A (Very) Brief Intro to Stats

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What type of variable do I have?

- Nominal or categorical
  - No particular relationship between options
  - Can't take an average, no real order
  - Examples
    - Gender
    - Eye colour

- Ordinal
  - Meaningful order, but that's where it ends
  - Can't take an average
  - Examples
    - The person who won the race came first, which means they ran faster than second place, but we don't know how much
    - Measuring attitudes/beliefs

- Interval
  - Order is meaningful
  - Addition and subtraction makes sense, but multiplication and division don't
  - Examples
    - Temperature in degrees C
    - Year someone started uni

- Ratio
  - Order is meaningful and there's a zero value
  - Multiplication and division make sense now
  - Examples
    - Response time

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Continuous Variables

Continuous vs Discrete Variables

- Continuous → for any two values, it's possible to have a value in between
- Discrete → um, not continuous…
  - Nominal/categorical and ordinal variables are ALWAYS discrete
  - E.g. There's no eye colour between brown and blue (categorical)
  - E.g. There's no placing between first and second (ordinal)

Response time example:

- Participant A: 3.1 seconds
- Participant B: 2.3 seconds
- Participant C can fall between A and B, therefore, it's continuous

→ B was 0.8s slower than A, which is 3.1 / 2.3 = 1.35 times as slow

What about Likert Scales?

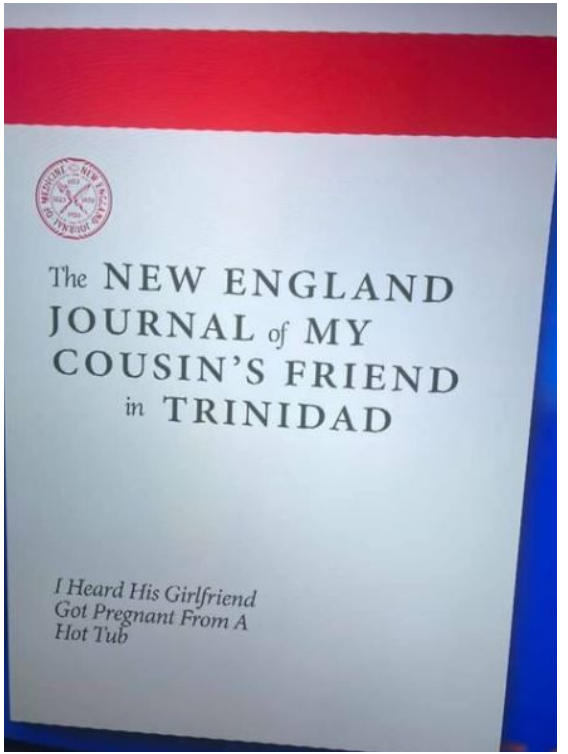
Hypothesis Testing

- Research Hypothesis: ‘Psychics are definitely not bullshit’
  - Experiment: Asking self-proclaimed psychics to guess whether a blue or red ball is under a black bucket
- Statistical hypothesis:
  - If psychics are bullshit, then participants will be guessing. There’s only two options, so the probability of them getting it right is Prob = 0.5
  - If psychics aren’t bullshit, then they should get it right more often than not… Prob > 0.5
  - If psychics aren’t bullshit, but I don’t want to upset anyone, I might just say that the probability of them getting it right is NOT 50% (i.e. Prob =/= 0.5)


Nicki Minaj
@NICKIMINAJ
My cousin in Trinidad won't get the vaccine cuz his friend got it & became impotent. His testicles became swollen. His friend was weeks away from getting married, now the girl called off the wedding. So just pray on it & make sure you're comfortable with ur decision, not bullied
7:44 AM · Sep 14, 2021 · Twitter for iPhone

The Curious Case of Nicki Minaj's Cousin's Friend in Trinidad

- Research Hypothesis: 'Covid vaccines lead to impotence' - Dr Nicki Minaj
  - Experiment: testing whether men with the covid vax are more likely to experience impotence than anti-vaxxers (measured via self report)
- Statistical hypothesis:
  - If the vaccine does NOT cause impotence, and all other things are matched, then the two groups of men have an equal chance of reporting impotence (**vax = antivax**)
  - If the vaccine does cause impotence, then those vaxxed should report impotence more often than those without (**vax > antivax**)
  - If the covid vax actually protects against impotence, then anti vaxxers should report a higher impotence incidence **(vax < antivax)**
  - If I don't know if the vaccine leads to impotence, I might just say that the two groups will differ in some way (**vax =/= antivax**)



