

19

## P\_hacking and replication crisis

# Probability and Statistics

COMS10011  
Dr. Anne Roudaut  
[csxar@bristol.ac.uk](mailto:csxar@bristol.ac.uk)  
<https://github.com/coms10011>

ego depletion  
story

1998

ROY Baumeister

do people have a **limited amount** of **will power**?



1998

so he conducted a study ...

the results show that humans **do have a limited pool of self-control**

once we have had to **resist temptation** it is a lot harder to do it again

1998

they called this

## Ego Depletion::

has had huge influence on psychological research,  
been incorporated into dieting tactics, training  
techniques, and even advertising used today

ads telling how we deserve a product, causing  
mental fatigue and frustration, leading us to buy

but today it seems that **this phenomenon does  
not exist at all**

1998

ROY Baumeister's hypothesis:

self-control is **a limited resource**, and it takes  
**energy and motivation to maintain restraint**

every time use your self-control, you draw on that strength and it takes some time for you to recover it



1998

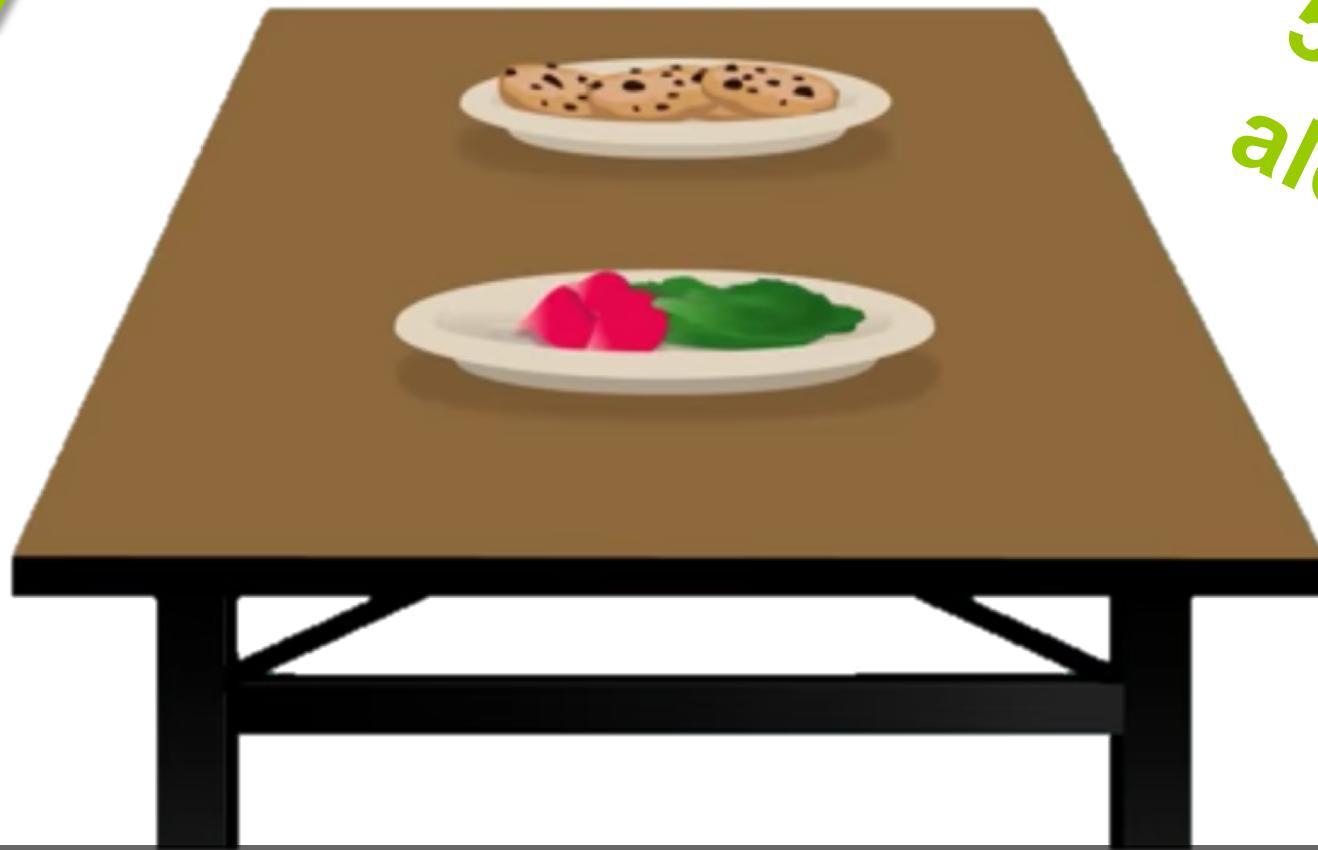
ROY Baumeister's task:  
two act of self-control back-to-back

1998



cooked delicious cookies and invited 67 students with empty stomach to sit in the baking room

1998



5 min  
alone

half the students told to **eat the cookies**  
half the students **the radishes**

1998

checked how long it  
took to give up

then asked to solve a difficult (in fact  
impossible) puzzle

1998

would resisting the cookies make it harder for participants to keep trying?

those who ate **radishes** = **8 minutes** of trying  
those who ate **cookies** = **19 minutes** of trying

<brainstorming: could you already see something wrong with their studies?>

1998

## **confounding variable::**

eating cookies (high in sugar) could be the reason  
of the longer effort provided

1998

would resisting the cookies make it harder for participants to keep trying?

those who ate **radishes** = **8 minutes** of trying  
those who ate **cookies** = **19 minutes** of trying  
3<sup>rd</sup> group with no cookies encounter = 21 minutes

and of course all these comparison with p<0.05 = strong evidences for ego depletion (who later became a subfield of psychology with many more studies done to confirm it)

