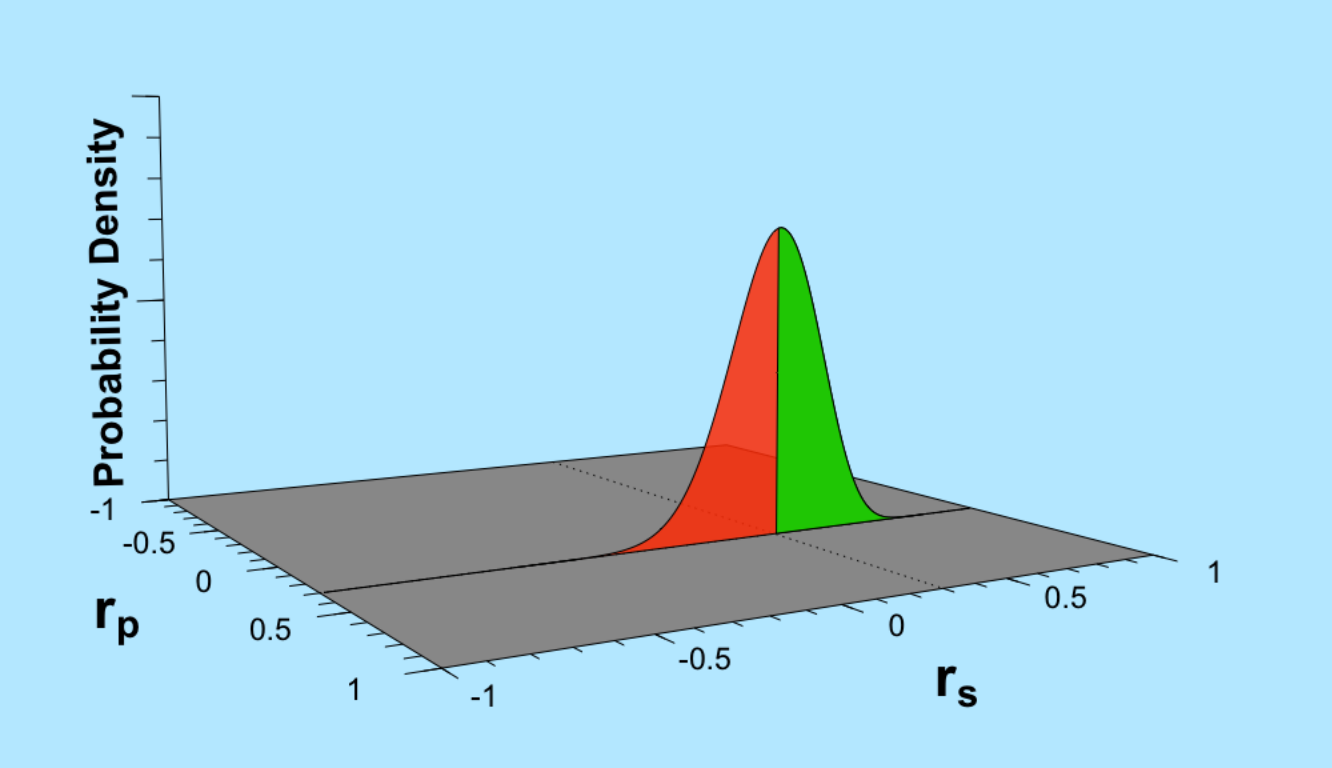
4. Inferential errors

When the NH is correct…
…all the samples in green will lead us to reject the NH: **errors**.



4. Inferential errors

When the NH is false…
…all the samples in red will lead us to fail to reject the NH: **errors**.



4. Inferential errors

Ignorance is not bliss.

