The big picture

? Subtopic question(s)

During this subtopic, you will be working towards answering the following subtopic question:

- What role can experiments play in understanding human cognition?

As you have learned, one event can be remembered very differently by individuals. But how do psychologists understand why this happens?

Cognitive psychologists use the experimental method to study processes like memory and decision-making (**Figure 1**). The experimental method allows us to measure variables that affect how we remember, think and make decisions. It adds objectivity to subjective experiences. When studying memory, experiments allow researchers to isolate variables (for example, word lists, time delays) while keeping other factors constant, which would be difficult to do in the real world.

In this subtopic, you will learn how to create your own experiment to study a cognitive process, such as memory, and why the experimental method is useful for understanding human behaviours.

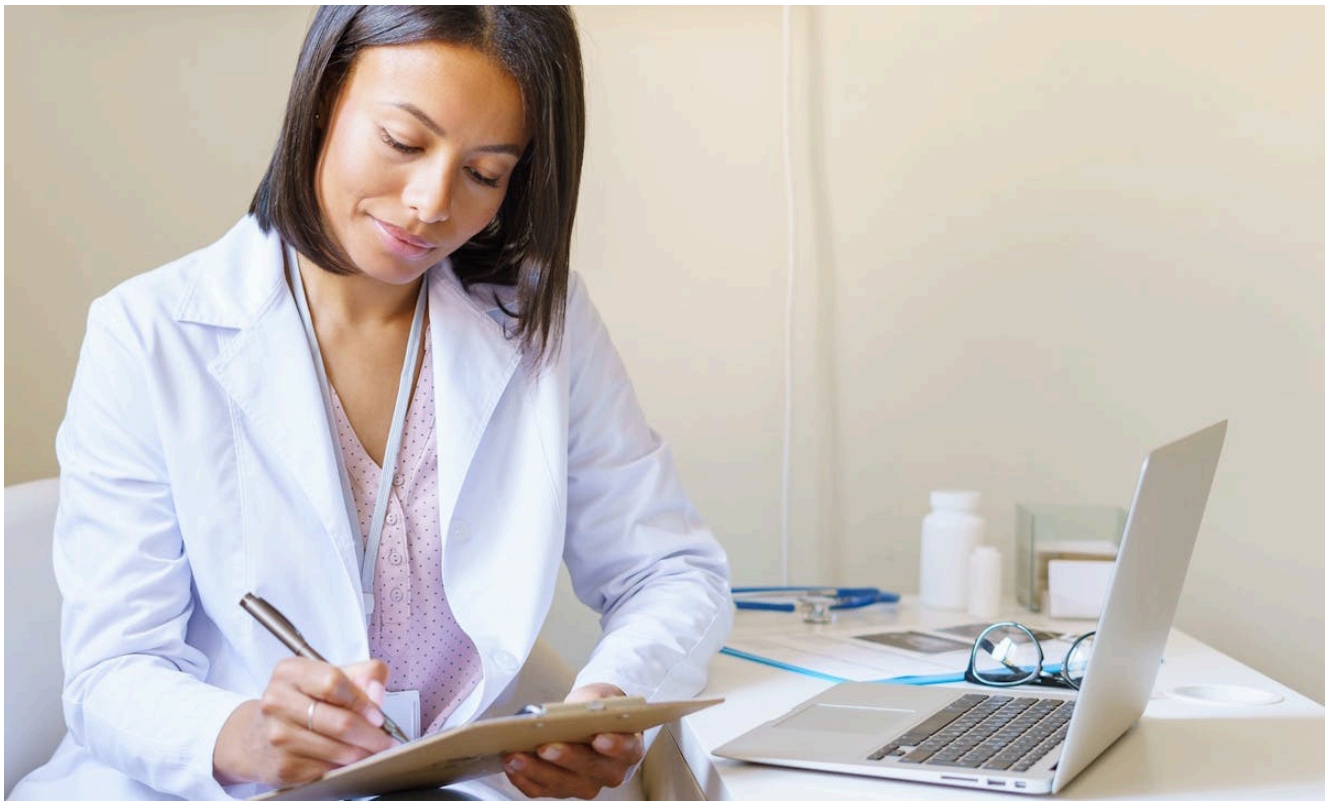

Figure 1. The experimental method in psychology has helped us gain insights into human cognition.

Credit: NataBene, Getty Images

Overview (/study/app/psychology-new/sid-540-cid-763690/c

The completion of the activities in this practical will be helpful when you are designing your own research proposal for the **Internal assessment** (/study/app/psychology-new/sid-540-cid-763690/book/introducing-the-internal-assessment-id-49477/). Your knowledge and understanding from the practicals will be assessed in Paper 2.

Making connections

- In **subtopic 1.1** (/study/app/psychology-new/sid-540-cid-763690/book/big-picture-id-49350/), you learned about the experimental method in psychology. In the current subtopic, you will learn how to apply those elements to studying one cognitive process.
- Many research studies on treatments for disorders utilise the experimental method through random or pre-existing allocation to treatment conditions (see **subtopic 2.2** (/study/app/psychology-new/sid-540-cid-763690/book/the-big-picture-id-49438/)).

3 section questions

Question 1

SL HL Difficulty:

Which of the following is a potential limitation of using a true experiment in cognitive psychology?

1 It may introduce demand characteristics that affect participant behaviour. ✓

2 It ensures that the results can be generalised to real-world settings.

3 It allows for a high level of control over other factors that could influence the dependent variable, but they are not the independent variables.

4 It minimises the risk of researcher bias affecting the results.

Explanation

Laboratory experiments are conducted in controlled, artificial environments, which provide high control over other variables.

Question 2

SL HL Difficulty:

Which of the following is a key characteristic of an experiment in psychology?

1 It allows researchers to establish cause-and-effect relationships by manipulating the independent variable. ✓

2 It aims to identify correlations between variables without manipulating them.

3 It requires participants to complete surveys and questionnaires only.

4 It focuses on observing natural behaviours.

Explanation

One of the defining features of an experiment in psychology is that it manipulates the independent variable to observe its effect on the dependent variable. This allows researchers to establish cause-and-effect relationships.

Student view

Question 3

SL HL Difficulty:

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Which of the following best describes the method used in Loftus and Palmer's study on the effect of language on memory?

1 Participants were randomly assigned to different conditions to test the effect of word choice on memory recall. ✓

2 A case study was conducted to observe individual memory recall.

3 A naturalistic observation was used to study memory in everyday situations.

4 A survey method was used to gather self-reported data about memory accuracy.

Explanation

In Loftus and Palmer's experiment, participants were exposed to different wordings of a question about a car accident, such as 'smashed' or 'hit,' to investigate how the language used could influence their memory recall of the event.