2007

in 2007, researchers figured out what seemed to be happening biologically:

as people used up their self-control, their blood sugar levels were dropping

they made subjects watching emotional videos without showing emotions / while others did not have to hold back

2007



subjects who used willpower = lower blood glucose, and when they replenished that glucose it restored their self-control

2010

evidences even more in 2010 when group of researchers led by Martin Hagger, examined **83 published studies** on ego depletion to conclude that **effect was real**

2012

but in 2012 researchers **casted some doubts**

e.g. subjects did not have to drink lemonade to replenish their will power, **tasting it** was enough

e.g. subjects who **believe in willpower** could affect their performance

2014

in 2014, researchers tried to replicate the original studies and **could not find the effect**

they also looked at the meta analysis of 2010 (the 83 papers) and found a lot of issues, e.g. they re run the analysis with newer methods ... and the **ego depletion effect disappeared**

this started a wave a concern about **replicability** hitting the field of psychology

2016

in 2016, the Association for Psychological Science opened a Registered Replication Report on ego depletion:

one official experiment would be conducted by researchers in many different labs

Baumeister (original study) even helped design the experiment and Martin Hagger (led of the meta analysis) lead the project

A Multilab Preregistered Replication of the Ego-Depletion Effect

2016

on 24 labs (different language and culture)

only **2 found the effect**

and **1 group found the opposite effect**

what does it mean?

could argue that it is just this particular task where ego depletion does not show up but that willpower is still a limited resource

or maybe ego depletion only happens under very specific circumstances ... if at all

this has created a lot of **movements in the scientific community** and a lot of researches is working on it to find ways to better analyze and report studies

p hacking

p crisis

replication  
crisis

(veritasium channel)



(veritasium channel)

mmm does it mean that all I have learned in this lecture is wrong?

**no fortunately** there are a many things you can do to analyse stats and report data correctly as well as minimise these problems ...

good  
statistics

# 1

design a study properly and don't go fishing!



fishering = gathering as many data as you can, then try to find something statistically significant in it and report it = **NO**

**rather have clear hypothesis** to start with (remember one hypothesis = logical sentence that can be directly tested) and **just test for your hypothesis**



research question / hypothesis?



look at raw data



in(dependant) variables?



look at distributions



within or between subjects?



check for normality



counterbalancing?



run some stats



how many repetitions/trials?



conclude



Richard Feynman (1964)

you could also decide to **pre-register your study** (more and more frequent in scientific venues)

OSFHOME ▾ My Quick Files My Projects Search Support D

Examination of Non-Newtoni... Files Wiki Analytics Registrations Contributions

Warning: This OSF project is private, but the GitHub repo sarabowman / newest-repo is public. The on GitHub [here](#).

Examination of Non-Newtonian Fluids

Contributors: Sara Bowman, Tim Errington, Billy Hunt III, Rebecca Rosenblatt

Affiliated Institutions: Center For Open Science

Date created: 2015-05-12 07:44 PM | Last Updated: 2018-05-04 10:59 AM

Category: Project

Description:

Results of fluid dynamics lab experiments conducted spring 2015

License: Add a license

Wiki

An introduction to non-Newtonian Fluids from the incomparable Anthony Carboni and Tara Long of Hard Science (<http://twitter.com/hardscienceshow>):

Biking Across a Pool of Cornstarch...



Citation

Components

Data

Rosenblatt & Bowman

Analysis

Rosenblatt

Oobleck Pr

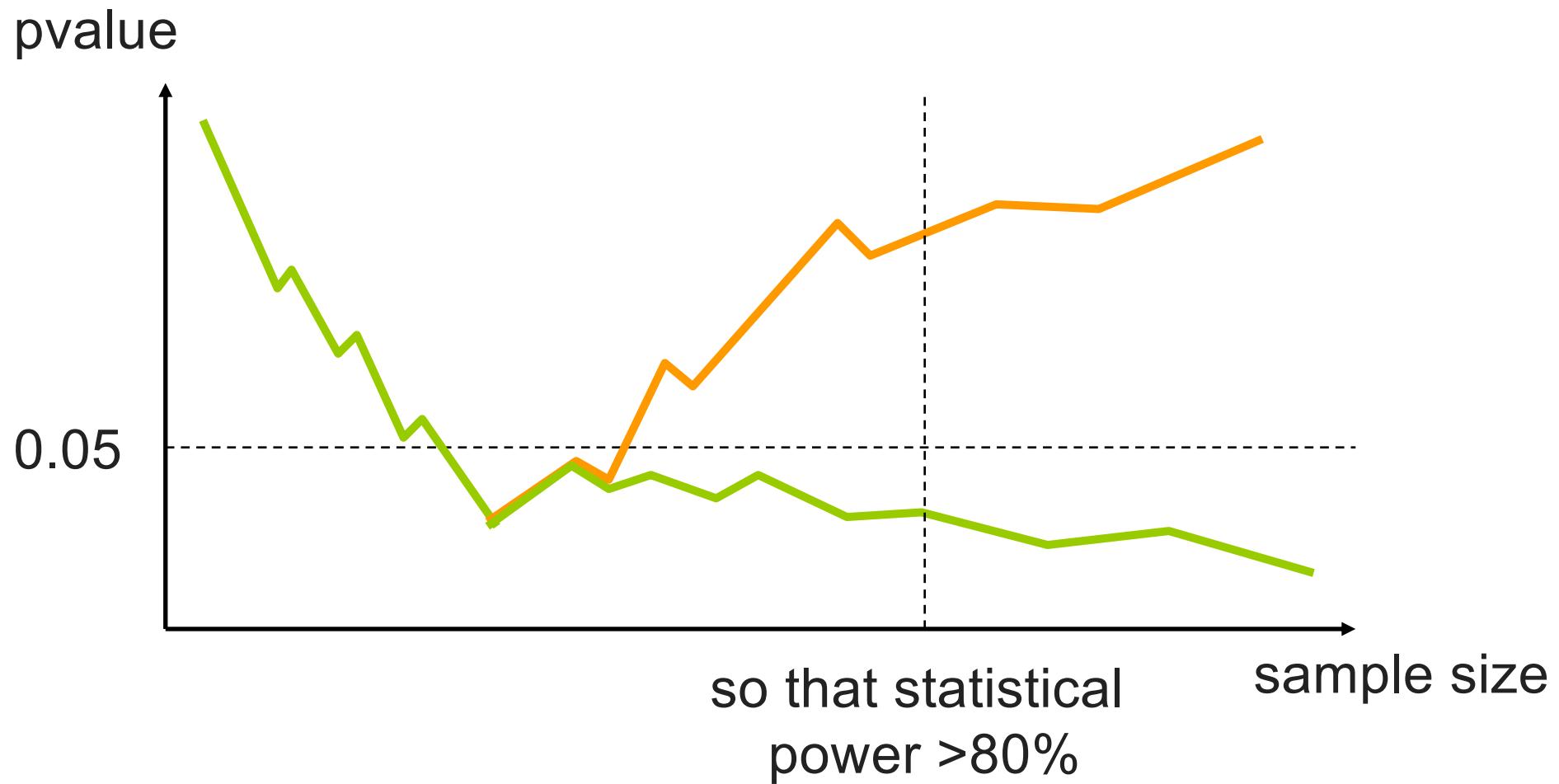
A pink arrow points from the 'Registrations' button in the top navigation bar to the 'Registrations' section on the right side of the page.