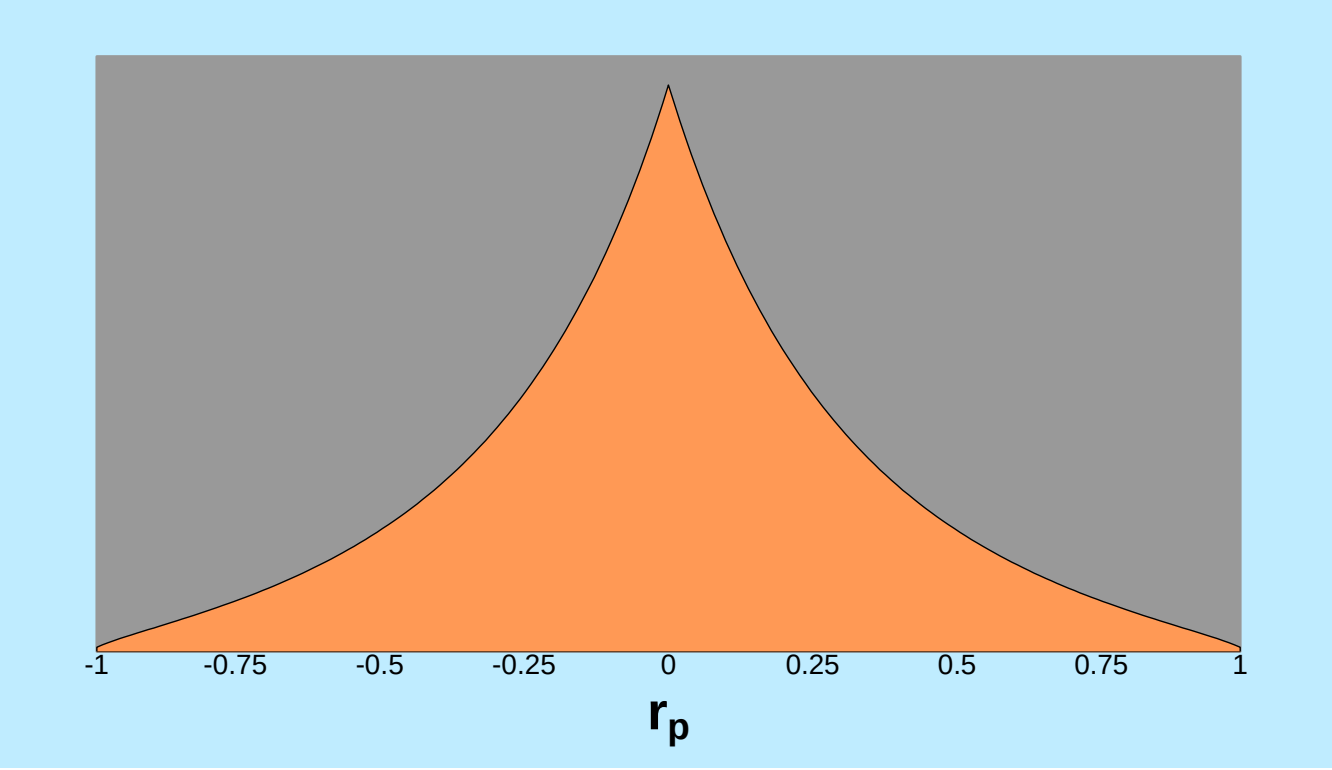
Since we don’t know whether the NH is correct or false,
we don’t know whether our inference is **an error**.

03. NHST in action

In the real world?

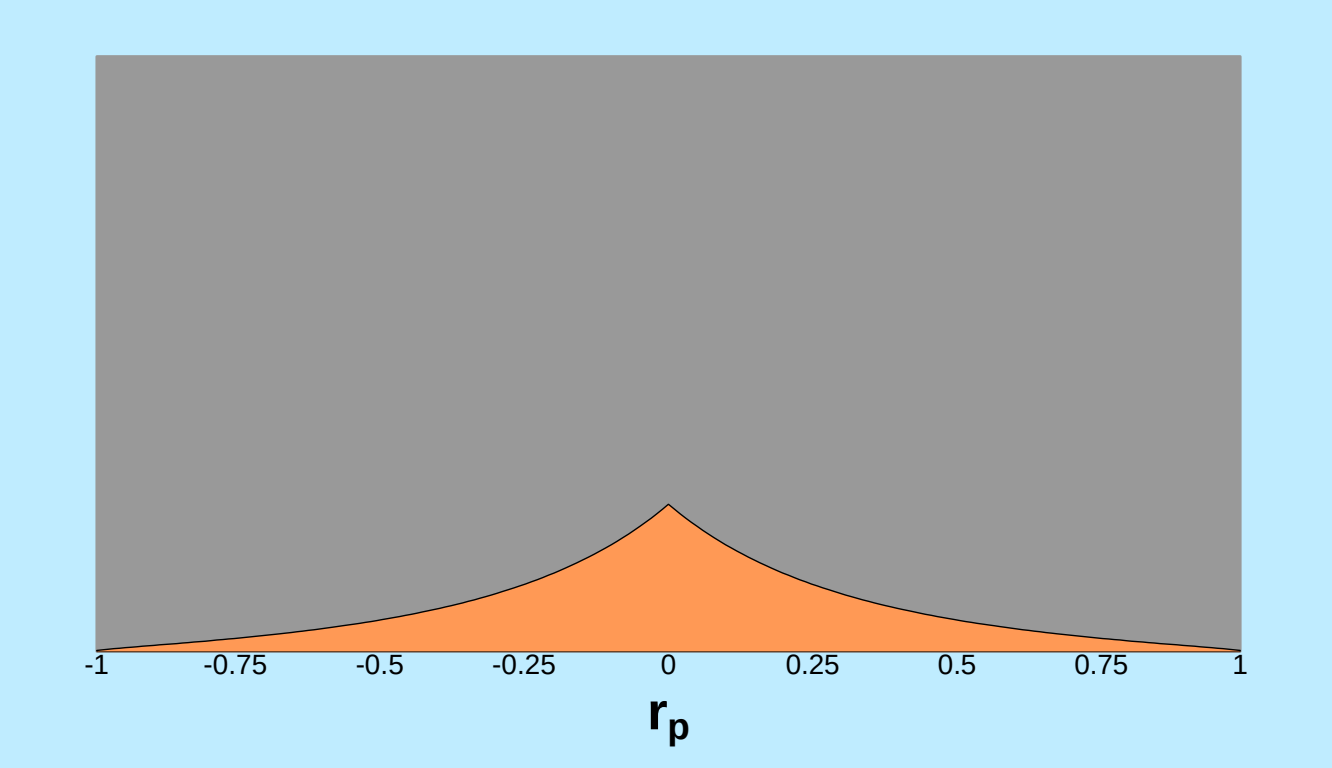
1. Population effect sizes

We really know that small effects are more frequent than large ones.