Previous section(/study/app/psychology-new/sid-540-cid-763690/book/collected-research-studies-id-50547/review/) Next section (/study/app/p

Student view

What are experiments?

C-4-2: Identify the appropriate selection of research methodology to investigate a psychological question.

C-4-3: Describe the advantages and disadvantages of different research methodologies.

C-4-7a: Identify and discuss how data is represented and analysed in different forms based on the design of the study and the nature of the data.

C-4-7b: Analyse and interpret different types of data tables, graphs and results.

Teacher instructions

Learning outcomes

- Identify the appropriate selection of research methodology to investigate a psychological question.
- Describe the advantages and disadvantages of different research methodologies.
- Identify and discuss how data is represented and analysed in different forms based on the design of the study and the nature of the data.
- Analyse and interpret different types of data tables, graphs and results.

Facilitation guidance

In this section, students will learn about experiments and their role in understanding human cognition. They will revisit content on quantitative research from **subtopic 1.1** (/study/app/psychology-new/sid-540-cid-763690/book/big-picture-id-49350/), and apply it to cognitive processes. Students will have an understanding of both quasi- and true experiments, as well as their strengths and limitations, and this will inform their decision on the type of experiment to conduct in their practical.

? Subtopic question(s)

During this subtopic, you will be working towards answering the following subtopic question:

- What role can experiments play in understanding human cognition?

Experiments in cognitive psychology have helped us understand the many different ways our minds work and are impacted. Experiments have demonstrated how our memories can be distorted easily, how our decisions can be influenced without our awareness and how our thinking can be highly prone to error.

Experiments are a common method used in cognitive psychology. They can help to isolate specific cognitive processes, such as memory, attention and decision-making. Experiments are also used to test hypotheses formed from theories and models of cognitive processes. The findings of these experiments allow these models (such as the multi-store model of memory) to be developed and refined. For example, in their memory experiments, Baddeley and Hitch (1974) (https://doi.org/10.1016/S0079-7421(08)60452-1) (https://doi.org/10.1016/S0079-7421(08)60452-1)noticed that people were able to complete two cognitive tasks well if they were different (such as a visual and a verbal task). They then developed their working memory model based on the findings from these experiments.

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Theory of knowledge

Experiments

Psychological experiments often bridge the gap between human sciences and natural sciences, however, there are key differences between the two.

Reflection questions

1. How are experimental results interpreted differently in human sciences compared to natural sciences?
2. Are experiments as rigorous in the human sciences as the natural sciences?
3. How does this affect knowledge gained in these two areas?

There are several types of experiment in psychology, as shown in **Table 1**. The two main types that will be discussed in this subtopic are true experiments and quasi-experiments. Two experiments that will be addressed as examples are:

- Landry and Bartling's (2011) (https://www.mcneese.edu/wp-content/uploads/2020/08/AJPR-11-07-Landry-5-09.pdf) true experiment investigating the phonological loop.
- Maguire et al. (2000) (https://doi.org/10.1073/pnas.070039597) quasi-experiment investigating the brains of London taxi drivers.

Table 1. The different types of experiment used in psychological research.

True experiment	The researcher manipulates the independent variable and randomly assigns participants in a controlled setting, usually a lab.
Quasi-experiment	The independent variable is pre-existing in a real-world setting, but there is less control over extraneous variables.
Field experiment	The researcher manipulates the independent variable in a real-world setting, but has less control over extraneous variables.
Natural experiment	The independent variable occurs naturally, and the researcher does not manipulate it or assign participants to conditions.

True experiments

In psychology, true experiments are used to establish a causational relationship between two variables: the independent variable (IV) and the dependent variable (DP). In cognitive psychology, experiments can help us understand mental processes, such as memory, and complex behaviours.

In true experiments, the IV is manipulated, and the effect of this on the DP is observed/measured (**Figure 1**). For example, in Landry and Bartling's experiment, the influence of an articulatory suppression task (counting '1, 2' repeatedly) on serial recall of lists of letters was observed.

There is at least one experimental condition and one control condition. The reason that experiments have a control group is to act as a baseline for comparison. This group does not receive the manipulation being tested. In Landry and Bartling (2011), the experimental condition was required to do the articulatory suppression task between seeing the lists of letters and recalling them, whereas the control condition did nothing at this time.

Student view

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Participants are randomly assigned to conditions. This means that any selection bias is minimised. In other words, because they are randomly assigned to groups, we can be more confident that the differences observed are because of the IV, not the pre-existing differences between the participants!

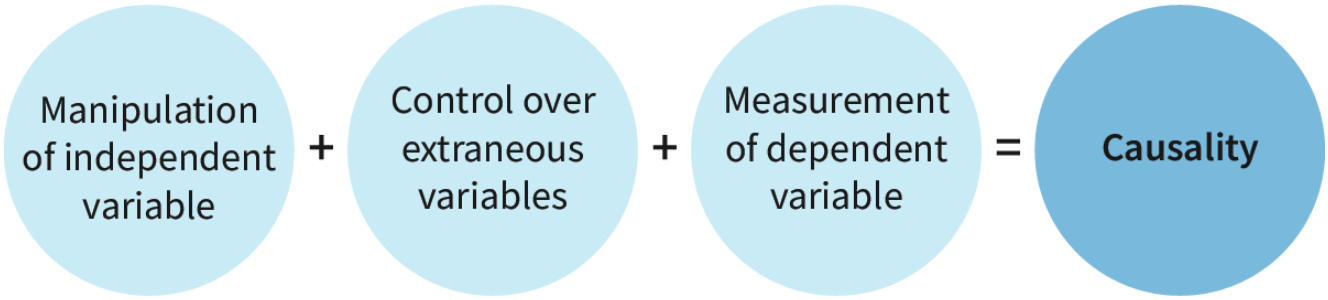

Figure 1. How experiments establish causality.

More information for figure 1

Four circles containing text. Plus signs connect the first and second circles, and the second and third circles, but an equals sign connects the third and fourth circles. From left to right, the whole diagram reads Manipulation of independent variable plus Control over extraneous variables plus Measurement of dependent variable equals Causality.

In true experiments, researchers aim to control the extraneous variables (any factors that are not the IV that could cause a change in the DV). For example, researchers conduct the experiment in the same environment at the same time of day to ensure that factors like room temperature or noise do not affect participant responses. In Landry and Bartling's study, participants only viewed one list of letters at a time to make sure they were not distracted by the other lists. This is an example of a controlled variable that could have impacted their recall. However, controlling for every single variable may not be possible in experiments.