and of course design your experiment to  
remove as much noise as possible

i.e. pilot it!



increase sample size or better compute the required sample size





## report p value with effect size

e.g. a new hair loss shampoo is statistically better than existing shampoo

but does not say that subjects who took it only grew 5 hairs more than control group ...

**effect size matters more!**





**report confident intervals and non misleading  
grap**

## **confident intervals::**

a 95% confidence interval is a range of values that you can be 95% certain contains the true mean of the population

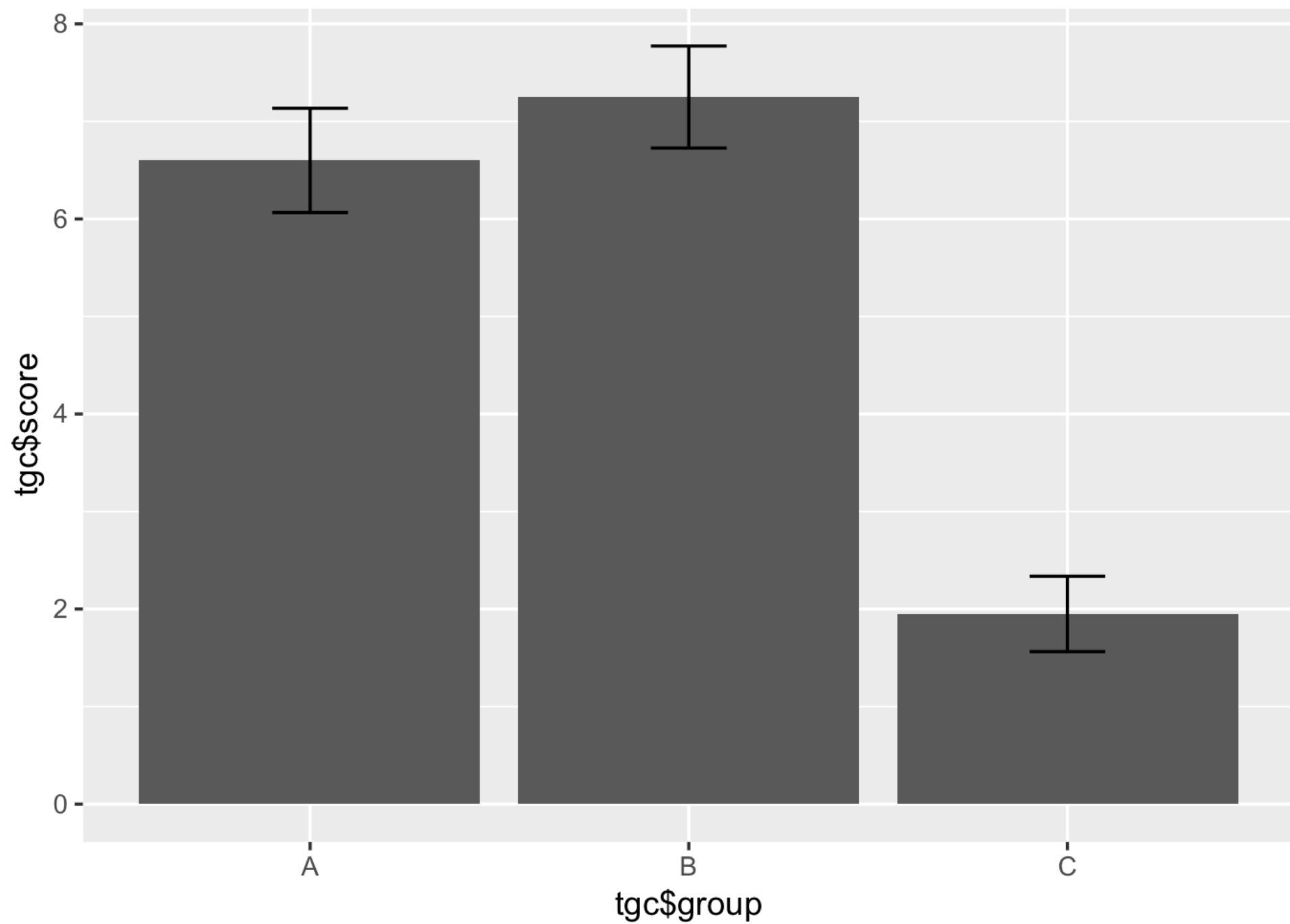
**a range of plausible values for the mean (values outside relatively implausible)**