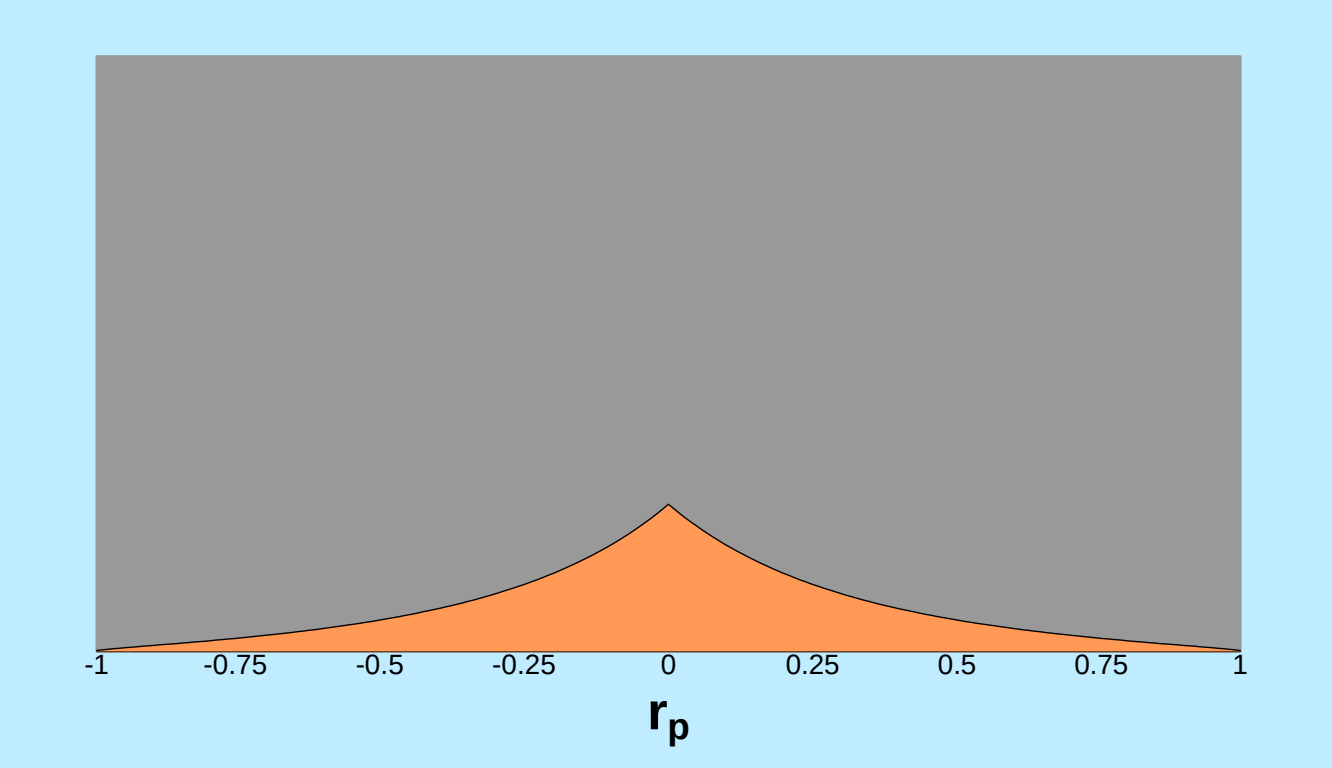
1. Population effect sizes

We really know that small effects are more frequent than large ones.
And that not many hypotheses are correct.



