

The background is a vibrant, abstract collage. It features large, organic shapes in shades of orange, blue, and lime green. These shapes are decorated with various patterns: some have a fine dotted texture, others have larger white dots, and some feature wavy white lines. Small, black, squiggly lines are scattered throughout the composition. A white horizontal bar is visible in the top left corner.

RESEARCH METHODS I

T-test

Stacey Coleman

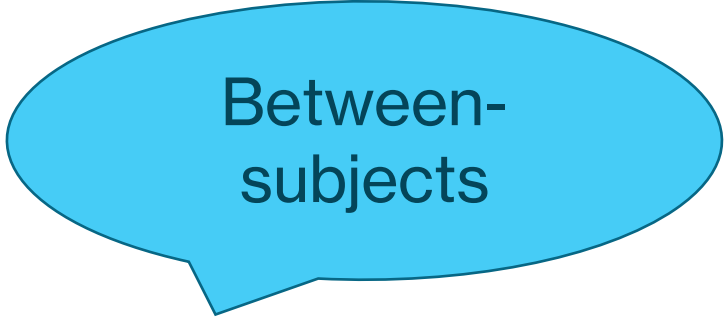
Lecture Outline

- 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

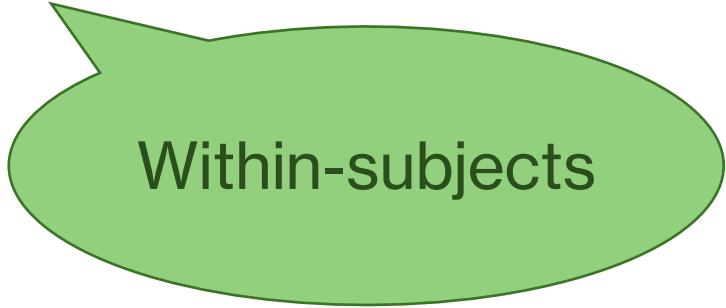
- Between-subjects (unrelated design)
- Within-subjects (related design)
- Mixed designs (a bit of both!)

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 less than .05, 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**

T-test analysis

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

Two types of t-test...

Between-subjects
design

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

Two types of t-test...

Within-subjects
design

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

T-test analyses

- When conducting a t-test, there are two separate analyses that we can use
 - **Independent samples t-test (between-subjects design)**
 - **Paired samples t-test (within-subjects design)**
- Both types of t-test generate similar information, and both are reported in exactly the same way



A t-value from calculating the t-score

Information from a t-test

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...)

Information from a t-test

- 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

Information from a t-test

- 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



A value for degrees of freedom

Information from a t-test

2. A value for degrees of freedom

- 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'