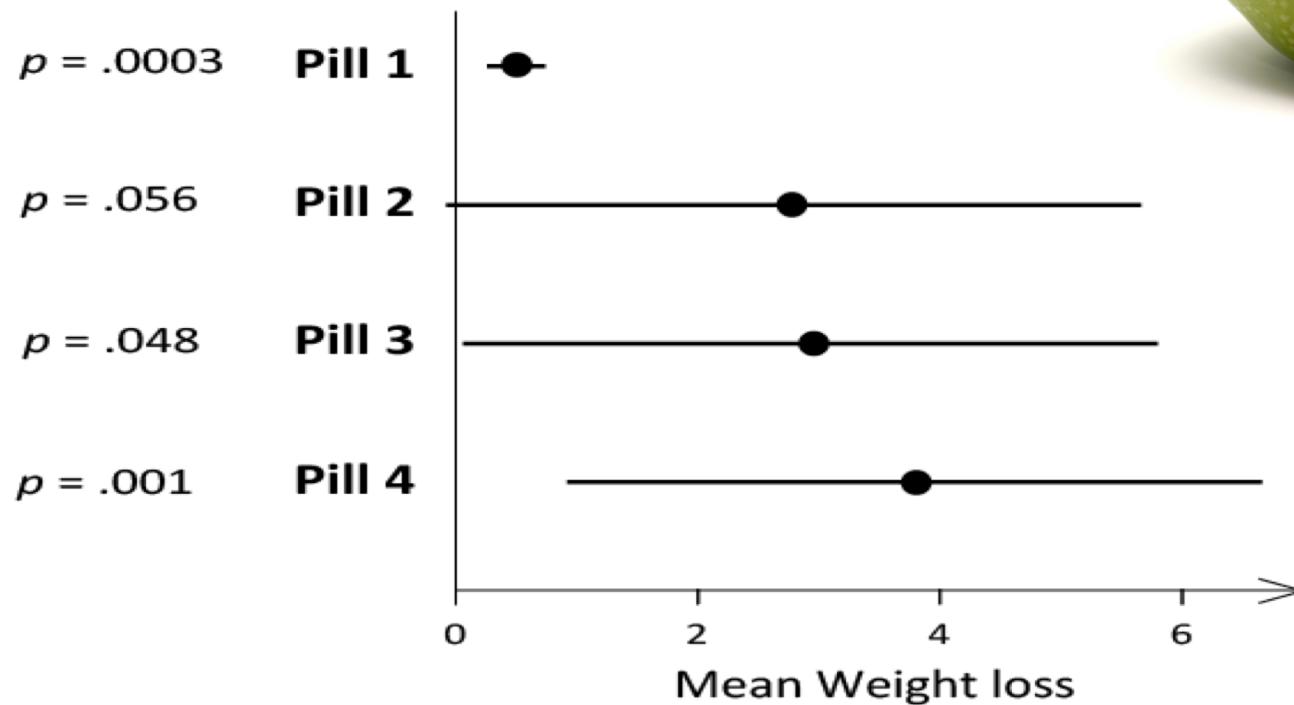


```
# first we run the one-way anova
library(Rmisc)
tgc <- summarySE(dat, measurevar="score",
groupvars=c("group"))
tgc
```

	group	N	score	sd	se	ci
1	A	20	6.60	1.1424811	0.2554665	0.5346976
2	B	20	7.25	1.1180340	0.2500000	0.5232560
3	C	20	1.95	0.8255779	0.1846048	0.3863824

```
ggplot(data = tgc, aes(x = tgc$group, y = tgc$score)) +
geom_bar(stat = 'identity', position = 'dodge') +
geom_errorbar(aes(ymin= tgc$score - ci, ymax= tgc$score +
ci), width=.2, position=position_dodge(.9))
```