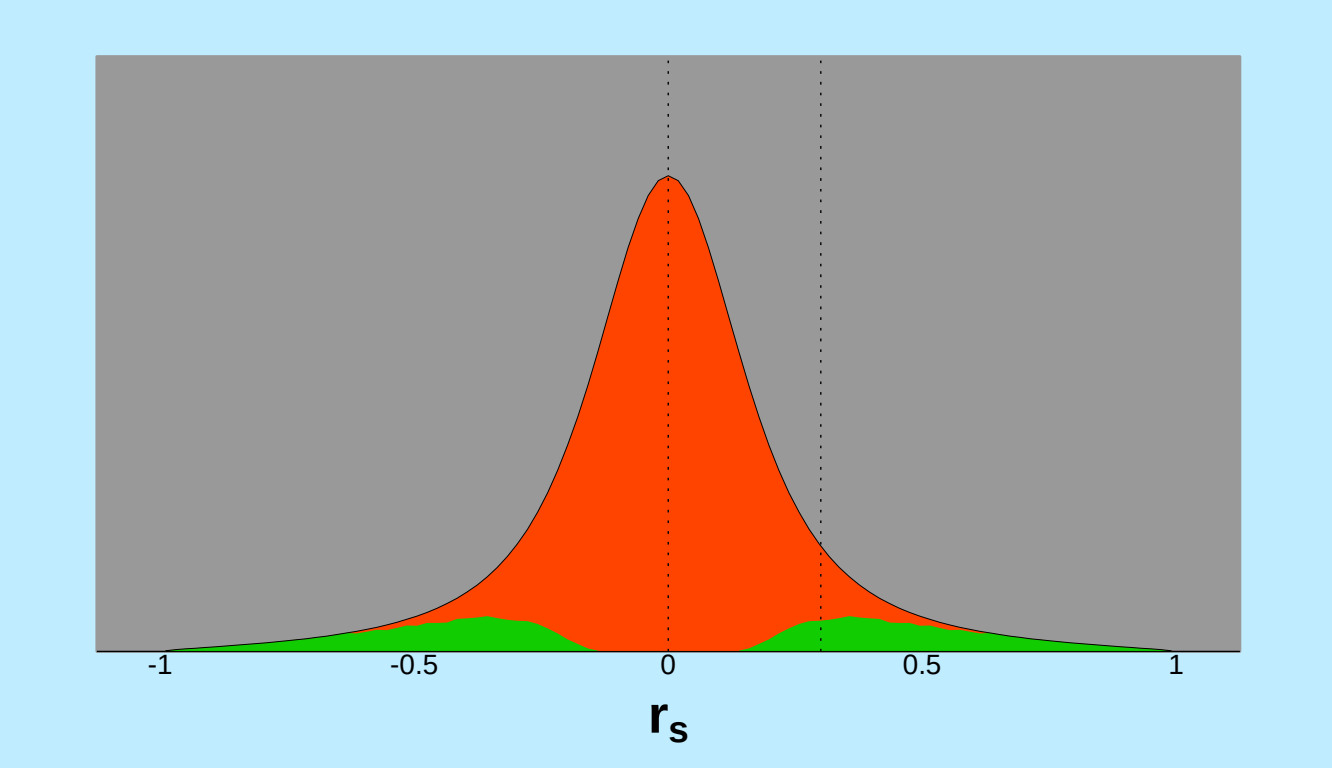
1. Population effect sizes

This is the situation in Psychology.
And only ~25% hypotheses are correct.



2. Results in Psychology

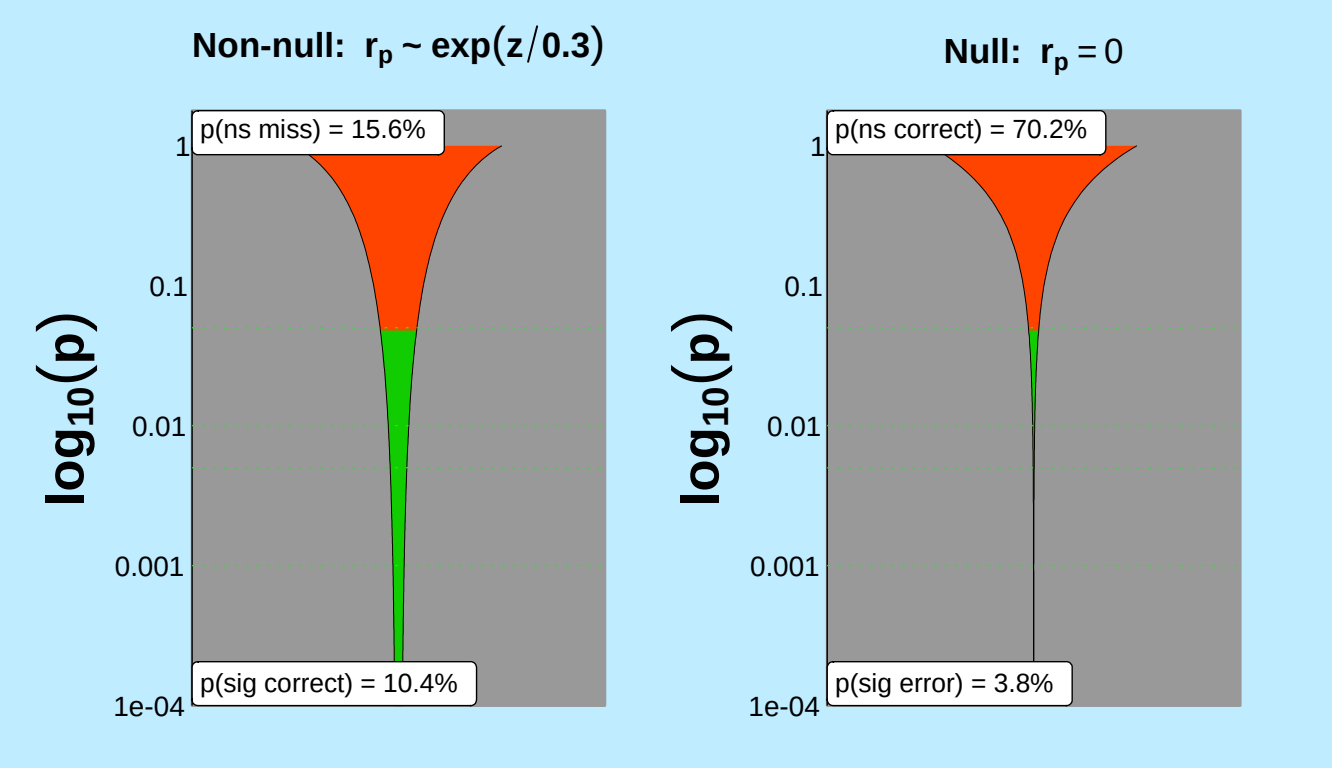
With the range of sample sizes in use,
most results in Psychology are not significant (red).