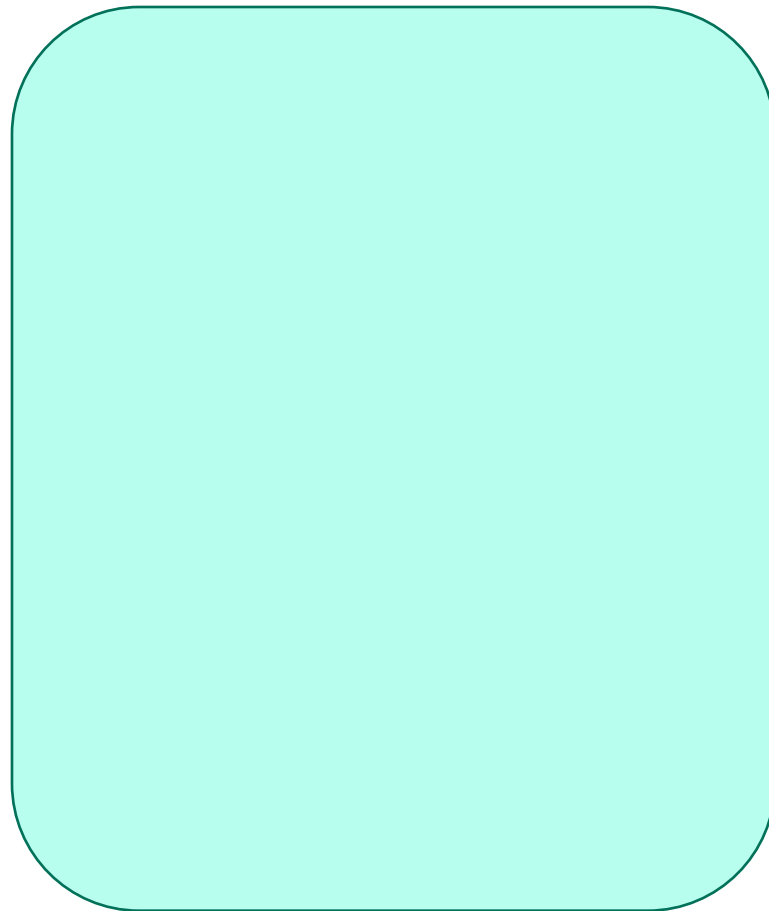
A large crowd of stylized human figures in various colors (blue, green, yellow, orange) with a prominent white figure in the center. The figures are arranged in a dense group, with the white figure standing out in the middle. The background is a soft, out-of-focus gradient of light blue and white.

**TEN VOLUNTEERS
NEEDED**

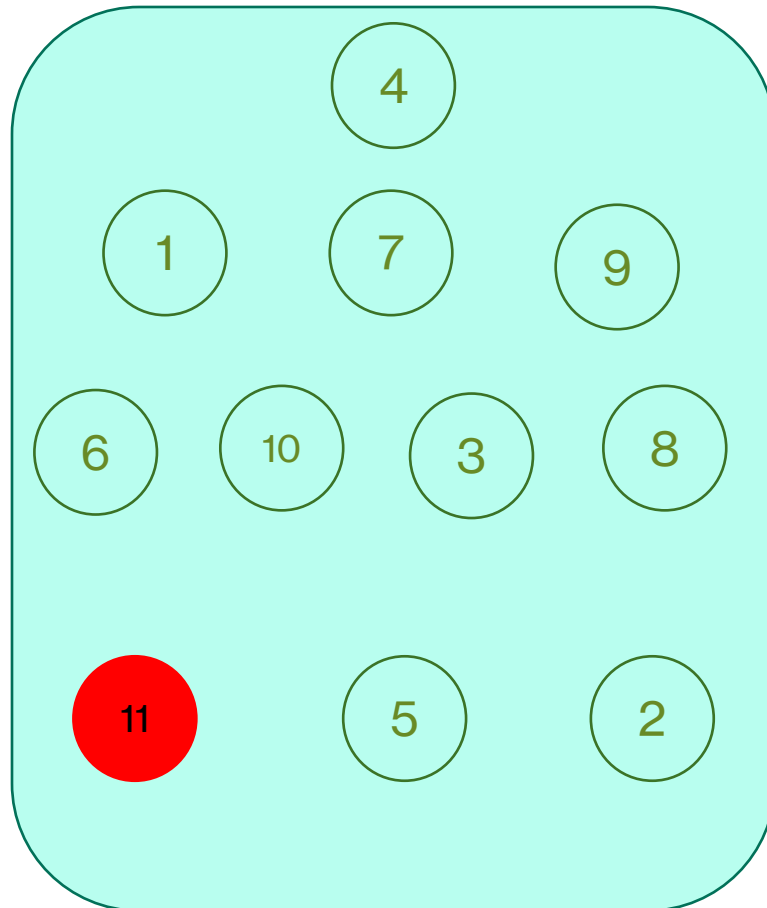
Degrees of freedom

- Removing statistics, we can start to understand DF using everyday things that we generally understand...
- E.g., football teams.
 - We know that there are two teams, and each team has 11 players. So we can use this to understand DF in **two groups**.