Perspective lens

Cognitive, biological and social approaches

Experiments are useful for studying behaviour through a cognitive approach, as many memory processes can easily be tested, and confounding variables can be controlled for. Experiments in cognitive psychology (for example, memory, attention, decision-making) can often be conducted in controlled lab settings, where variables are easier to manipulate and measure (for example, reaction times, recall accuracy). There are also fewer ethical concerns since tasks are often non-invasive.

In contrast, it may be more difficult to conduct experiments to study behaviour from a biological or sociocultural perspective.

Reflection questions

1. Brainstorm an example of an experiment used in the biological approach and an example of an experiment used in the sociocultural approach.
2. With reference to these examples, what challenges exist when conducting experiments to understand behaviour from a biological and sociocultural approach?

Student view

Researchers can use a single-blind design, where the participants are unaware of the experimental condition they are in. If participants are aware of which condition they are in (either the experimental or control), they may change their behaviours, either consciously or unconsciously. This is known as demand characteristics. Sometimes, researchers may

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also use a double-blind design, meaning that neither the participants nor the researchers are aware of the condition in which participants are placed. This means that both participant bias and researcher bias are minimised when collecting and interpreting data.

HL Extension

Motivation

Understanding and managing motivation is essential to conducting valid experiments in psychology. In many experiments, for example, participants may volunteer to participate due to some kind of reward, which may mean that they are highly motivated.

Bowen and Kensinger (2017) (https://doi.org/10.1525/collabra.77) explored how different types of compensation, such as cash or course credit, can affect motivation and performance in a memory task. Participants who were paid in cash showed better memory for high-value items, suggesting that money made them more focused on rewards. In contrast, those who received course credits performed similarly regardless of reward value, even when given the chance to earn bonus credit. These findings suggest that cash rewards may increase motivation by making participants more engaged with the task, whereas course credit does not have the same effect. This study demonstrated the importance of considering how compensation of participants influences motivation in psychology research.

Reflection questions

1. Why do you think participants were more motivated by cash rewards in this study?
2. How else do you think the motivation of both the researcher and the participants could influence the outcomes of experiments? How can this be avoided?

Because researchers use random assignment, and take measures to control for extraneous variables, experiments have high internal validity. True experiments follow standardised procedures, meaning that other researchers can replicate the same experiment in similar conditions. This is important for verifying the findings of research and ensuring they are reliable.

True experiments have high internal validity by rigorously controlling variables. However, because of this, they may create artificial environments that do not reflect real situations, thus lowering the ecological validity and mundane realism of the study. When studying cognitive processes, it could be argued that these lab-based experiments may not truly capture the complexity of these processes. Therefore, the generalisability of these findings to everyday situations may be limited.

Concept

Responsibility

In the world of scientific research, particularly psychology, there is a growing issue that many researchers are struggling to replicate research findings.

This issue was brought to people's attention by an Open Science Collaboration in 2015 (https://doi.org/10.1126/science.aac4716), where they failed to replicate findings from over 100 psychology studies published in three journals.

This puts into question the **responsibility** researchers and institutions have to ensure their results can be replicated. This issue was found to be due to problems with the methods used and publication bias in research.

Student view

Reflection questions

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1. Conduct research on the 'replication crisis' in psychology. How can researchers and institutions take responsibility to ensure that their experiments are replicable? What factors may be contributing to this replication crisis?
2. What counts as good evidence for a claim?

Quasi-experiments

There are several key differences between true experiments and quasi-experiments. In quasi-experiments, participants are not randomly assigned to conditions. Instead, they are assigned based on pre-existing characteristics such as gender or occupation. For example, in Maguire et al.'s 'taxi driver' study, participants were either a taxi driver or not a taxi driver – two conditions that are impractical to randomly assign to! Using pre-existing conditions is beneficial when random assignment may be difficult or even unethical.

Because there is no random assignment in quasi-experiments, control over extraneous variables is often harder than in true experiments. As a result, we cannot establish a strong cause-and-effect relationship between the IV and the DV. Random assignment helps to eliminate selection bias and confounding variables, which is not done in a quasi-experiment. For example, in Maguire et al.'s (2000) study, we cannot be sure that the differences in the brains of taxi drivers existed before their driving experiences or whether it was because of their driving experiences.

While this is a limitation, quasi-experiments may have higher external validity because they take place in less controlled settings and involve fewer control variables, making the results more applicable to real-world situations (**Table 2**).

Table 2. The differences between true and quasi-experiments.

True experiments	Quasi-experiments
A type of experiment where participants are randomly assigned to conditions.	A type of experiment where participants are assigned to conditions based on pre-existing factors.
The IV is manipulated by the researcher.	The IV is not manipulated. Instead, this is based on pre-existing differences.
There is high control over confounding variables due to random assignment.	There is less control over confounding variables, as the groups may differ in ways not related to the IV.
A strong causal relationship can be established.	A weaker causal relationship is established.

Both quasi- and true experiments have their strengths and limitations. The choice of experiment depends upon the research question, context and practical considerations.

International mindedness

Experiments are grounded in universal scientific principles, such as hypothesis testing and replicability, that are applicable cross-culturally.

Reflection questions

1. How can experiments be used to explore universal aspects of human behaviour?
2. What might be the strengths and limitations of using experimental methods for this purpose?

Student view

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Paper 2 criteria

Knowledge and understanding

- The response demonstrates detailed knowledge and understanding of the research methodology relevant to the class practical.
- Psychological terminology is used accurately.

Compare and contrast

- Similarities and differences are discussed in detail.
- Psychological terminology relevant to the research methods is used effectively.

Teacher instructions

Goals

- Identify the appropriate selection of research methodology to investigate a psychological question.
- Describe the advantages and disadvantages of different research methodologies.

Facilitation guidance

For the activity, divide students into pairs to investigate a research question each. Students can share their findings via a gallery walk, or by creating new groups.

Activity

IB learner profile attribute: Knowledgeable/Thinker/Communicator

Approaches to learning: Thinking

Time required to complete activity: 20 minutes

Activity type: Pairs/Group

Which type of experiment is best?

You will be allocated one of the following research questions (RQ) and asked to choose a type of experiment (true or quasi) to investigate the question. Consider the following questions in relation to your RQ when designing your experiment:

1. Why did you choose that type of experiment? Identify the strengths and limitations of your experiment choice.
2. **(Concept application: measurement)** How would you operationalise the variables in this experiment? How does operationalising variables help to increase the validity of measurement?
3. Who would make up your sample?
4. Create a brief procedure for your experiment.
5. What ethical considerations could arise in your procedure?