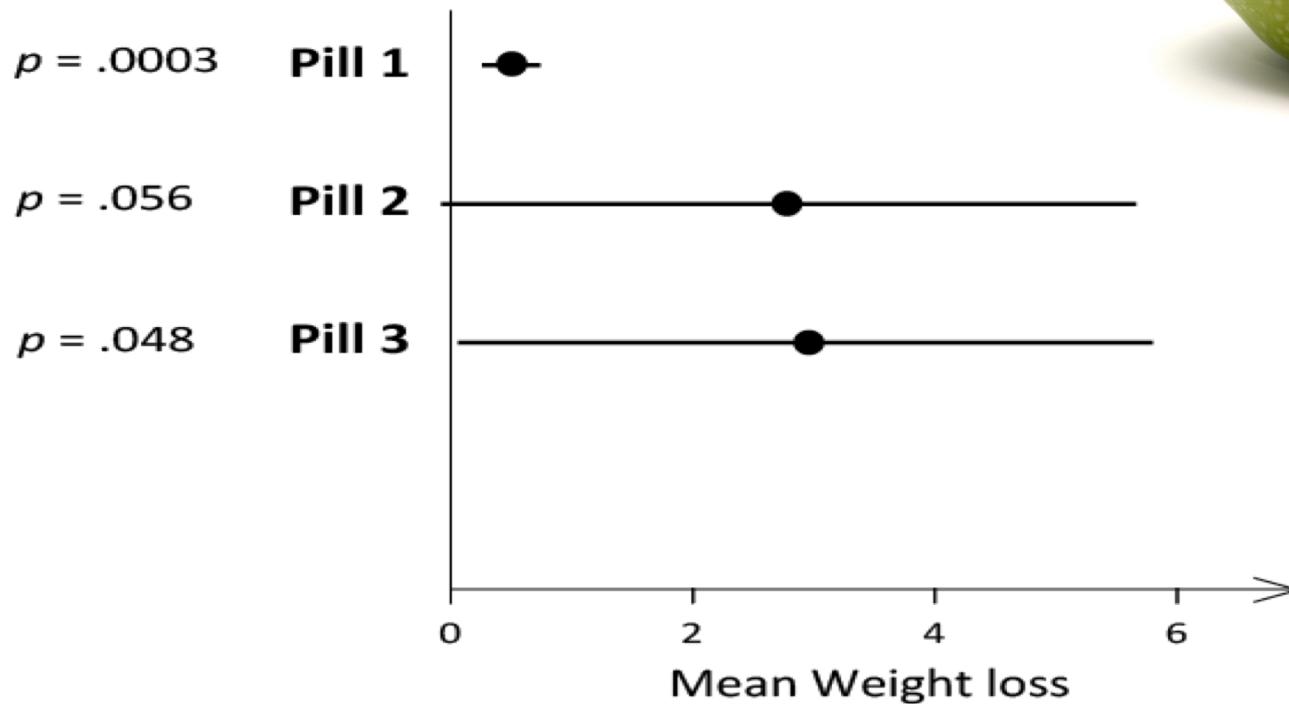


Error bars are 95% CIs

p-values are based on a null hypothesis of no effect

Adapted from  
(Ziliak and McCloskey, 2009)

which weight-loss pill would you recommend?

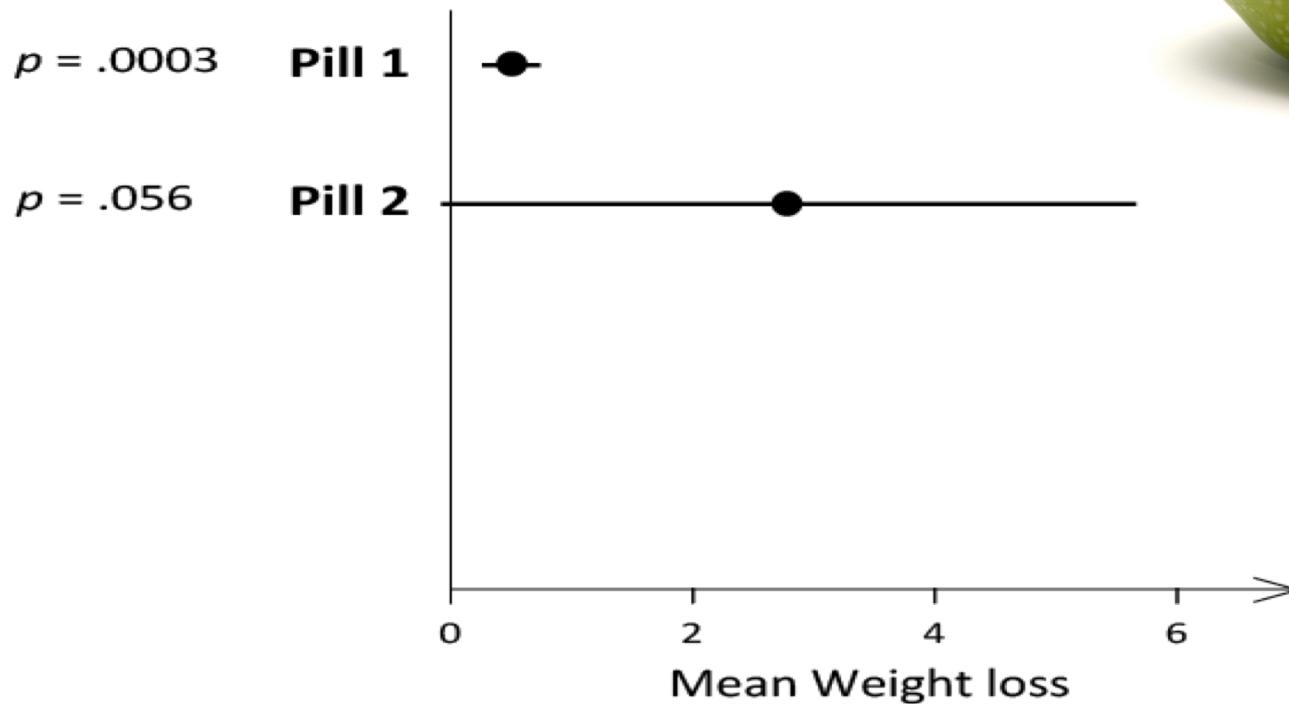


Error bars are 95% CIs

$p$ -values are based on a null hypothesis of no effect

Adapted from  
(Ziliak and McCloskey, 2009)

which weight-loss pill would you recommend?



Error bars are 95% CIs

$p$ -values are based on a null hypothesis of no effect

Adapted from  
(Ziliak and McCloskey, 2009)

which weight-loss pill would you recommend?

**4<sup>th</sup>**

$p = .0003$

**2<sup>nd</sup>**

$p = .056$

**1<sup>st</sup>**

$p = .048$

$p = .001$

**Pill 1**

**Pill 2**

**Pill 3**

**Pill 4**



Error bars are 95% CIs

$p$ -values are based on a null hypothesis of no effect

Adapted from  
(Ziliak and McCloskey, 2009)

which weight-loss pill would you recommend?

