

✧ Experimental Design ✧

Experimental (or research) design is a concept that should be taught early in any scheme of work on research methodology. It is important that students can clearly identify the features of independent groups, repeated measures, and matched pairs; as well as discuss the strengths and limitations of each. This book includes several experiments that can be used to demonstrate these concepts, with independent groups being a key feature of the laboratory experiments I have suggested. I have provided an example of each type in this chapter, along with resources to facilitate comparison and discussion.

When delivering this topic, you should emphasise the following aspects:

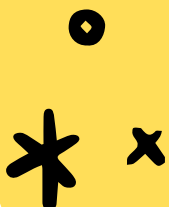
- Independent groups - Less chance of demand characteristics and order effects, but requires more participants and is affected by participant variables.
- Repeated measures - Eliminates participant variables but increases the risk of demand characteristics and order effects.
- Matched pairs - Reduces participant variables and order effects but is more complex to manage.

#1 - Independent Groups - Anchoring

This is a simple experiment to demonstrate Kahneman and Tversky's concept of anchoring. In my experience, this consistently produces a noticeable difference between the two groups. Students who see a relatively low number are likely to predict a much lower answer in response to the question compared to those who see a larger number.

DELIVERY

- Using Worksheet ED1, cut up the squares so that you have enough numbers for each student in the class. Half the group should receive the smaller number (10), while the other half should receive the larger number (65).
- Cut up the required quantity of each number, fold them in half, and place them in a pot, hat, or another receptacle of your choice. Ask each student to pick out a number but instruct them not to look at it just yet.
- At this stage, I recommend avoiding any detailed explanation of the experiment's aims to minimise demand characteristics. You could even introduce a slight misdirection by suggesting that the number will be needed for something later in the lesson.



10



65



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- Instruct students to look at the number privately, then fold it back up and put it to one side.
- Next, simply read out a question asking them to estimate a fairly ambiguous quantity. Here are some suggested questions, starting with the one used by Kahneman in the original study:
- Estimate the percentage of African countries in the United Nations.
- How many tiles are there on a standard Scrabble board?
- What percentage of the Earth's surface is covered by water?
- What percentage of the world's population lives in Asia?
- What percentage of the human body is made up of water?
- Of course, you can come up with your own questions. The answer should be between 1 and 100, and not something the average person would likely be sure about.
- Once the estimates are in, simply add up the mean estimate for each condition (the '10' group and the '65' group). You will likely find a higher estimate for the group who were anchored with a higher number. You can then reveal the true aims and hypothesis of the experiment.

You can link this to the Cognitive approach and talk further about the work of Kahneman and Tversky. You could introduce ideas like priming, cognitive biases and system 1 and 2 thinking.

DEBRIEF

Discuss the fact that each condition contained different participants. Ask them if they knew the aims. You can also discuss the lack of demand characteristics. You should highlight the participant variables e.g. will Geography students be more likely to know the answer?

STATS & GRAPHS

A simple bar chart should be used here to present the mean difference between the conditions. Level of measurement is ordinal.

Mann-Whitney

inferential stats testing should be used here.

#2 - Repeated Measures - Concentration

This is a way of demonstrating repeated measures by looking at how music can affect concentration. I have provided a manual Stroop test to measure concentration, but there are many online versions that would work just as well. You could also find other ways to measure concentration that would be equally effective.

DELIVERY

- You could start by explaining the concept of repeated measures and making it clear that all students will be taking part in both conditions of the independent variable (IV).
- Explain how the Stroop test works. If using the paper version (ED2), explain that they first need to use the incongruent grid. They should read out the colour, not the word, for each item in the grid and time themselves (they will have timers on their phones or watches)

Incongruent Grid:

RED	BLUE	GREEN	YELLOW	BLUE
PURPLE	ORANGE	GREEN	BLUE	RED
YELLOW	RED	BLUE	ORANGE	PURPLE
GREEN	ORANGE	YELLOW	RED	BLUE
YELLOW	RED	ORANGE	BLUE	PURPLE



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- Students should note the time taken to read the incongruent words (they can do this in their heads or aloud, depending on the setup in your room).
- They need to repeat this with the congruent words (where the word and colour match). They should record the time taken for this. The Stroop effect is the difference between their incongruent and congruent times. If you want to streamline the process, you can simply use their incongruent time as the dependent variable (DV) measure for concentration.
- The independent variable (IV) in this case is music. When they first complete the Stroop test, you should play some relaxing music at a fairly audible volume in the classroom. This could be classical music or any type of soothing, relaxing music.
- Get students to repeat the test, but this time play music that is much more high-energy. You could opt for heavy metal or high-tempo dance music, for example.
- Finally, calculate the average Stroop effect for each of the two music conditions. Remember, a smaller Stroop effect is evidence of better cognitive processing and concentration.



The Stroop effect is a way to measure cognitive filtering. This is linked to the cognitive approach.