Degrees of freedom: Team 1



Degrees of freedom: Team 1



How many of the
players have been 'free'
to choose their own
position??

N minus 1

$N = 11$
 $N \text{ minus } 1 = 10$

Degrees of freedom

- The exact same is then true for Team 2 (e.g., group 2)... so, the DF for that group is also 10.
 - So, if we had 22 participants across two groups, our DF would be 20.
 - This means that the DF for the **entire sample of data** is **N – 2!**
- THE DF FOR AN INDEPENDENT SAMPLES T-TEST IS ALWAYS N-2**

Degrees of freedom

- If we have a within-subjects design where **one group of participants** takes part in two conditions, then the DF is $N - 1$.
- **THE DF FOR A PAIRED SAMPLES T-TEST IS ALWAYS $N-1$**

Degrees of freedom in terms of stats...

- Beyond a basic explanation of what DF's are, we can start to understand what this means when using numbers
- E.g., if we have 4 numbers (pieces of data) then 3 of these are free to move around / change whilst the last is set...

6 , 8 , 2 , 8 total = 24 so mean equals 6

Three of these can change to any other number, and the final number is set because the mean has to remain the same!



A p-value / sig. value that indicates a significant or non-significant difference

Information from a t-test

3. A significant or non-significant result

(i.e., $p < / > .05$)

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

How does this all fit together?

Example stats:

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

Formula for reporting a t-test
(BOTH)

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

So...

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



INDEPENDENT SAMPLES T-TEST

Between-subjects designs

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

Between-subjects designs

- ***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?

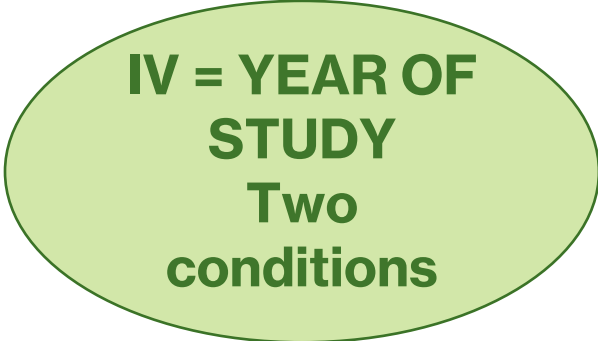
Example study 1

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

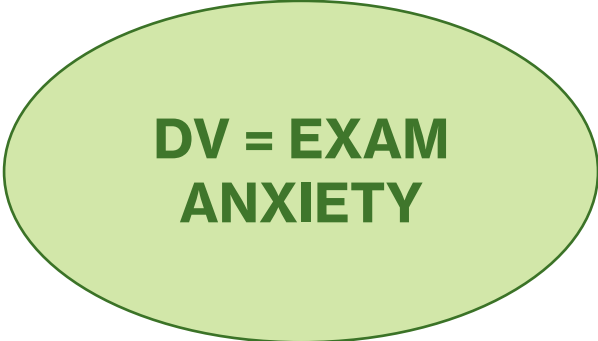
- We are looking for a difference between two independent groups  First year students and third year students
- We take a sample from each population  A sample of first years and a sample of third years
- We compare the two samples by comparing the mean differences on a given variable  Exam anxiety

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?