**4<sup>th</sup>**

$p = .0003$

0 kilo lost

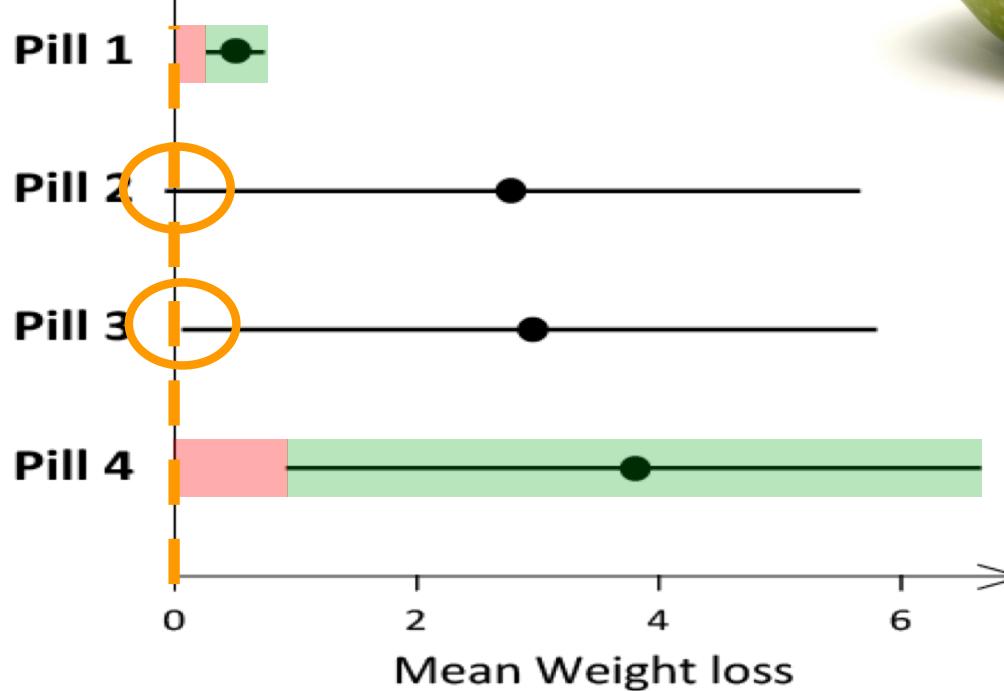
**2<sup>nd</sup>**

$p = .056$

**1<sup>st</sup>**

$p = .048$

$p = .001$



Error bars are 95% CIs

$p$ -values are based on a null hypothesis of no effect

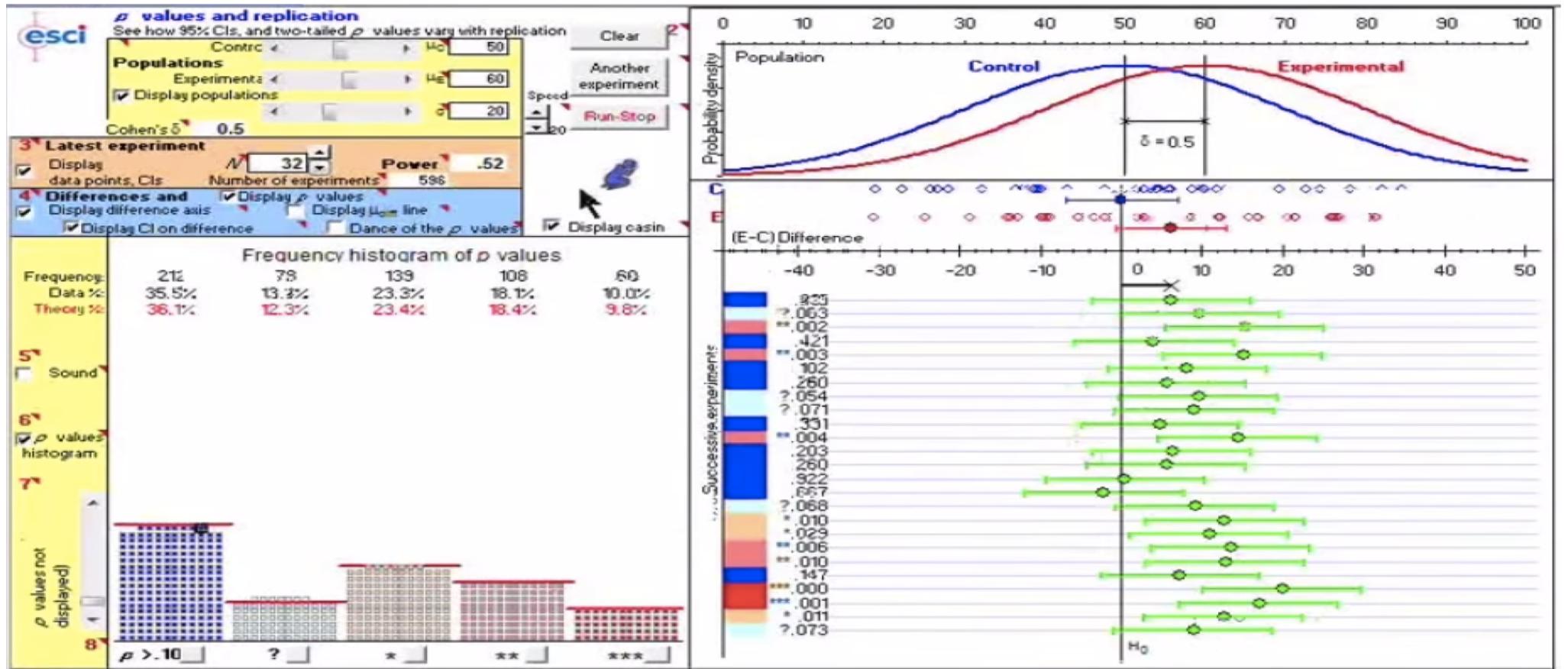
Adapted from  
(Ziliak and McCloskey, 2009)

which weight-loss pill would you recommend?

