

RESEARCH METHODS

Lecture 5: Differences Between Samples

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Lecture Outline

- Recap types of experimental design
- Introduction to the t-test
 - *Independent samples t-test*
 - *Paired samples t-test*
- Calculation of t

Recap: Types of experimental design

- Between-subjects (unrelated design)
- Within-subjects (related design)
- Mixed designs (a bit of both!)

Recap:

Between-subjects

- Are you looking for differences between two (or more) groups, or are you looking for changes within the same group of participants?

Within-subjects

- Sounds simple – but one of the most common stumbling blocks for students!

Basic introduction to the t -test

- A t -test is used to determine whether there is a significant difference between the means of two groups
- The DV is assumed to fit a normal distribution
- With a t -test, we want to state with some degree of confidence that the obtained difference between the means of the groups is too great to be a chance event (i.e., has occurred in error or by chance).

Basic introduction to the t -test

- If our t -test produces a t -value that results in a probability of .05 or less, then we say that the likelihood of getting the difference we found by chance would be 5 or less times in 100.
- We could therefore say that it is unlikely that our results occurred by chance and the difference found probably exists in the populations from which it was drawn

Basic introduction to the t-test

- Parametric test
- Requires **one categorical IV** and **one continuous DV**

Two types of t-test...

Independent samples t-test

- Data collected from two separate groups of participants on a single variable
- Tells us whether the two means are significantly different from one another

Paired samples t-test

- Data collected from one set of participants but on two occasions/ across two conditions
- Assesses whether the mean of one set of scores is significantly different from the mean of the other

This is the test you will be using for your first report

BETWEEN-SUBJECTS DESIGN AND THE INDEPENDENT SAMPLES T-TEST

Between-subjects

- Different participants across two conditions/groups
 - Participants can only contribute to **one group** of scores
- Data are independent
 - Responses are independent of others

Independent samples t-test (Between-subjects design)

- The t-test is a **parametric test**, therefore relies on certain assumptions about the data we obtain
- **Assumptions:**
 - Interval or ratio data
 - Normally distributed data
 - The variances of the DV in the two populations are equal (homogeneity of variance)

Between-subjects

- Research question examples:
 1. Do first year students experience higher levels of exam anxiety than third year students?
 2. Are there gender differences in the effects of pet ownership on reported stress levels?

Example study 1

Do first year students experience higher levels of exam anxiety than third year students?

- We are looking for a difference between two independent groups (*first year students and third year students*)
- We take a sample from each population (*a sample of first years and a sample of third years*)
- We compare the two samples by comparing the mean differences on a given variable (*exam anxiety*)

Example study 1

- Between-subjects designs = independent samples
- Why?
 - *Can only be part of ONE group*

IV = YEAR OF STUDY
Two conditions

DV = EXAM ANXIETY

Data

First year student	Exam anxiety
1	9
2	10
3	8
4	7
5	9
6	7
7	8
8	8
9	7
10	10

Third year student	Exam anxiety
1	5
2	6
3	4
4	1
5	3
6	3
7	4
8	5
9	2
10	6

Hypothesis?

- Hypothesis must **always** be generated from your literature search and can be directional (one-tailed) or non-directional (two-tailed)
- **Non-directional (two-tailed)**
 - *There will be a significant difference in the reported exam anxiety scores of first and third year students*
- **Directional (one-tailed)**
 - *Third year students will report significantly lower exam anxiety*

Why test for a difference?

- The independent samples t-test assesses whether the **difference** between reported scores of exam anxiety of the two groups is **significant**
 - *Can we reject the null hypothesis?*
 - *Must we accept the null hypothesis?*
- Need to calculate a probability value (sig. value in SPSS) for any difference found

Independent samples t-test

- Where we have **one IV** with **two conditions/groups**:
 - **IV = year of study**
 - *Groups = first OR third year*
- t-test to compare the data
- Assessment of difference between the groups using means
- T-statistics to look up the p-value (for the significance)

Independent samples t-test

- The t-value for an independent samples t-test is calculated in a different way to a paired samples t-test
- But, both types generate similar information and both are reported in exactly the same way...

What do you get?