3. Inferential errors in Psychology

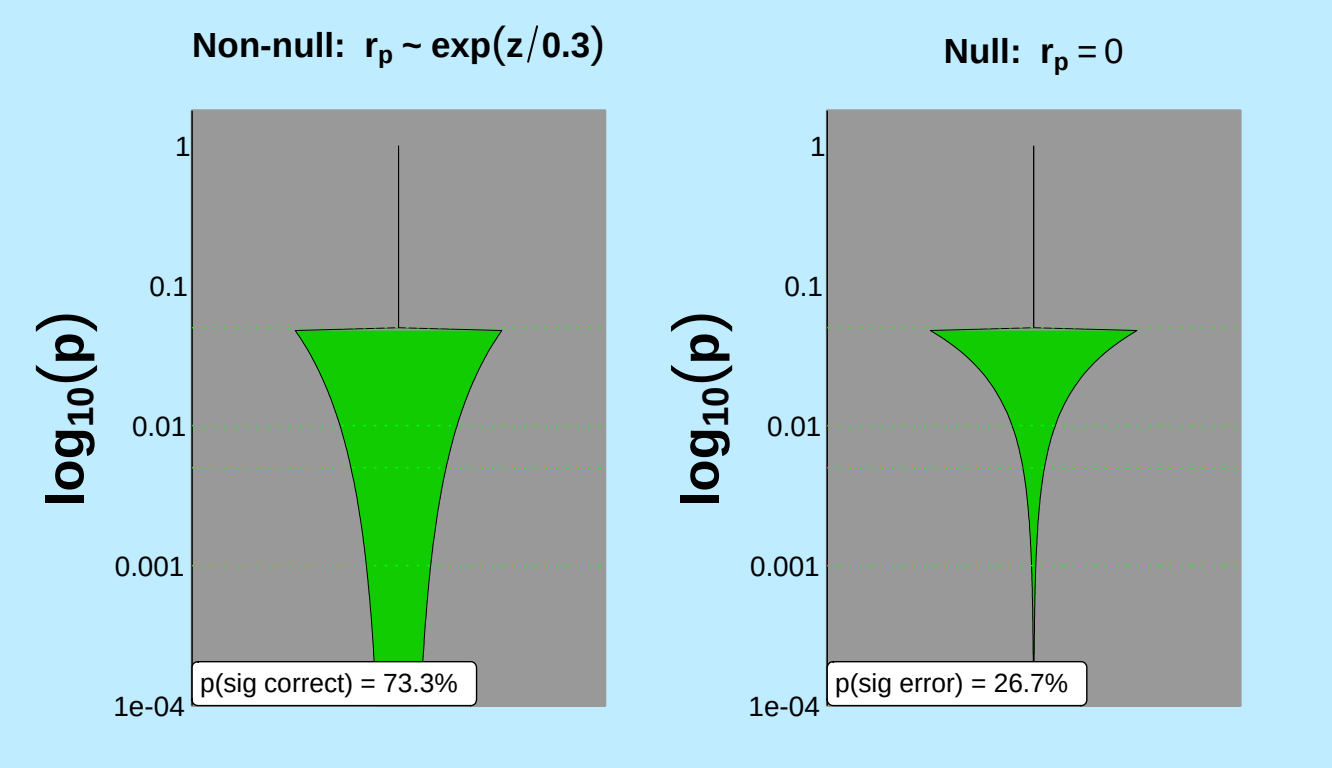
We can split the distribution of p-values into

- those from non-null hypotheses
- those from null hypotheses



3. Inferential errors in Psychology

Looking at just significant results,
the true discovery rate is only 74%



4. Some observations

None of this is good.