“Statistical significance is perhaps the least important attribute of a good experiment; it is never a sufficient condition for claiming that a theory has been usefully corroborated, that a meaningful empirical fact has been established, or that an experimental report ought to be published” (Likken, 1968)

“We have the duty of communicating our conclusions in intelligible form, in recognition of the right of other free minds to utilize them in making their own decisions” (Fisher, 1955)

“no confidence interval should be interpreted as a significance test” (Schmidt and Hunter, 1997)



# Geoff Cumming's dance of p-values

<https://www.youtube.com/watch?v=ez4DgdurRPg>

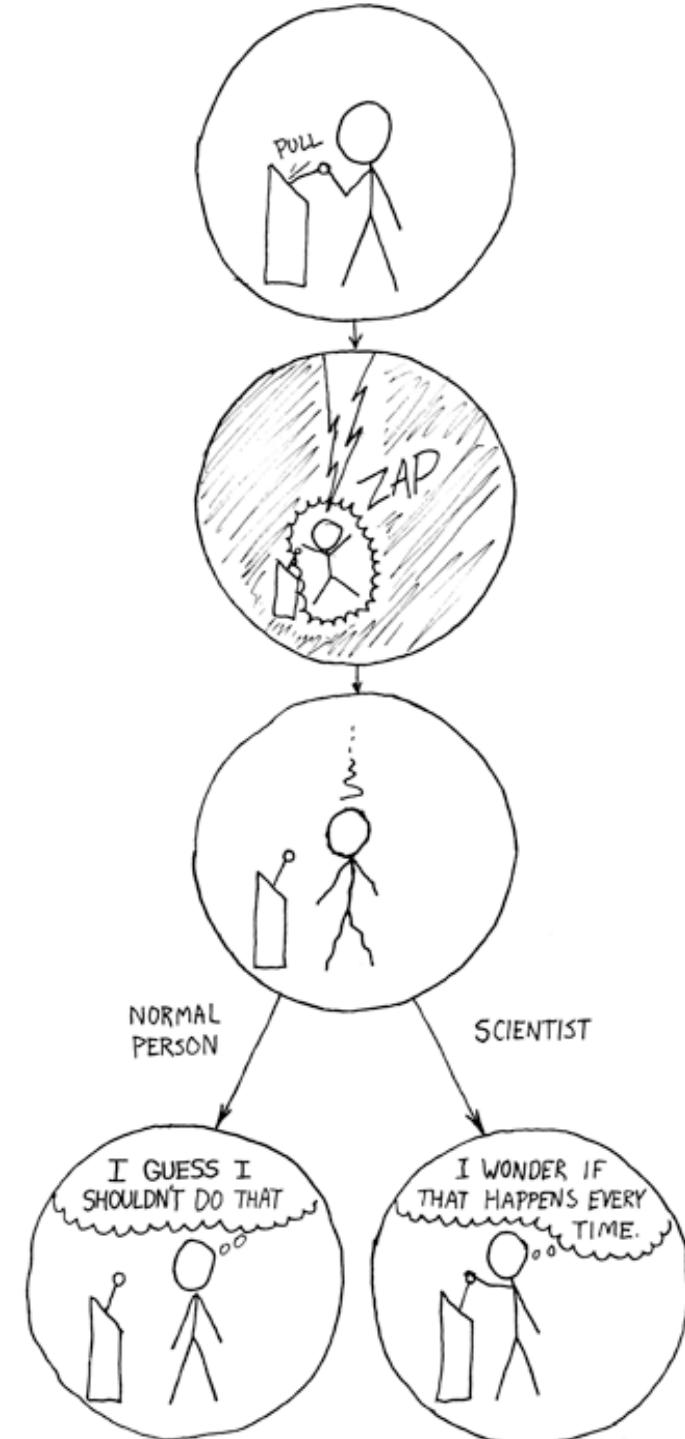
spot misleading graphs



replicate!

and fight publication standards,

e.g. in certain fields there are  
conferences to publish  
replication studies





rather use artificial data

certain tasks are **very sensitive to human variability** (e.g. ego depletion on will power but also anything that related to preferences)

tasks involving participants but relying on motor skills (e.g. tapping on a key) **suffer less from human variability**

or **use data without involving human** (e.g. algorithms comparisons)



**remember this is an active field, always look up for new statistical methods**

e.g. at the moment there is a strong tendency to push for **Bayesian testing**, although it also has drawbacks

need **prior data**

simple for AB testing but **could become quickly complex**

unclear **how it compares** to pvalue testing

**(still some research to do on this so keep your eyes open!)**

for the curious: tutorial on GitHub to do a simple comparison of two groups with Bayesian methods



## be ethical

i.e. moral principles that govern a person's behaviour or the conducting of an activity

why are you doing a study, intrinsically because you want to learn something, not just publishing  
of course be also ethical with your study design



research goes wrong (Stanford Experiment)  
... use ethical boards (in each university)

summary

1. Explain what is the replication crisis
2. Give the steps seen in class to avoid phacking and do good statistics
3. Understand that this is a hot topic of research and know that you need to keep your eye open if you ever encounter stats later in your career

take away

1. Linear regression
  2. Hypothesis testing, comparing things
  3. Experimental design a: T-test
  4. Experimental design b: ANOVA
  5. How T-test and ANOVA work
  6. Non-parametric tests a, normality tests
  7. Non-parametric tests b
  8. Categorical data: Chi-square
  9. Sample size, power and effect size (luluah)
  10. Replication crisis and good stats
- 11. Questions before exam**