Share your decision and responses to the following with one other group.

Research questions

1. How does the use of visual imagery affect the recall of word lists?
2. Does multitasking reduce accuracy in memory recall?

Student view

Overview (/study/ap new/sid-540-cid-763690/c

3. Do background noises, such as music, affect focus during a task?
4. Does providing students with immediate feedback improve test performance?

Learning outcomes

By the end of this section, you should be able to:

- Identify the appropriate selection of research methodology to investigate a psychological question.
- Describe the advantages and disadvantages of different research methodologies.
- Identify and discuss how data is represented and analysed in different forms based on the design of the study and the nature of the data.
- Analyse and interpret different types of data tables, graphs and results.

3 section questions

Question 1

SL HL Difficulty:

A researcher conducts an experiment on memory recall using two different groups of students: students who already study with music and students who prefer to study without music.

Which type of experiment is this?

Quasi ✓

Accepted answers
Quasi

Also accepted
Quasi-, Quasi-experiment, Quasi experiment

Explanation
The students are in pre-existing groups based on their preferences for studying, either with music or without music.

Question 2

SL HL Difficulty:

In a true experiment, the 1 independent ✓ variable is manipulated, and the 2 dependent ✓ variable is measured.

Accepted answers and explanation

#1 independent

#2 dependent

General explanation

In an experiment, the **independent variable (IV)** is the factor that the researcher deliberately changes or controls to observe its effects. The **dependent variable (DV)** is what is measured to see how it responds to changes in the IV.

Question 3

SL HL Difficulty:

How can demand characteristics and researcher bias affect the validity of an experiment, and what strategies can researchers use to minimise these effects?

Student view

Overview (/study/ap new/sid-540-cid-763690/c

1 Demand characteristics and researcher bias can reduce the internal validity. Strategies like double-blind procedures and standardised instructions can minimise their effects. ✓

2 Demand characteristics and researcher bias can increase the internal validity. Strategies like random sampling are used to reduce their effects.

3 Demand characteristics and researcher bias can reduce external validity. Strategies like random allocation can minimise their effects.

4 Demand characteristics and researcher bias are irrelevant to the validity of an experiment. No strategies are necessary.

Explanation

Demand characteristics refer to cues or signals in an experiment that might influence participants' behaviour, often leading them to guess the study's purpose and alter their responses accordingly. Researcher bias occurs when the experimenter's expectations or personal beliefs influence the way they conduct the study or interpret the results, also compromising internal validity.

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Student view

Practical activity: Introduction

C-4-2: Identify the appropriate selection of research methodology to investigate a psychological question.

C-4-3: Describe the advantages and disadvantages of different research methodologies.

Teacher instructions

Goals

- To identify the appropriate selection of research methodology to investigate a psychological question.
- To describe the advantages and disadvantages of different research methodologies.

Facilitation guidance

In this section, students will develop their hypothesis to test and choose either a quasi- or true experiment. This will be developed based on pre-existing research and/or theory. Students can either replicate or modify an existing study, but they should only use one condition of the independent variable to keep it a simple experiment. You may wish to provide students with examples of studies they could replicate for this practical.

Some example studies (but not limited to) that are simple to modify or replicate include Loftus and Palmer (1974) (https://doi.org/10.1016/S0022-5371(74)80011-3), Landry and Bartling (2011) (https://www.mcneese.edu/wp-content/uploads/2020/08/AJPR-11-07-Landry-5-09.pdf), Diemand-Yauman et al. (2011) (https://doi.org/10.1016/j.cognition.2010.09.012), or Bransford and Johnson (1972) (https://doi.org/10.1016/S0022-5371(72)80006-9).

? Subtopic question(s)

During this subtopic, you will be working towards answering the following subtopic question:

- What role can experiments play in understanding human cognition?

Experiments in psychology test a hypothesis, which is developed from a theory or an observation of some kind of behaviour. Prior to developing your hypothesis, choose an area of cognitive psychology you wish to investigate, for example, memory or thinking. You can develop your own experiment or choose a study to replicate, such as Landry and Bartling (2011), or Loftus and Palmer (1974) (https://doi.org/10.1016/S0022-5371(74)80011-3). Often, in cognitive psychology experiments, one factor which influences one cognitive process is isolated. For example, you could investigate how typing notes influences memory recall.

It is important to identify your variables in your experiment. The independent variable (IV) is the variable you manipulate and the dependent variable (DP) is the variable you measure (**Figure 1**). It is important to keep your experiment simple and choose only one level of the IV (that is, only two conditions: control and experimental). Let's look at an example using Landry and Bartling (2011):

- **Independent variable:** the articulatory suppression task (counting '1,2' between presentation of the letters and recall). The control condition did not do this task.
- **Dependent variable:** serial recall (the number of lists of letters recalled accurately).

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Next, you will need to operationalise your variables. This means that you need to clearly state how you manipulated and measured your variables. The purpose of operationalisation is to define abstract concepts in measurable terms. So, for example, an 'articulatory suppression task' needs to be defined in order to measure this concept effectively.

Once you have identified your variables, you are going to develop your hypothesis. A hypothesis is a clear and testable prediction of the relationship between your independent variable and your dependent variable. You will develop both an alternative hypothesis and a null hypothesis.

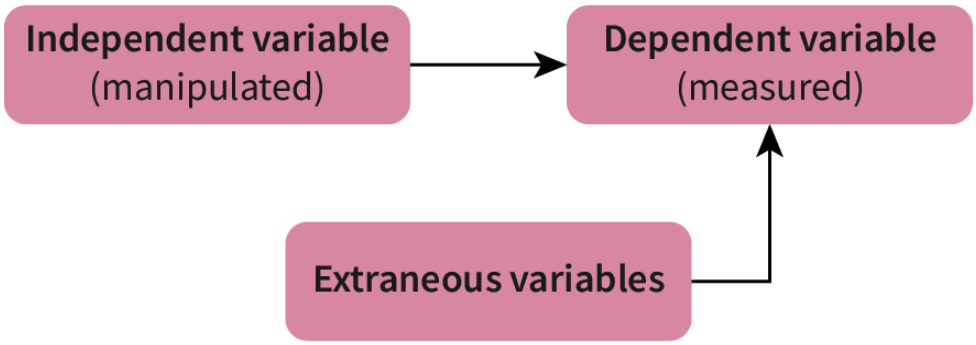

Figure 1. The independent variable has an effect on the dependent variable in true experiments, but you need to be aware of extraneous variables, as they can influence the outcome.