Stroop tests have been used to research cognitive processing in people with schizophrenia, for example.

DEBRIEF

You should discuss the issue of order effects in relation to the experimental design. In the case of the Stroop test, you should mention the practice effect and how this may have had a greater impact than the type of music. You could also discuss other potential confounding variables.

STATS & GRAPHS

A simple bar chart should be used here to present the mean difference between the conditions. Level of measurement is interval as stroop effect has no true Zero. Wilcoxon testing should be used here.



#3 - Matched Pairs - Caffeine

A proper matched pairs design would be quite difficult to implement in the average classroom. This experiment would work well as another example of independent groups, but there are some relatively simple ways to try and match students on a few characteristics. In this experiment, the independent variable (IV) is whether or not students have consumed a caffeinated drink, and the dependent variable (DV) is reaction time.



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DELIVERY

- Make sure you fully explain how a matched pairs experimental design works.
- Next, attempt to allocate students into the caffeine and no-caffeine conditions.
- There are a few different ways to try and match your pairs. If you teach in a single-sex school, gender will not be a factor in your matched pairs design. If you have a mixed class, you should pair people up with someone of the same sex.
- Ask the class what factors, other than caffeine consumption, might impact reaction time. Try to guide them towards some of the following categories:



How well have they slept?
Did they have breakfast?
How tall are they?
Do they play sports?



- Now comes the challenging part! Depending on the number of students and their answers to the above questions, try to pair them up as best as you can.
- For example, if you have a boy who slept well and had no breakfast, see if you can find a similar counterpart. If you have a tall girl who plays sports, try to find another student with similar traits.
- This will not be an exact science and may be a bit chaotic, but do your best to match students as well as possible. It may be easier to focus on just one factor, like breakfast, and pair up based on that factor. The key is for students to see the principle of matched pairs in action to some degree.
- Once you have two groups, pour a small measure of a caffeinated energy drink for each student in the caffeine condition and get them to drink it.
- Wait for a few minutes, then have them measure their reaction time by holding a 30cm (or 1 metre) ruler between their thumb and index finger at the lower end. They must let go of the ruler and then grab it again with their thumb and index finger as quickly as possible. The measure will be the number of centimetres (or millimetres) that the ruler has dropped, indicated by where they catch it.
- Have the non-caffeine group do the same. Then, simply calculate the mean reaction time in centimetres for each group and compare the results.

You could make links to the biological approach by discussing the impact of a substance like caffeine on the body. You might also explore the issue of addiction and consider the extent to which caffeine can be problematic.

DEBRIEF

Discuss the benefits of matched pairs in the context of reducing participant variables. It's important to note that the process was much more complicated and time-consuming. You can also consider that there are still likely to be other confounding variables at play.

STATS & GRAPHS

A simple bar chart should be used here to present the mean difference between the conditions.

Level of measurement is ratio.
A Wilcoxon inferential stats test should be used here.