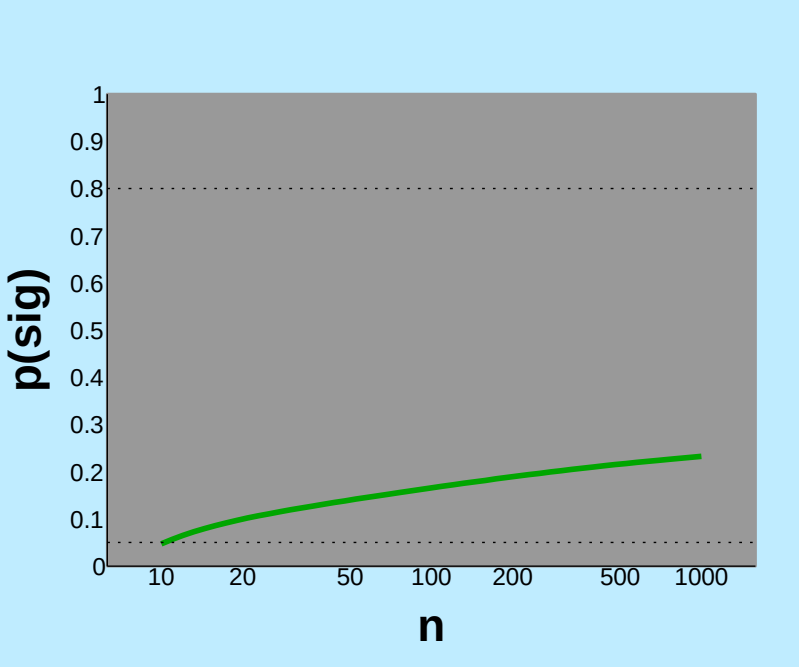
Researchers: the probability of a significant result is ~15%.
Readers: the probability of a true discovery is ~75%.

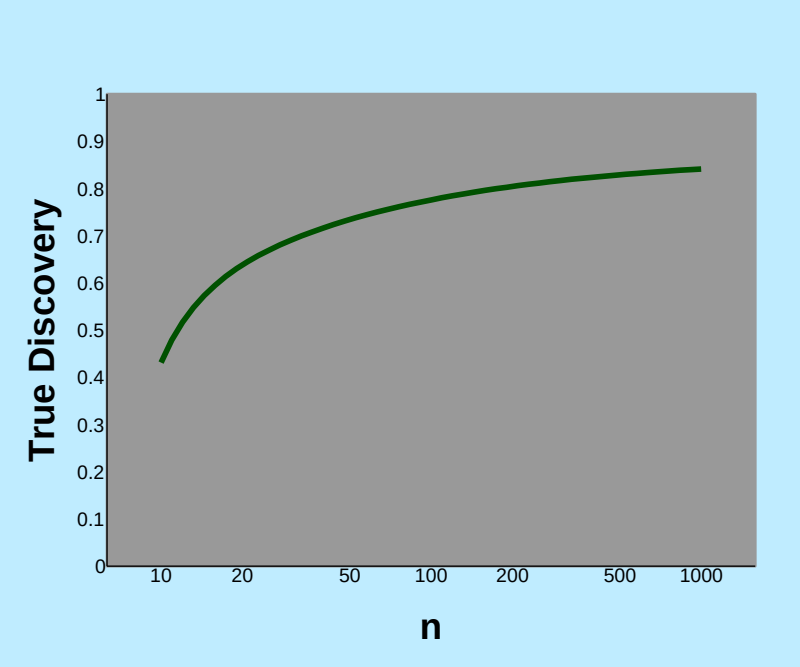
04. Possible improvements

How do we improve this?

1. Increase sample size?

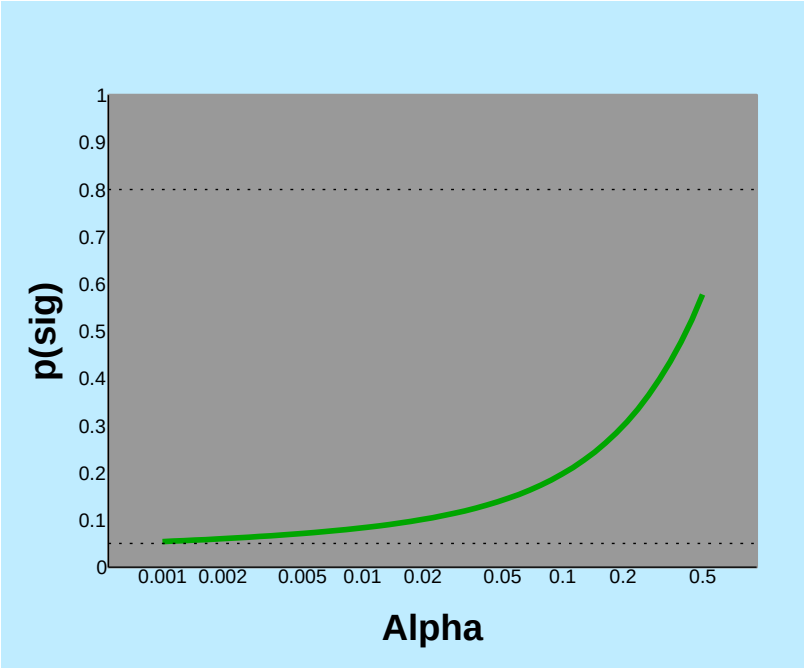
Not enough benefit.