Null and Alternative Hypotheses

- In the Curious Case of Nicki Minaj's Cousin's Friend in Trinidad
  - NULL HYPOTHESIS → vax = no vax (i.e. there will be NO difference -Nicki's cousin's friend in Trinidad was bullshitting)
  - ALTERNATIVE HYPOTHESIS → vax =/= no vax (i.e. there *will* be a difference- Nicki's cousin's friend in Trinidad was indeed not bullshitting)
- Statistical tests aim to prove that the null hypothesis is *false*
- 'Trial of the null hypothesis'
  - The null hypothesis is believed to be true unless the researcher proves that the null is false
  - Design your experiment in a way that maximises the chance of you reaching a conviction
  - However, the statistical test sets a range of rules you need to follow… If the null is true, the chances of a false conviction need to be low

Errors

	ACCEPT Null	REJECT Null
Null is TRUE (no difference)	Correct	Type 1 error
Null is FALSE (difference)	Type 2 error	Correct

Punishing the innocent is worse than letting the guilty walk free… A statistical test needs to control for the possibility of type 1 errors by setting a *significance level*

Errors

	ACCEPT Null	REJECT Null
Null is TRUE (no difference)	1-α Correct (probability of correct retention)	α (Type 1 error) FALSE POSITIVE
Null is FALSE (difference)	β (Type 2 error) FALSE NEGATIVE	1-β (power of the test)

- We need to keep the probability of a type 1 error low by setting a significance level: 0.05, 0.01, 0.001…
- Power: probability with which we reject a null when it is actually false

p-values

- The *p*-value is the smallest Type 1 error rate you are willing to tolerate if you want to reject the null hypothesis
  - P = 0.05 → 5% chance that if we reject the null, that it is a false positive
- In other words...
  - The *p*-value is the probability of obtaining results at least as extreme as the observed results of a statistical hypothesis test, if the null hypothesis is correct
  - Or, if there truly is no difference (the null is correct), then we'd only see a value this extreme 5% of the time

Effect Sizes

	Big Effect Size	Small Effect Size
Significant Result ($p<0.05$)	Difference is real and we should (probably) care	Difference is real, but honestly, who cares?
Non-Significant Result ($p>0.05$)	No effect observed	No effect observed

A quick word on power

- Obviously, we don’t want to accept the null when there actually is a difference (i.e. false negative)
- We minimise the Type 2 error rate by maximising the statistical power of the test
- How?
  - Increase your effect size by designing an experiment that isn’t shit (unfortunately I haven’t worked out how to do this yet…)
  - Increase your sample size

Picking a Test: Choose Your Own Adventure

1. Is your outcome variable DISCRETE or CONTINUOUS?

If you chose ‘continuous’...

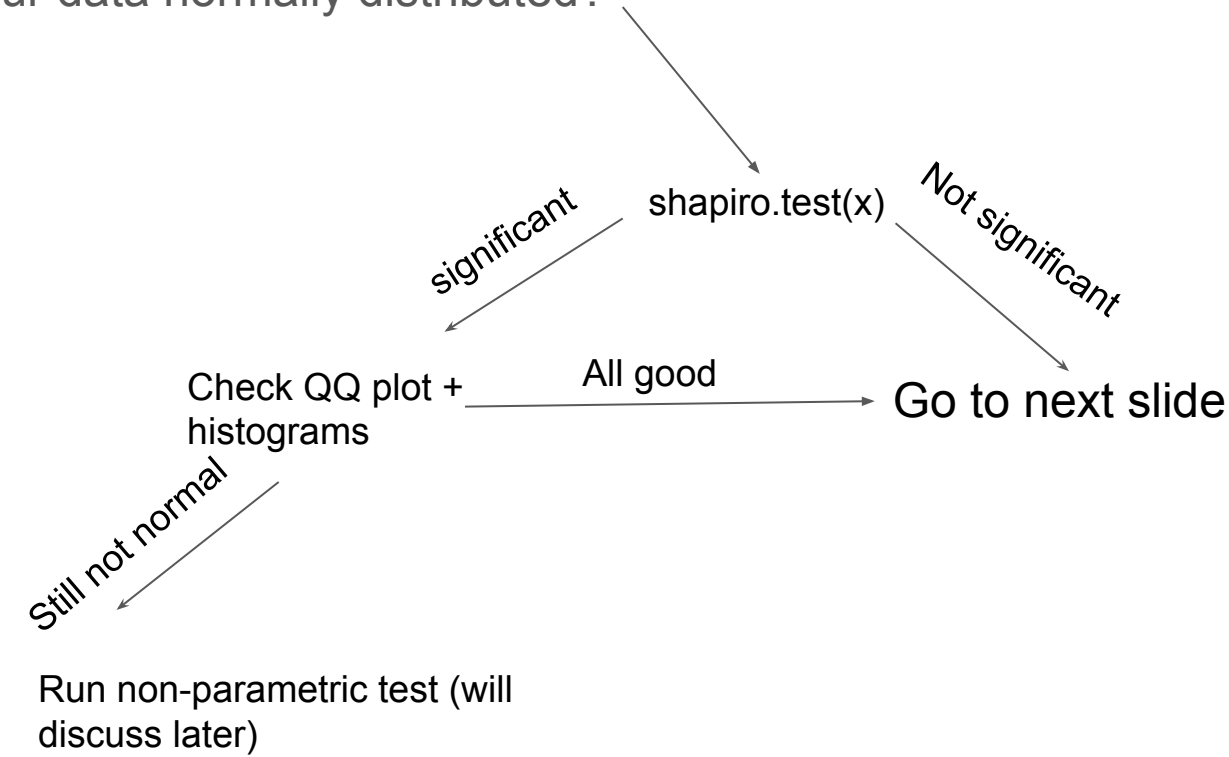
2. What are you trying to do?