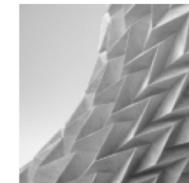
unit menu

to go further

[www.biglab.co.uk](http://www.biglab.co.uk)

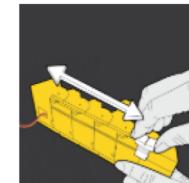
# BristolIG lab (Youtube)

example of what we do  
<https://www.youtube.com/watch?v=liPzZleX54M>



HCI meets Material Science  
2018

interact

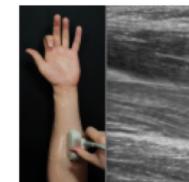


INTERACT  
2018



KnobSlider  
2018

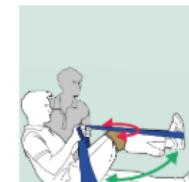
Morphees+  
2018



EchoFlex  
2017



Free form displays  
2017



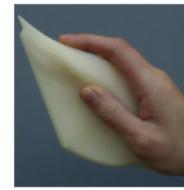
Frozen Suit  
2017



Inflashoe  
2017



SensIR  
2017



The Dibber  
2017



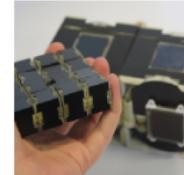
Understanding Grip Shifts  
2017



Virtual Resistance  
2017



CRITICAL  
2016



Cubimorph  
2016



EMPress  
2016



Floating charts  
2016



PhysiCubes  
2016



PhysiCubes  
2016



PhysiCubes  
2016

**BIG** Bristol Interaction Group

**human**

**inter-  
action**

**computer**



to go further:

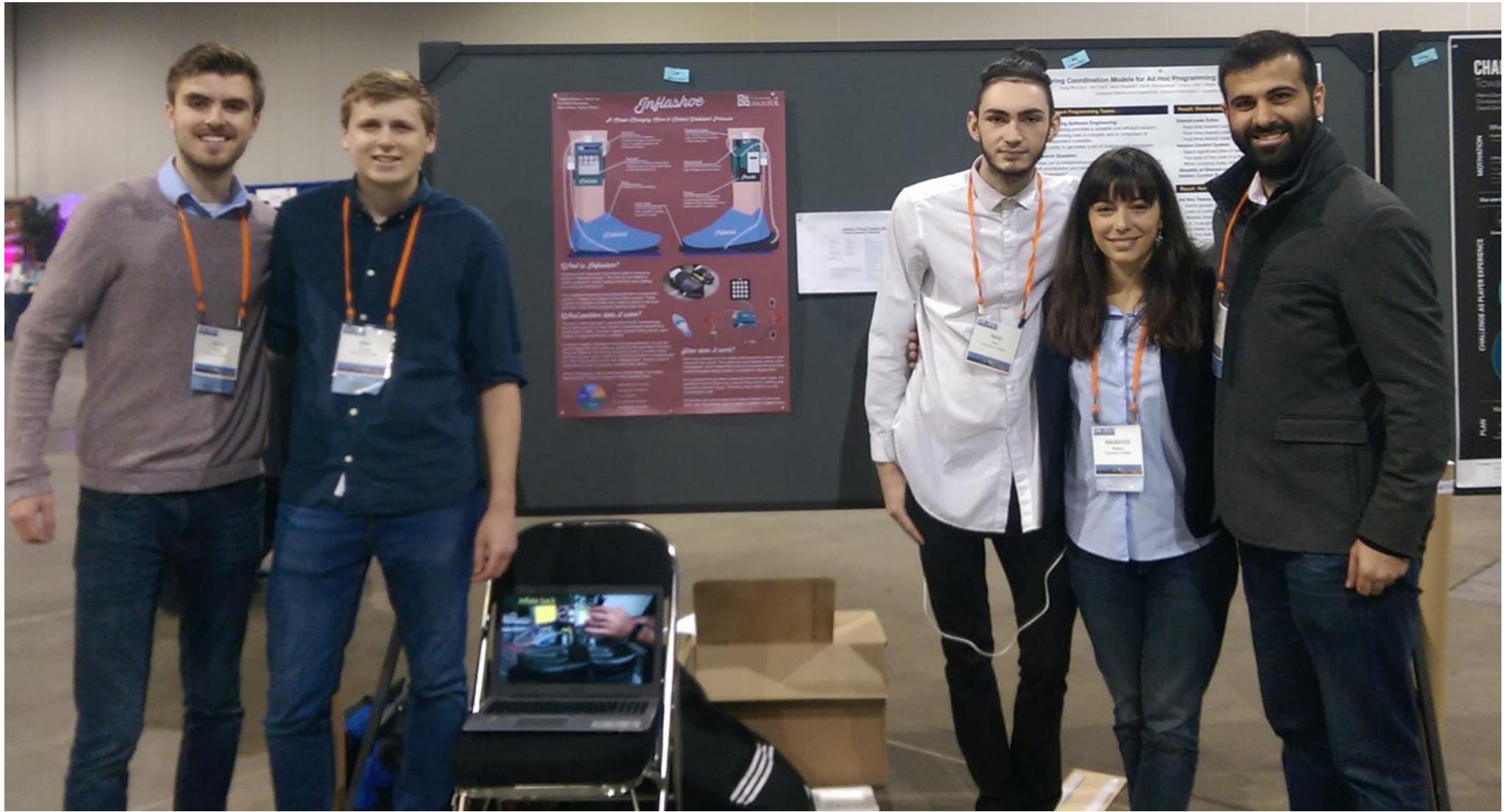
year 1: **Probability and statistic**

year 2: **CS and society** (with introduction to HCI)

year 3 (currently year 2): **HCI**

year 4: **Interactive Devices (pre-req HCI)**

curriculum



students presenting their inflating shoes at best conference in HCI in Montreal in 2018

end