More information for figure 1

Three boxes containing text. One box is labelled Independent variable, manipulated, and another is labelled Extraneous variables. Two arrows point from these boxes to a box labelled Dependent variable, measured.

The alternative hypothesis predicts that there is a significant relationship between your variables. In contrast, a null hypothesis states that there is no relationship between your variables. When you do your analysis, you will conduct tests to determine which hypothesis is true. In psychology, researchers assume that the null hypothesis is true and calculate inferential statistics to determine this.

For example, in Landry and Bartling's study, we can suggest the following hypotheses:

- **Alternative hypothesis:** The percent accuracy of serial recall (number of lists recalled correctly) will be higher, on average, in the control group (no articulatory suppression) versus the experimental group (articulatory suppression task).
- **Null hypothesis:** There will be no difference in the percent accuracy of serial recall between the control group (no articulatory suppression) and the experimental group (articulatory suppression task).

Complete the following steps to apply your understanding of variables and hypotheses to your own experiment.

Concept

Causality

Experiments are a powerful method for establishing **causality** — the idea that one variable directly influences another. This is because experiments allow researchers to control for confounding variables and isolate the effect of an **IV** on a **DV**.

However, we know that human behaviours are complex.

Student view

Overview (/study/ap new/sid-540-cid-763690/c

Reflection questions

1. In psychology, how can experiments be designed to establish causality?
2. What barriers are there in establishing causality?

Paper 2 criteria

Knowledge and understanding

- The response demonstrates detailed knowledge and understanding of the research methodology relevant to the class practical.
- Psychological terminology is used accurately.

Section Student... (0/0) Feedback Print (/study/app/psychology-new/sid-540-cid-763690/book/practical-introduction-id-50549/print/) Assign

Application

- The knowledge and understanding of the concept are well developed.
- There are clear and detailed links between the concept and the class practical.

Practical tasks

Hypothesis development

Develop a research question and then a hypothesis by following these steps.

1. On a sheet of paper, identify one cognitive process you are interested in, such as memory.
2. Then, identify one factor that could influence this process (for example, how music can affect memory recall).
3. Conduct preliminary research into this broad topic – use your IB DP Psychology course, online databases or research you have looked at so far to learn more about the pre-existing research. Find two experiments on this topic. You can choose to do a simple replication or modification of an existing experiment.
4. Formulate a research question based on prior research or a cognitive theory. Keep the question simple, focused and clear. Use the following format:
   - What is the effect of [IV] on [DV]? (For example: What is the effect of music on memory accuracy?)
5. Operationalise your variables.
   - Independent variable (IV): What will you manipulate (for a true experiment) or compare (for a quasi-experiment)? (For example, the presence of rock music.) Do not forget to determine what your conditions will be (for example, the presence of rock music or no music).
   - Dependent variable (DV): How will you measure the outcome (for example, the numbers of correctly recalled letters)?
6. Develop your research hypothesis. A hypothesis is a specific, testable prediction about the relationship between your IV and DV.
   - Start with a general prediction: The [IV] will affect [DV]. (For example, the presence of music will decrease memory accuracy.)
   - Then, make it precise and directional: Participants exposed to [condition of the IV] will have higher/lower [DV] than participants in [other condition of the IV].
7. Develop your null hypothesis. This is a statement that assumes there is no effect, relationship or difference between the variables being studied, and is the default assumption to be tested against.
   - For example, listening to music [IV] has no effect on memory recall [DV].

Student view

Once you have developed your hypotheses, share them with another peer for feedback. Go back and refine them, if necessary.

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The completion of the activities in this practical will be helpful when designing your own research proposal for the Internal Assessment. Your knowledge and understanding from the practicals will be assessed in Paper 2.

Internal assessment criteria

Introduction

- The aim or research question is clearly stated and focused.
- The real-life problem is described and the impact on the population of interest is explained.
- Relevant findings and conclusions of two pieces of research are explained and linked to the investigation.

Learning outcomes

By the end of this section, you should be able to:

- Identify the appropriate selection of research methodology to investigate a psychological question.
- Describe the advantages and disadvantages of different research methodologies.

3 section questions

Question 1

SL HL Difficulty:

In an experiment testing the effect of background noise on reading comprehension, is reading comprehension the independent or dependent variable?

Dependent ✓

Accepted answers
Dependent

Explanation
The dependent variable is what is measured in an experiment. In this case, researchers measure how well participants comprehend what they read under different noise conditions.

Question 2

SL HL Difficulty:

A 1 null ✓ hypothesis states that there is no 2 relationship ✓ between the independent and dependent variables.

Accepted answers and explanation

#1 null

#2 relationship

General explanation

Student view

Overview (/study/ap new/sid-540- cid- 763690/c

A null hypothesis is a statement in research that assumes no effect, no relationship or no significant difference between variables. It assumes that any observed effect is due to chance rather than a real effect.

Question 3

SL HL Difficulty:

A researcher wants to study how attention span changes with age. Which of the following is the best example of operationalising the dependent variable?

1 Defining ‘attention span’ as the number of seconds a participant can focus on a visual stimulus. ✓

2 Using a stopwatch to measure how long participants can focus on a task before becoming distracted.

3 Dividing participants into three age groups: 5—10 years, 11—20 years and 21—30 years.

4 Dividing participants into ‘young’ and ‘old’ groups.

Explanation

Operationalisation means defining variables in measurable terms. Since attention span is the dependent variable, it needs to be categorised in a way that allows for easy comparison.

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Student view

Practical activity: Explore and design

C-4-2: Identify the appropriate selection of research methodology to investigate a psychological question.

C-4-3: Describe the advantages and disadvantages of different research methodologies. C-4-4: Describe the potential effects of ethical considerations in psychological research.

C-4-6: Discuss the advantages and disadvantages of different sampling techniques.

C-4-13: Discuss factors that should be considered when transferring findings of a study to another population or context.

Teacher instructions

Goals

- To identify the appropriate selection of research methodology to investigate a psychological question.
- To describe the advantages and disadvantages of different research methodologies.
- To describe the potential effects of ethical considerations in psychological research.
- To discuss the advantages and disadvantages of different sampling techniques.
- To discuss factors that should be considered when transferring findings of a study to another population or context.

Facilitation guidance

In this section, students will design their experiment and create a procedure. It is important that they decide on either a quasi-experiment or a true experiment. They should be aware of the strengths and limitations of both. Students should create their own materials, or if replicating an experiment, replicate the same materials. Ensure students have only one level of the independent variable, to keep the procedure (and analysis) simple. The dependent variable should also be easily quantified, such as scores on a memory test or estimation of speed. For example, if they choose to replicate Loftus and Palmer, they should only choose two verbs from the five in the original experiment.