B. Examine a relationship between two or more variables

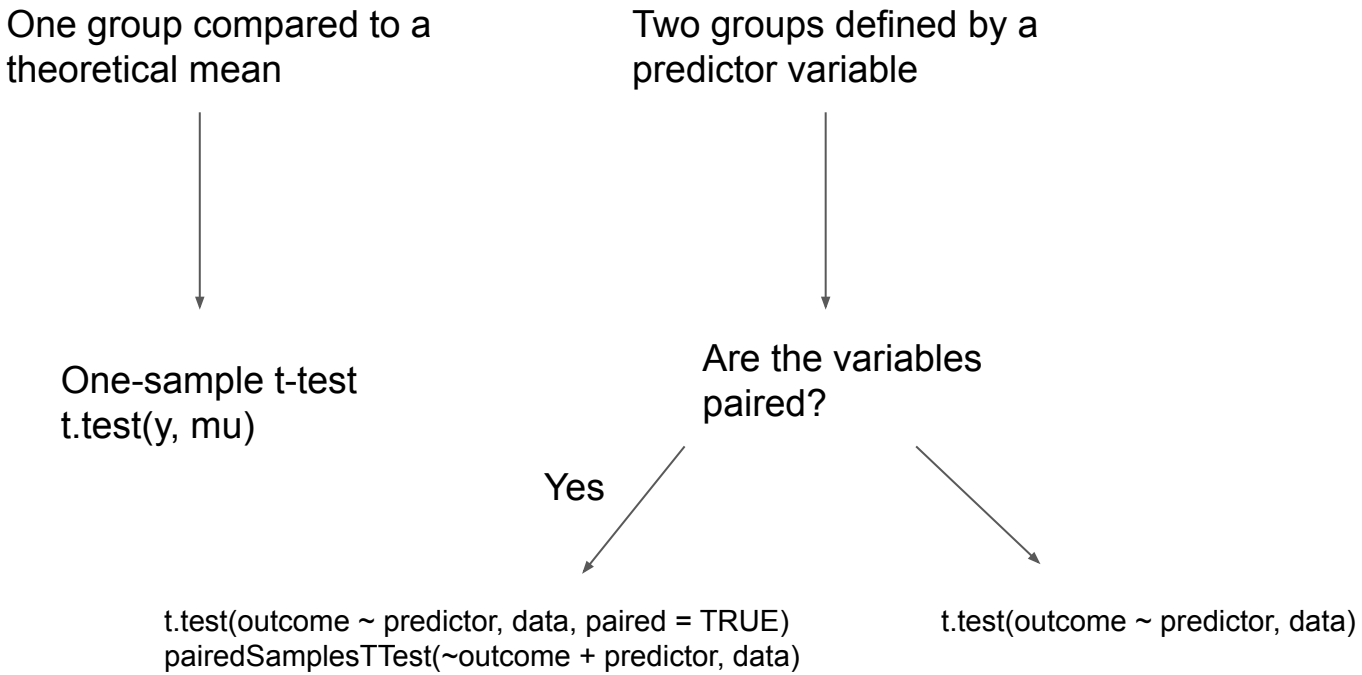
A. Compare group means on an outcome variable

If you chose A...