1. A t-value from calculating the t-score

- A larger t-value indicates a bigger mean difference
- A smaller t-value indicates a smaller mean difference

(i.e., a larger t-value is more likely to indicate a significant difference between your two sets of means...)

What do you get?

- As the **variation** in the difference **increases**, the t-value **decreases**
 - *Smaller t-value indicates MORE variable difference*
 - The difference can, in part, be attributed to a consequence of natural variation
 - *Bigger t-value indicates LESS variable difference*
 - This occurs when most or all of the differences between each group are large

What do you get?

- As the number of data points increases (N), the t -value increases
 - As N gets larger, we automatically get higher t -values as the size of the data set increases
 - *Larger samples are therefore likely to increase the t -value, and in turn increase the likelihood of a significant difference*

What do you get?

2. A value for your degrees of freedom (always $N - 2$ for independent samples t -test)

- What do we mean by 'degrees of freedom?!' (DF)
 - DF = the number of values in the final sample of data that are 'free to vary'
 - *E.g., football teams*
 - 11 players per team (so two groups!)

Degrees of freedom – independent samples t -test

- The exact same is then true for team 2 (or group 2)... so, the DF for that group is also 10.
- So, if we had 22 participants our DF would be 20.
 - *Further example to come with the paired samples t -test...*
- This means that the DF for the **entire sample of data** is **$N - 2$**

What do you get?

3. A significant or non-significant result (i.e., $< / > .05$)

- Report that there is either a significant difference between the two groups, or there is no difference...

How does this all fit together?

Example stats:

- t-value = 6.20
- DF = 20
- $p < .05$ (significant)

Formula for reporting a t-test (BOTH)

$t(df) = t\text{-value}, p < / > .05$

So...

$t(20) = 6.20, p < .05$

WITHIN-SUBJECTS DESIGN AND THE PAIRED SAMPLES T-TEST

Within-subjects

- Exploring change/differences within the same group of participants..
 - Over time
 - Before/after experimental manipulation or intervention

Within-subjects

- The same participants take part in ALL conditions of the study
- Randomly assigned to different orders in which the conditions are to be run (if applicable)#
 - Counterbalancing
- Individual differences remain constant in all conditions, therefore differences between the conditions must be attributed to the IV (if significant)

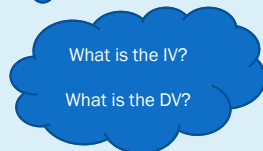
Examples of within-subjects designs

- 1) Creativity scores measured at two different times

Time 1: 1 March
Time 2: 1 September

IV: time points –
march and
September

DV: creativity



Examples of within-subjects design

2) Memory recall of pictures and words

IV: two different conditions – pictures and words

DV: number of words recalled

What is the IV?

What is the DV?

Why test for a difference?

- The paired samples t-test assesses whether the **difference** between the two conditions or two time points is **significant**
 - *Can we reject the null hypothesis?*
 - *Must we accept the null hypothesis?*
- Need to calculate a probability value (sig. value in SPSS) for any difference found

Paired samples t-test

- We still have **one IV** with **two conditions/groups**:
 - *E.g.,*
 - **IV = time points**
 - *Groups = March AND September*
- t-test to compare the data
- Assessment of difference between the conditions using means
- T-statistics to look up the p-value (for the significance)

Paired samples t-test (Within-subjects design)

- The t-test is a **parametric test**, therefore relies on certain assumptions about the data we obtain
- **Assumptions:**
 - Interval or ratio data
 - Normally distributed data
 - The variances of the DV in the two populations are equal (homogeneity of variance)

What do you get?

1. A t-value from calculating the t-score

- A larger t-value indicates a bigger mean difference
- A smaller t-value indicates a smaller mean difference

(i.e., a larger t-value is more likely to indicate a significant difference between your two sets of means...)

What do you get?

2. A value for your degrees of freedom (always $N - 1$ for paired samples t-test)

- DF = the number of values in the final sample of data that are 'free to vary'
- Why is it $N - 1$???



What do you get?

3. A significant or non-significant result (i.e., $< / > .05$)

- Report that there is either a significant difference between the two conditions, or there is no difference...

How does this all fit together?

Example stats:

- t-value = 2.40
- DF = 19
- $p > .05$ (non-significant)

Formula for reporting a t-test (BOTH)

$t(df) = t\text{-value}, p < / > .05$

So...