? Subtopic question(s)

During this subtopic, you will be working towards answering the following subtopic question:

- What role can experiments play in understanding human cognition?

In this next part of your practical, you will design your experiment. The type of experiment you use will be either a true experiment or a quasi-experiment. In order to decide on the type of experiment, you need to look at your independent variable (IV). Is this pre-existing or can you manipulate your IV in an ethical and practical way?

The next step is to choose your experimental design: either independent measures, repeated measures or matched pairs.

- In an independent measures design, participants are randomly allocated into separate groups and only experience one condition (usually the experimental or control condition). By using this design, there are no order effects such as fatigue or practice effects. However, a larger sample size is required compared to a repeated measures design (**Figure 1**).
- In a matched pairs design, participants are paired up based on a specific characteristic that is relevant to the study. For example, age or gender. Each pair is split and allocated to a different condition. While this design might be time-consuming to do, it controls for confounding variables such as individual differences.

- In a repeated measures design, participants experience all conditions of the experiment. So, they may do the experimental condition first, then the control condition. This design eliminates individual differences because the same participants are used. However, it is prone to order effects like practice or fatigue effects. You can counterbalance the conditions to avoid order effects. This means that the participants experience both conditions in different orders. For example, half of the participants may complete Condition A first, then Condition B, whereas the other half may complete Condition B first, then Condition A. Some experiments may not be suitable to this type of design, as it could influence participant responses. For example, if Loftus and Palmer had done their experiment using repeated measures, participants may have guessed the purpose of the experiment as they would notice the verb changing in the leading question, and they would get better at estimating the speed of the cars with practice.

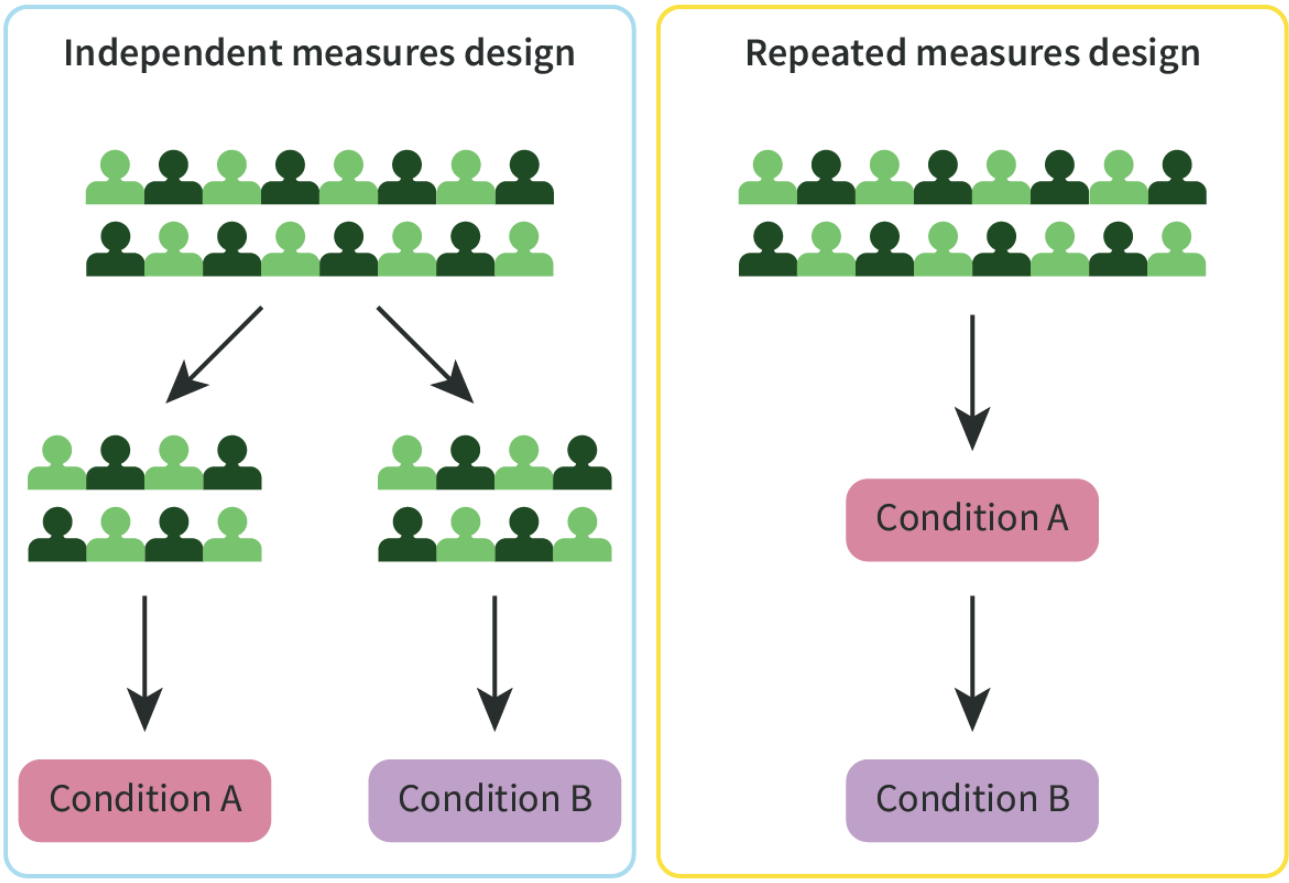

Figure 1. Independent sample and repeated measures designs.

More information for figure 1

Two diagrams labelled Independent Measures Design and Repeated Measures Design. On the left side, under Independent measures design, icons represent a group of 16 people, and arrows show this group being split into 2 groups of 8. Arrows point from each group of 8 to 2 separate boxes labelled Condition A and Condition B. On the right side, under Repeated measures design, there is a group of 16 people with an arrow pointing to a box labelled Condition A. Another arrow points from condition A to another box labelled Condition B.

Concept

Bias

When designing your experiment, it is important to introduce controls to minimise bias, as these can significantly impact the outcome of the experiment.

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Reflection question

1. Discuss how you can minimise **bias** when designing your experiment. Consider the role of the researcher, the research design and your sample.