Experimental Design*

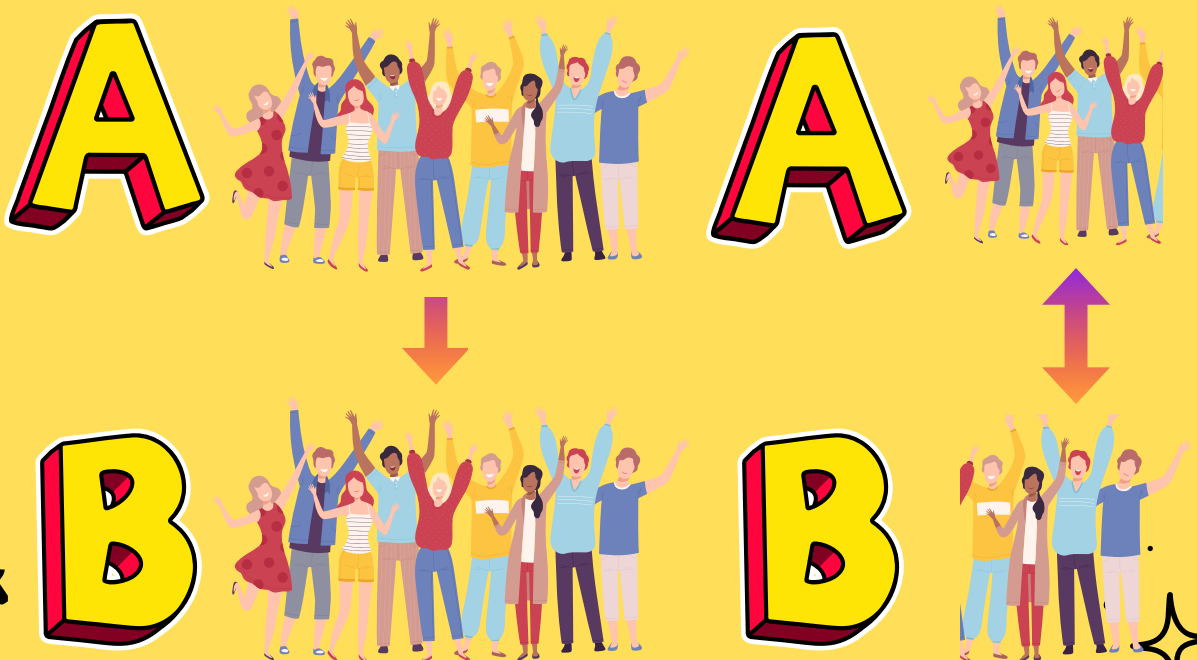
Extension and Development

Comparing and contrasting these different experimental designs is important, and you could use the Worksheet ED3 to help. You could swap out the experiments here for many of the others you will find in other chapters of this book to illustrate the same points.

The repeated measures study here is highly adaptable, and you could experiment with the independent variable (IV). Stroop scores could be influenced by many other factors, such as the lighting or conditions in the room, the size and type of font used, or the proximity of other people.

One important aspect you could develop is the way in which you can address the problems posed by each type of design. Counterbalancing is a concept you could introduce at this stage. You could demonstrate this by getting half of the class to complete the Stroop test with relaxing music first, followed by high-energy music, while the other half does the opposite. You could also discuss the fact that demand characteristics are much more likely to be a factor in this scenario.

Students can complete some graph work and summary notes on the sheets provided, as well as the comparison table.



10	10	10	10	10
10	10	10	10	10
10	10	10	10	10
10	10	10	10	10
10	10	10	10	10

65	65	65	65	65
65	65	65	65	65
65	65	65	65	65
65	65	65	65	65
65	65	65	65	65

Stroop Test

Instructions: In the incongruent grid, say the colour of each word, not the word itself. For the congruent grid, just read each word as you go through the list.

Incongruent Grid:

RED	BLUE	GREEN	YELLOW	BLUE
PURPLE	ORANGE	GREEN	BLUE	RED
YELLOW	RED	BLUE	ORANGE	PURPLE
GREEN	ORANGE	YELLOW	RED	BLUE
YELLOW	RED	ORANGE	BLUE	PURPLE

Congruent Grid:

RED	BLUE	GREEN	YELLOW	BLUE
PURPLE	ORANGE	GREEN	BLUE	RED
YELLOW	RED	BLUE	ORANGE	PURPLE
GREEN	ORANGE	YELLOW	RED	BLUE
YELLOW	RED	ORANGE	BLUE	PURPLE

Research Methods Reimagined

Time taken for incongruent grid _____

Time taken for congruent grid _____

Stroop Effect (difference) _____

ED2

Experimental Design

Experimental Design	How was it used in this research?	What were the strengths of using it in this research?	What were the limitations of using it in this research?	How could these limitations be reduced or overcome?
INDEPENDENT GROUPS				
REPEATED MEASURES				
MATCHED PAIRS				

Research Summary *

Experimental/Alternative hypothesis:

Null hypothesis:

Independent variable (state how it was operationalised):

Dependent variable (state how it was operationalised):

What experimental design was used?

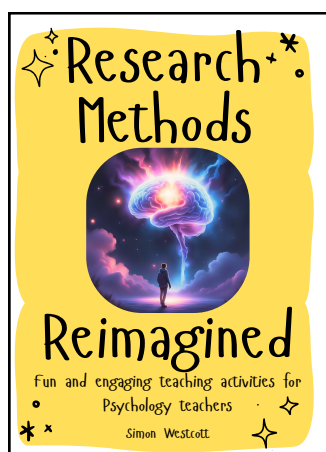
Identify one strength & one limitation of the experimental design used in this study.

Identify any validity, reliability or ethical issues that may have impacted on the research.

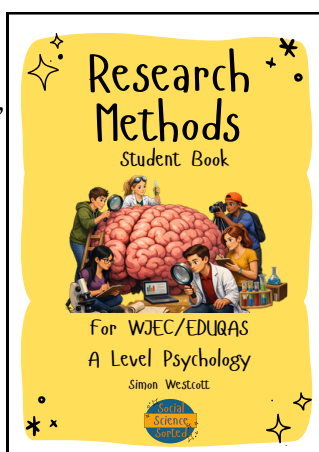


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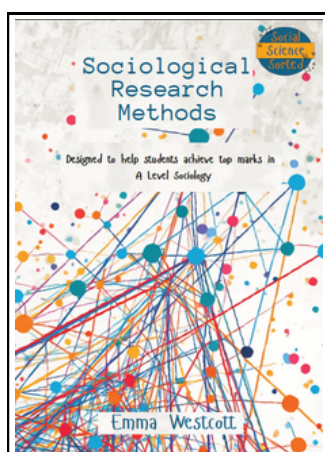


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