

# Hypothesis testing

**test statistic**

Examples

## Summary of hypothesis testing

	Do not reject $H_0$	Reject $H_0$
$H_0$ is True	Correct Decision	Type 1 error
	$1 - \alpha$	$\alpha$
$H_0$ is False	Type 2 error	Correct decision

$H_0$ is false	Type 2 error	Correct decision
	$\beta$	<i>power</i> : $1 - \beta$

## How different is different?

- How do we know that the difference between the experimental and control groups is not due to chance?
- We don't! But we can calculate the odds that it is.
- This is the *p value*
- In repeated experiments of this sample size, how often would

- In repeated experiments of this sample size, how often would you see a result as or more extreme than this, assuming the null hypothesis?

## p value

- If the test is two sided:  $\mu \neq \mu_0$ 
  - $p\text{ value} = 2 * P(X > |\text{observed value}|)$
- - $H_A: \mu > \mu_0$
  - $p\text{ value} = P(X > \text{observed value})$

- $p\text{ value} = P(X > \text{observed value})$
- $H_A: \mu < \mu_0$
- $p\text{ value} = P(X < \text{observed value})$

Significance Level

# The Truth Wears Off (Lehrer 2010)

<http://www.newyorker.com/magazine/2010/12/13/the-truth-wears-off>

John Davis, University of Illinois

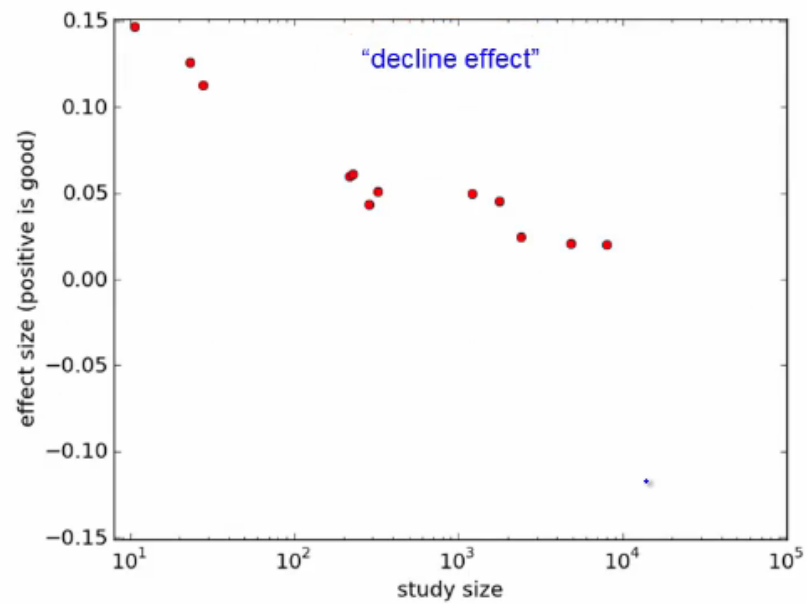
Anders Pope Moller



Reason 1: Publication Bias (Jooper 2012)

negative results are completely absent

# The Decline Effect



...publication bias

Effect Size

Effect Size

Effect Size

how

Effect Size

Cohen's Heuristic

- small 0.2
- medium 0.5
- large 0.8

## Confidence Interval (off effect size)

- If we repeated the experiment 100 times than we expect that the interval will contains the observed effect size 95/100

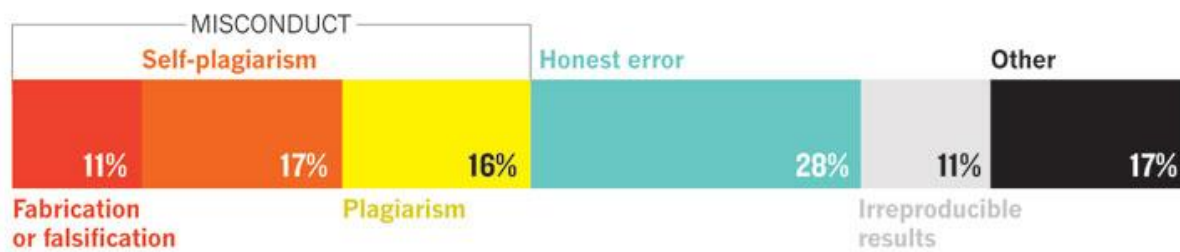
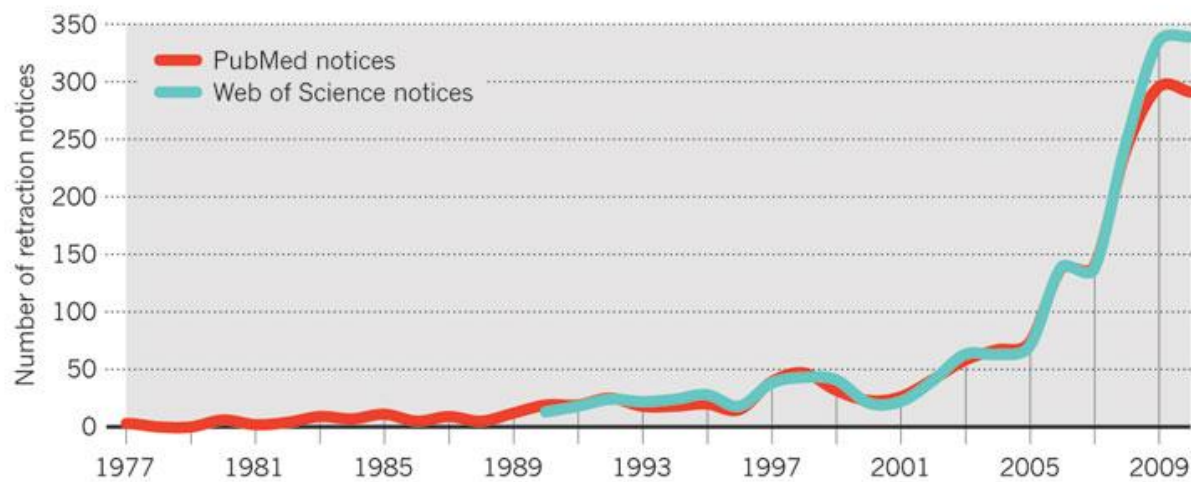