The next important step when designing your experiment is deciding on a sampling technique in order to gather your participants. Identify your target population (for example, first year IB DP students), then choose from the following techniques to recruit your participants:

- **Self-selected/volunteer:** Participants volunteer to take part in a study, often in response to an advertisement or an email.
- **Opportunity:** Participants are selected based on availability and willingness at the time of the study. For example, you may recruit participants who have a free period when you want to conduct your experiment.
- **Stratified:** The target population is divided into subgroups, and participants are randomly selected from each subgroup in proportion to their representation in the population. For example, if your school has 60% first year IB DP students and 40% second year IB students, you will divide students into these two groups and randomly select participants from each group in the same proportion.
- **Random:** Every individual in the target population has an equal chance of being selected. For example, you create a list of all of the students in the IB DP programme and randomly select from that list.
- **Snowball:** Existing participants recruit others, creating a chain of referrals. For example, you ask your friends to participate and get them to ask their friends to take part.

Creativity, activity, service

Strand

Service

Learning outcomes

- Demonstrate the skills and recognise the benefits of working collaboratively.
- Demonstrate engagement with issues of global significance.

Many universities and online platforms advertise for participants to take part in their research.

Reflection question

1. To experience participation in a real experiment, investigate research participation opportunities by contacting the psychology department at your local university, and then reflect on your experience.

You may notice that not all of these may be suitable for your experiment as the technique may be too time-consuming or difficult to conduct, such as stratified sampling and random sampling. You will also need to be cautious of sampling bias. Make sure that you have a representative sample from your target population. For example, if your target population is all IB DP students at your school, you should have people from a range of year levels and classes.

Section Student... (0/0) Feedback Print (/study/app/psychology-new/sid-540-cid-763690/book/practical-explore-and-design-id-50550/print/) Assign

Paper 2 criteria

Design

- The procedure of the research method is explained with accuracy and detail.
- Psychological terminology relevant to the research method is used effectively.

Student view

Overview (/study/app/psychology-new/sid-540-cid-763690/c

Ethical considerations are an incredibly important part of your experiment as they protect participants from undue stress or harm. They ensure you are conducting your research in an ethical way. Before you conduct your experiment, it is important to create a consent form to gain informed consent. If your participants are under the age of 16, you will also need to obtain parental consent. In your consent form, inform participants of the experiment's purpose, procedures, potential risks, benefits and their right to withdraw at any time. You will also need to uphold the following:

- **Debriefing**: Participants must be informed of the study's true purpose and any deception used after their participation.
- **Right to withdraw**: Participants must be allowed to leave the study at any time without consequences. This should be outlined on the consent form.
- **Confidentiality**: Personal data and identifiers must be kept private and secure. For example, you could do this by giving participants random ID numbers on their answer sheets.
- **Protection from harm**: Participants must not be exposed to physical or psychological harm beyond everyday risks.
- **Deception**: If used, deception must be justified, minimised and revealed during debriefing. You might use mild deception in your experiment to avoid demand characteristics, but only if entirely necessary. For example, in Loftus and Palmer's study, they did not inform participants of the aim of the study until afterwards in their debriefing, as knowing this could have caused the participants to change their behaviour.

Overall, there are many important elements of planning an experiment. Follow the steps below before conducting your experiment and to ensure you have addressed all of these elements.

Internal assessment criteria

Research methodology

- The choice of research method is explained.
- The procedure is explained.
- Relevant ethical considerations are described and explicitly linked to the investigation.

Practical tasks

Now that you have your hypothesis and variables, it is time to design your experiment and create your procedure.

Design your experiment

1. Decide on a type of experiment (quasi- or true) and an experimental design.

- If you choose a true experiment, participants are randomly assigned to conditions in an independent samples design or they are exposed to both conditions in a repeated measures design (for example, music or no music). If you choose a repeated measures design, decide if you are going to counterbalance the conditions. If appropriate, you could also use a matched pairs design, where participants are closely matched on certain variables related to the experiment (for example, age or gender) and then they are randomly assigned to different experimental conditions.
- If you choose a quasi-experiment, identify what the pre-existing groups will be (for example, age or gender).

2. Operationalise your variables. Make sure this is specific and clear.

Student view

- What will the conditions of the IV be? (For example: What type of music will they listen to? For how long?)

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- How will you measure the DV? (For example: What words are they recalling? How many?)

Concept

Measurement

Figuring out how to measure the DV is a crucial component of designing research. The extent to which your method of measurement reduces confounds and maintains face validity can be the difference between valid and invalid findings.

Even a simple memory recall experiment requires careful consideration of the DV. For example, when testing the impact of Bollywood dance music (IV) on long-term memory recall of words, it may seem straightforward enough to just generate a word list for each condition (the music present condition and the no-music present condition). However, there are some things you must consider:

- Are the word lists similar enough so as to not introduce a confound?
  - The words in each list must contain the same number of syllables or one list may end up being 'longer' than the other. For example, the word 'origami' may be harder to recall than 'pen.'
- Are the words in each list similar in complexity or familiarity?
  - Words that are more familiar to your participants may be easier to recall than words that are less familiar. For example, the word 'origami' may be harder to recall than 'basketball' for some populations.
- Are the words in one list related to each other in some way that may make them easier to recall?
  - One method of encoding is through meaning. Therefore, if one of the word lists contains words that are related to one another, it may be easier to recall those words than non-related words. For example, a list containing the words 'court,' 'ball,' 'player,' 'uniform' may be easier to recall than a list containing words that have no relation.

3. Identify your target population (for example, high school students) and decide which sampling technique you will use to recruit participants (for example, an opportunity sample).

4. Create your materials. This includes:

- ethical considerations, such as informed consent, briefing and debriefing. If your participants are under 16 years old, parental consent will need to be obtained before you conduct the experiment.
- introducing the IV: How will your conditions differ? What materials do you need to gather and create to do so? (For example, a music clip.)
- measuring the DV: How you will collect the data? (For example, a list of words.)
- any other necessary materials, such as a computer or a presentation to show your participants. Make sure you test this and your timings before you run the experiment!
- if you use a presentation, make sure your slides are automatically timed, in order to reduce human error.
- all of your materials should be standardised so that every participant is exposed to identical stimuli, such as the same wording in your instructions, the same images in visual tasks, or the same audio recordings in a memory test.

Create your procedure

With your group members, come up with a step-by-step procedure for your experiment.

Make sure you include:

- controls to minimise bias. For example, maintaining the same environmental conditions for each group.
- how you will assign participants to conditions. For example, using a random number generator.
- the role of your group members. For example, who gives the instructions, who hands out the materials.

Student view

Overview (/study/ap new/sid-540-cid-763690/c

Here is an example procedure:

1. Greet and brief participants.
2. Obtain consent and answer questions.
3. Randomly assign participants to Group A (control) or Group B (experimental) in the same room.
4. Read standardised instructions to each group.
5. Introduce the IV to Group B and the control to Group B.
6. Administer a cognitive test (DV) to both groups.
7. Collect and record results.
8. Debrief participants about the study's purpose.