$t(19) = 2.40, p > .05$

SO... HOW DO WE
CALCULATE THE 'T'?! 

Hand calculating the t...

Step 1: Calculate the Standard Error of Difference

Step 2: Calculate the T score

Step 3: Use the t-distribution table to determine significance

Calculating the t-score

$$\frac{\bar{D}}{SE}$$

Step 1: Sum of
D squared

Standard Error of D

Step 2: (Sum of
D squared
divided by N

$$\sqrt{\frac{\sum D^2 - \frac{(\sum D)^2}{N}}{N - 1}}$$

Step 3: N - 1
[note: this is
your degrees of
freedom]

$$\sqrt{N}$$

Step 4: Square
root of N

Group of participants take part in both conditions

Participant number	Stats exam year one	Stats exam year three
1	50	62
2	49	48
3	30	52
4	59	71
5	57	65
6	42	40
7	48	50
8	25	43
9	61	59
10	47	72

Step 1: calculate differences between the two sets of scores

Participant number	Stats exam year one	Stats exam year three	Difference
1	50	62	+12
2	49	48	-1
3	30	52	+22
4	59	71	+12
5	57	65	+8
6	42	40	-2
7	48	50	+2
8	25	43	+18
9	61	59	-2
10	47	72	+25
Total =			94

Step 2: calculate the difference squared for each P and the total

Participant number	Stats exam year one	Stats exam year three	Difference	Difference squared
1	50	62	+12	144
2	49	48	-1	1
3	30	52	+22	484
4	59	71	+12	144
5	57	65	+8	64
6	42	40	-2	4
7	48	50	+2	4
8	25	43	+18	324
9	61	59	-2	4
10	47	72	+25	625
Total =			94	1798

Step 1: Sum of D squared

Step 2: (Sum of D squared divided by N

Step 3: N - 1 [note: this is your degrees of freedom]

Step 4: Square root of N

$$\sqrt{\frac{\sum D^2 - \frac{(\sum D)^2}{N}}{N - 1}}$$

$$\sqrt{N}$$

$$\frac{\overline{D}}{SE} = 9.4$$

$$= 3.19$$

$$T = 2.95$$

Paired Sample t-Test			
		Mean	Std. Deviation
Pair 1	firstyear - thirdyear	-9.40000	10.07968

		Std. Error Mean
Pair 1	firstyear - thirdyear	3.18748

t	df	Sig. (2-tailed)
-2.949	9	.016

Reporting t-test stats

- Specific convention is the same as with the independent samples t-test

$t(df) = t\text{-value}, p\text{-value} (p < / > .05)$

e.g., $t(9) = 2.95, p < .05$

Writing the results

- For this section of your report, you need to include the statistical formula on the previous slide, plus include the means and SD's for each of the conditions...
 - *For this assessment, the means and SD's for each of the two conditions will be provided for you – you simply have to calculate the 't' and work out whether you have a significant difference in your results or not!*

Writing the results

- You **MUST** include both descriptive statistics and inferential statistics in the results section of the report
 - Descriptives = means and SD's of each condition
 - Inferentials = the t-test formula with the correct stats
- How you do this is up to you... either a sentence at the beginning highlighting the descriptives or have these in a table.
 - *Note that with a t-test, the descriptives are also used to demonstrate the DIRECTION of the difference...*

Writing the results

- Example results section for our stats exam 'study'
 - A paired samples t-test was conducted in order to assess the difference in participants scores on a stats test across two time points; year one of the degree and year three of the degree. Results show that participants scored significantly higher in year three ($M = 56.20$, $SD = 11.29$) than in year one ($M = 46.80$, $SD = 11.79$); $t(9) = 2.95$, $p < .05$.

Some additional conventions...

- The following letters are always italicised, and are presented as below (i.e., in lower case or upper case)
 - M (upper case)
 - SD (upper case)
 - t (lower case)
 - p (lower case)

And that is it...



Workshop this week

Data collection for REP30_1

- VERY IMPORTANT that you attend/stay for this – failure to attend will result in you not having any data...

Then ...

- Start to construct the method section
- Practice calculating 't' using a dummy set of data