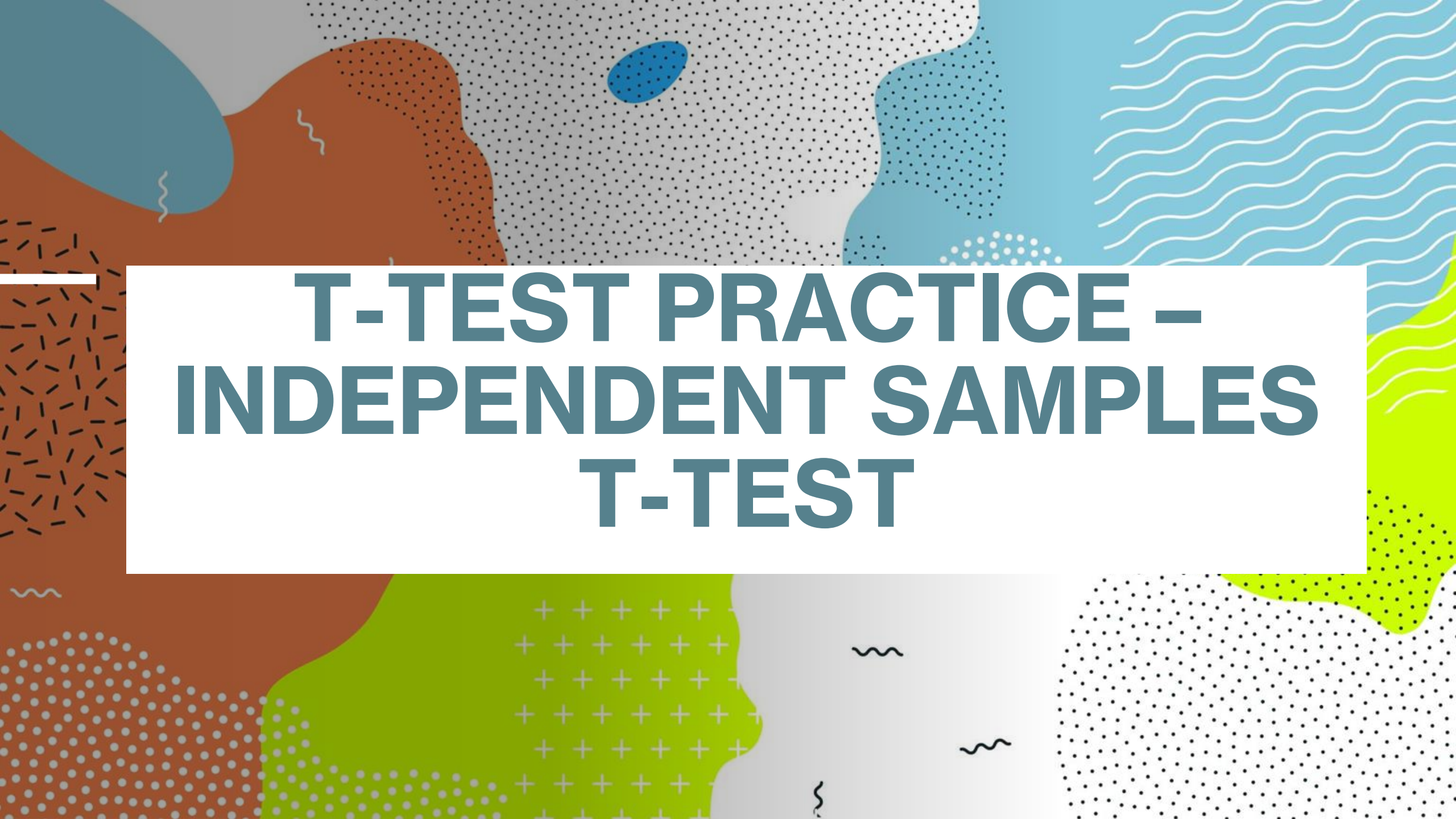
- Hypothesis must **always** be generated from your literature search and can be directional (one-tailed) or non-directional (two-tailed)
- **Non-directional (two-tailed)**
 - There will be a significant difference in the reported exam anxiety scores of first- and third-year students
- **Directional (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-TEST PRACTICE – INDEPENDENT SAMPLES T-TEST



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 with two levels:
March and September

DV: creativity

What is the IV?

What is the DV?

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?