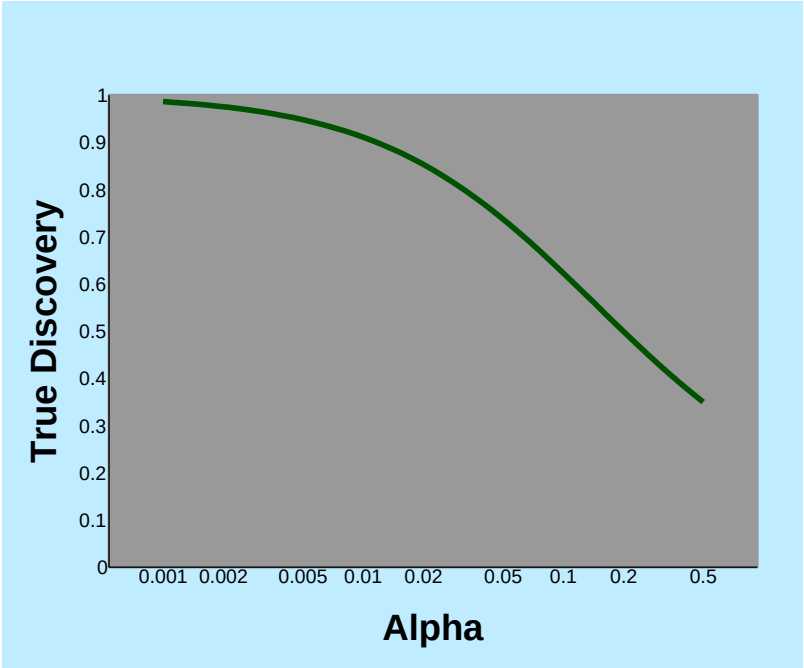




2. Reduce alpha?

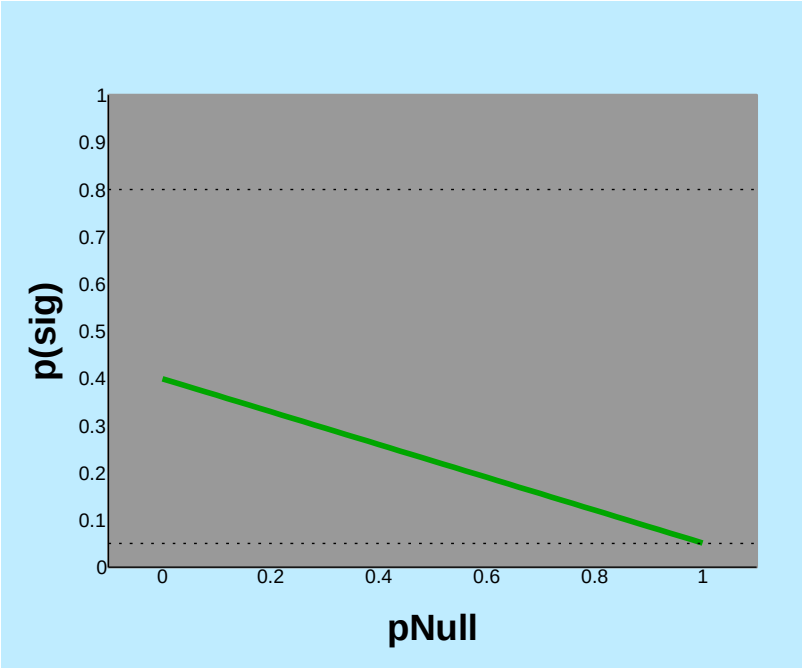
Cost outweighs benefit.