times

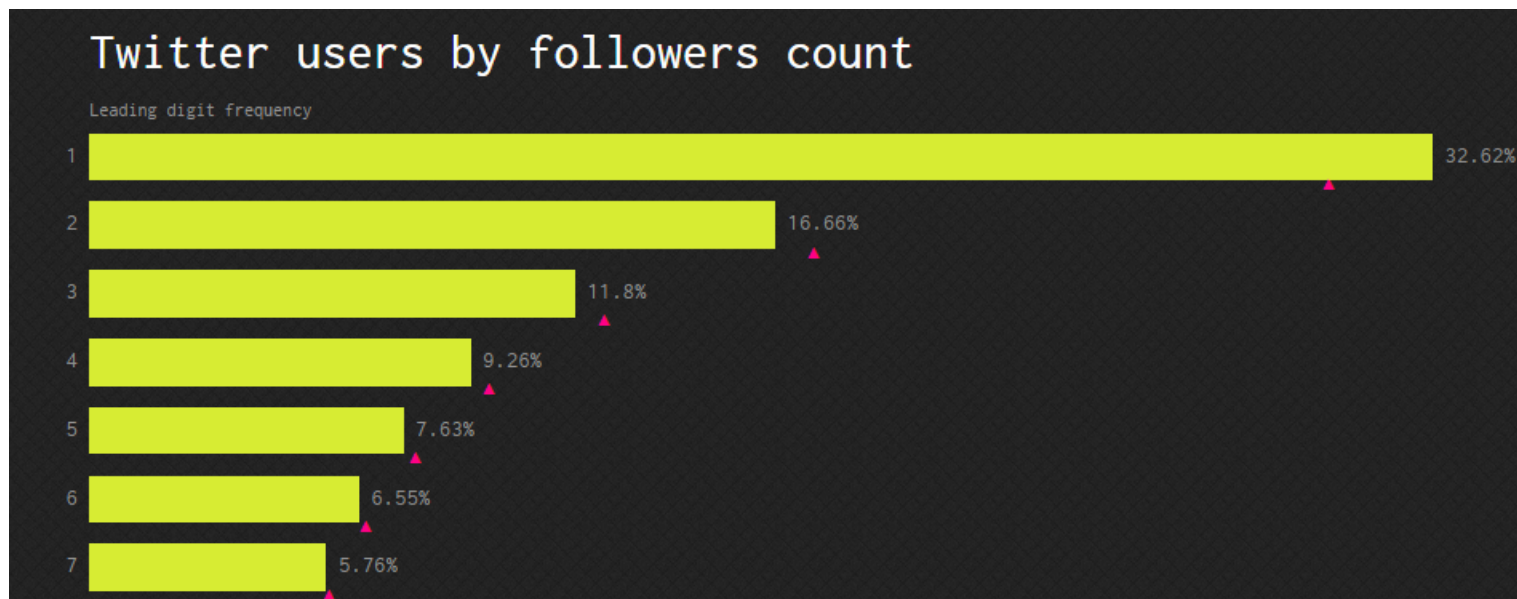
- If the confidence interval includes zero, then this is equivalent to saying that the result is not statistically significant.

## Reason 2: Mistakes and Fraud (Reason 2)

- From 2001-2011: 10X increase in retractions but only 1.44X increase in papers.



# Example of method to detect fraud





<http://www.testingbenfordslaw.com/>