3. Are your data normally distributed?



How many groups are there?



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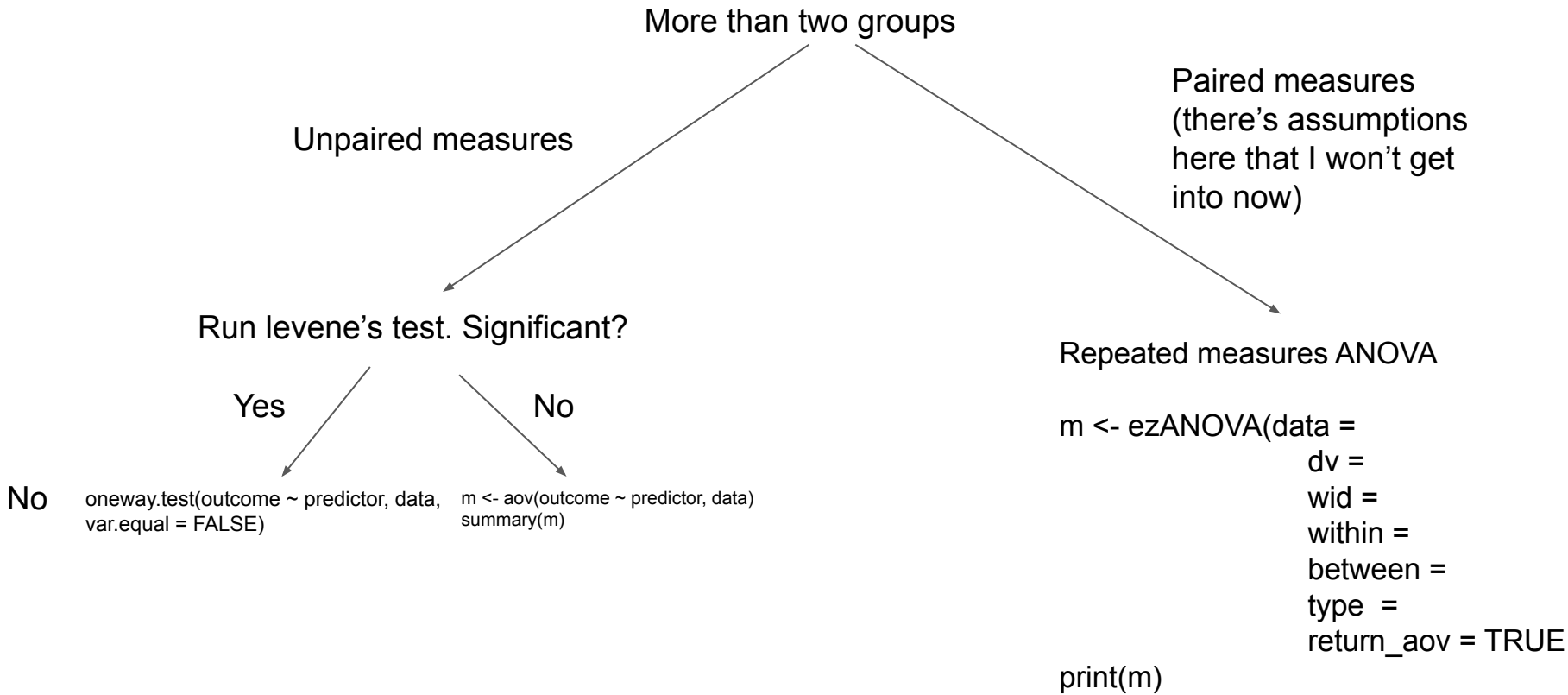

If you chose B...

Finding the relationship between two outcome variables


```
cor.test(data$x, data$y)
```

Finding the relationship between two or more outcome variables


```
m <- lm(outcome ~ predictor1, predictor2 ... , data
summary(m)
```

If you chose ‘categorical’…

What are you trying to do?

Compare one variable x against a theoretical comparison p

Chi-squared goodness of fit test
chisq.test(x, p)

Compare two variables x and y against each other

Chi-squared goodness test of association
chisq.test(x, y)