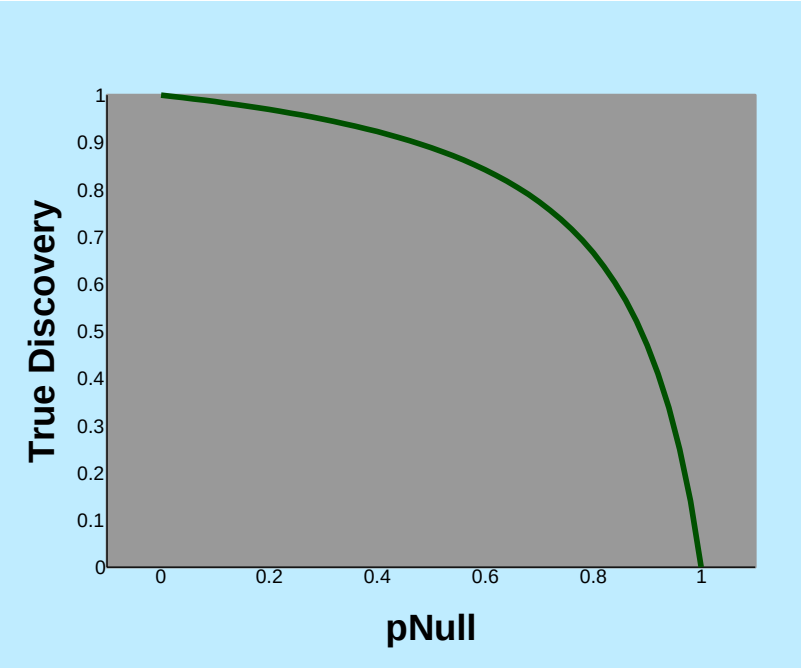




3. Avoid false hypotheses?

Yes. but…

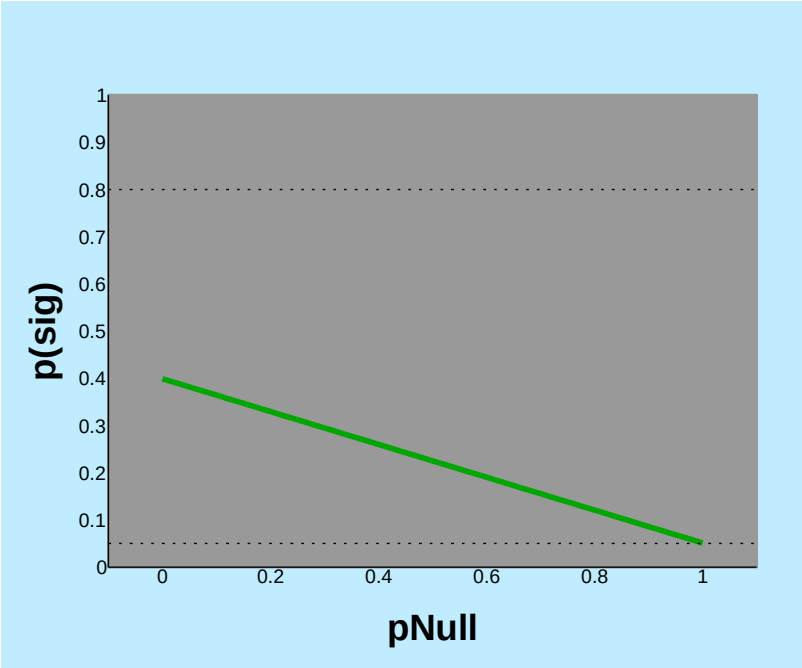


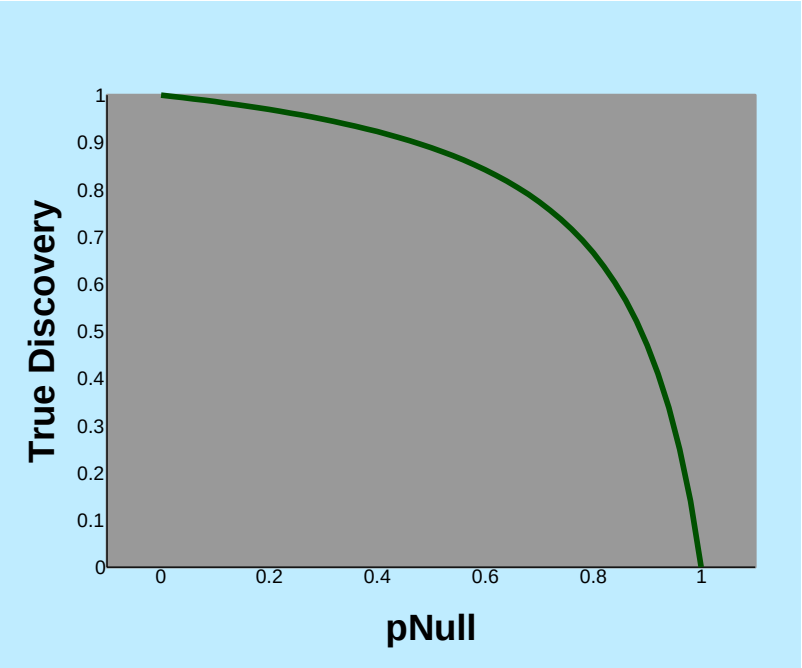


3. Avoid false hypotheses?

Yes. but…

…this is not really under our control.





05. To conclude

What is wrong with NHST?

1. NHST is wasteful

It is wasteful – because it only rejects the NH.

If we could reject the alternative hypothesis, there would be much less waste.

To reject the alternative hypothesis, we need a prior.

2. The alternative hypothesis

What does “reject the NH” mean?

can we even really do this?

What is the alternative hypothesis?

3. Prior

Basically, we need a prior.

Questions?

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