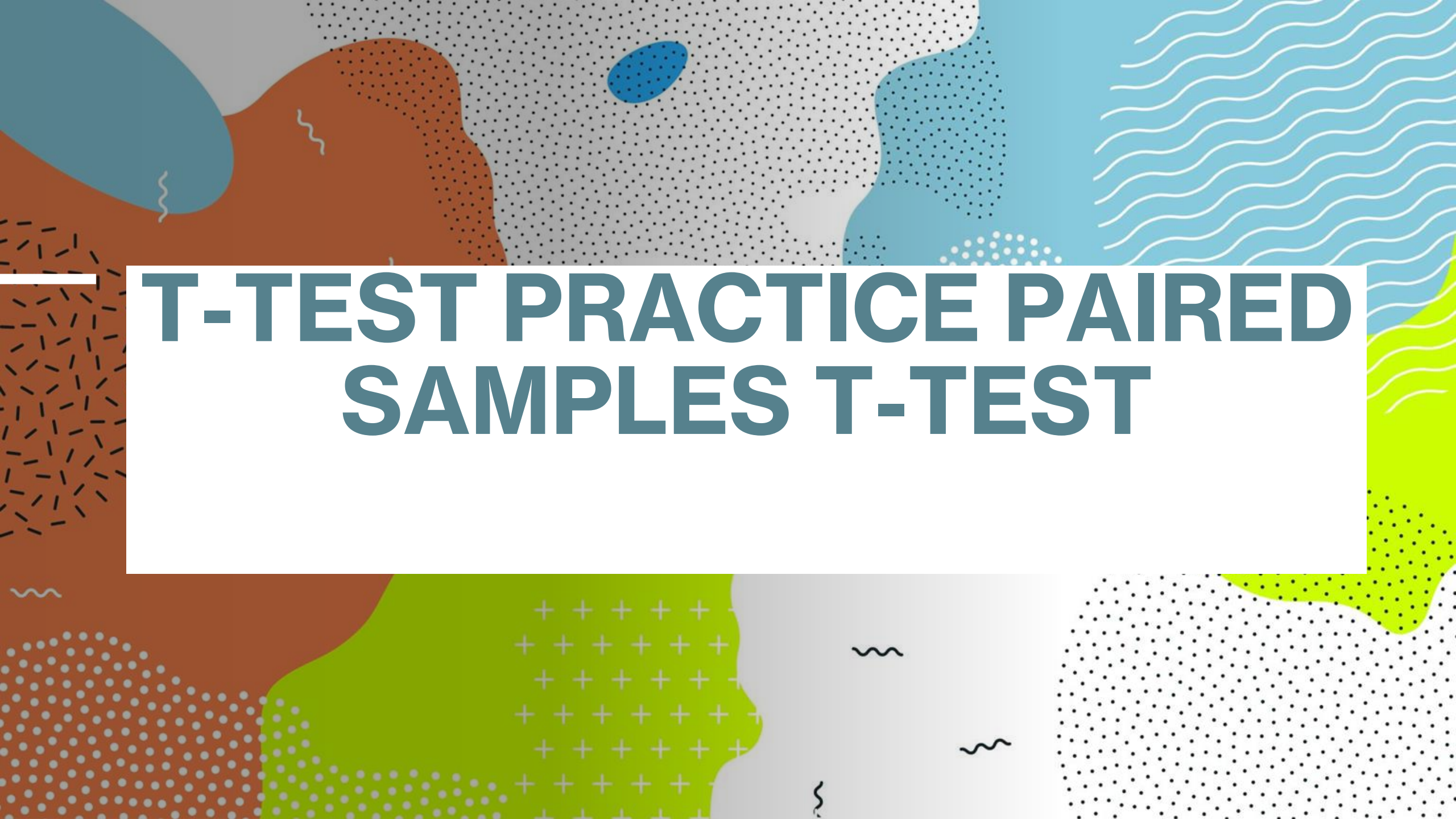
What is the DV?

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-TEST PRACTICE PAIRED SAMPLES T-TEST