Learning outcomes

By the end of this section, you should be able to:

- Identify the appropriate selection of research methodology to investigate a psychological question.
- Describe the advantages and disadvantages of different research methodologies.
- Describe the potential effects of ethical considerations in psychological research.
- Discuss the advantages and disadvantages of different sampling techniques.
- Discuss factors that should be considered when transferring findings of a study to another population or context.

3 section questions

Question 1

SL HL Difficulty:

Which sampling technique is most likely to produce a sample that is highly representative of the target population?

Random ✓

Accepted answers
Random

Also accepted
Random sampling

Explanation
Random sampling ensures that every member of the target population has an equal chance of being selected. This minimises selection bias and increases the likelihood that the sample accurately reflects the characteristics of the population, making the results more generalisable.

Question 2

SL HL Difficulty:

Using independent samples design in experimental research reduces the risk of 1 order ✓ effects, such as practice or 2 fatigue ✓ .

Accepted answers and explanation

#1 order

#2 fatigue

Student view

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General explanation

In an independent samples design, participants are only exposed to one condition of the experiment. This means that they do not experience multiple conditions in sequence, reducing the risk of order effects.

Question 3

SL HL Difficulty:

Which of the following is a potential effect of ethical considerations on psychological research?

1 It may limit the types of research questions that can be investigated. ✓

2 It ensures that all participants are fully informed about the research before data collection.

3 It guarantees that researchers can conduct experiments without needing informed consent.

4 It allows for deception in all cases without restriction.

Explanation

Some psychological research questions may require methods that are ethically unacceptable. For example, investigating extreme stress or trauma through an experimental method would be ethically not acceptable.

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Student view

Practical activity: Collect and process

C-4-7a: Identify and discuss how data is represented and analysed in different forms based on the design of the study and the nature of the data.

C-4-7b: Analyse and interpret different types of data tables, graphs and results.

Teacher instructions

Goals

- To identify and discuss how data is represented and analysed in different forms based on the design of the study and the nature of the data.
- To analyse and interpret different types of data tables, graphs and results.

Facilitation guidance

In this section, students will process and analyse their data. They may need additional guidance in doing this, such as teaching them how to calculate mean, median, range and standard deviation. Additionally, they will run statistical tests to test their hypotheses. Discuss the role of outliers in data sets, and guide students through whether or not they keep these in their data sets.

? Subtopic question(s)

During this subtopic, you will be working towards answering the following subtopic question:

- What role can experiments play in understanding human cognition?

Once you have run your experiment and collected your data, you will need to process this data in order to draw accurate conclusions about your experiment. There are two types of statistics that you will need to produce from your raw data: descriptive statistics and inferential statistics. These statistics have different purposes, but work together to provide a detailed understanding of the data from your experiment.

Descriptive statistics

Descriptive statistics help us organise large amounts of data into meaningful summaries (for example, graphs) and describe the trends and patterns in a data set. For example, in Landry and Bartling's study, descriptive statistics told us that the mean number of lists recalled correctly in the articulatory suppression task group was much lower than the control group.

Level of measurement

Before you can decide what descriptive statistics to use, decide which level of measurement your data falls under:

- **Nominal**: categories with no particular order (for example, colours).
- **Ordinal**: ordered categories without equal intervals (for example, likert scales).
- **Interval**: numeric scales with equal intervals but no true zero (for example, IQ score, depression rating).
- **Ratio**: numeric scales with equal intervals and a true zero (for example, number of lists recalled, reaction time).

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Knowing which level of measurement your data is will help you determine the descriptive and inferential statistics to calculate.

Measures of central tendency

Measures of central tendency are used to represent the 'centre' or the 'typical value' of your data set. This value best represents the data set of each condition. The measure of central tendency can also allow us to compare groups and understand the general patterns in the experiment. There are three main measures of central tendency that you will choose from, based on your type of data:

- **Mean**: average of the data set. Calculated by the sum of all values divided by the total number of values. This is best used for interval and ratio data, with no extreme outliers.
- **Median**: middle value when ordering data from lowest to highest. This is best used for ordinal, interval or ratio data, especially with skewed distributions or when there are outliers.
- **Mode**: the most frequently occurring value in a data set. This is best used when the data is nominal or the most popular.

What about outliers?

Outliers are values in your data set that are significantly different from the rest of your data set. They can occur for a number of reasons, such as measurement error, practical purposes (for example, a participant did not complete the answer sheet correctly), participant bias (like the 'screw you effect') or they could be real.

In order to determine if one of your values is an outlier, you can use the statistical method, using the Interquartile Range (IQR) Rule:

1. Calculate the lower quartile, **Q1 (25th percentile)** and the upper quartile, **Q3 (75th percentile)** of your data set.
2. Compute **IQR = Q3 – Q1**
3. An outlier is any value beyond **1.5 × IQR** above Q3 or below Q1.

There are a few things you can do, if you think you have outliers in your data set:

- If the outlier is due to an error (for example, a typo or mis-recorded value), you can correct or remove it.
- If the outlier is real but skews the mean heavily, you can use the median instead of the mean.

Measures of dispersion

Measures of dispersion will help you understand the variability of your data set. This looks at how spread out or dispersed the values are and how they deviate from the central value (mean or median). This is important in your experiment, as you often want to know how consistent the responses are.

The most common measures of variance you can use are:

- **Range** (highest value – lowest value): this takes into account all values of your data set. So, if you have extreme values, it may not be appropriate.
- **Interquartile range** (upper quartile – lower quartile): the IQR is particularly useful for data with outliers, because it eliminates them at both ends.
- **Standard deviation**: this shows how much individual data points deviate, on average, from the **mean** of the data set.

Student view

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Generally, if you calculated the median as your measure of central tendency, the range is appropriate. If you calculated the mean as your measure of central tendency, the standard deviation is appropriate.

Tip: use Excel or Google sheets to help you calculate these statistics accurately!

A high measure of variance indicates higher variability of the data, whereas a low measure of variance indicates less variability, meaning that the responses are more consistent. If you are comparing your two conditions, the data set with the larger standard deviation or range will have more variability.

Visually representing your data

One of the easiest ways to compare your measures of central tendency between your two conditions is to create a visual representation of your data. There are three common ways that you can visualise your data:

- **Bar graph**: this is a simple way to compare the mean or median between two conditions. Each bar represents the measure of central tendency and the height of the bar shows the value of the central tendency.
- **Box plot**: this compares both the median and the range (and IQR) between two conditions. It also shows outliers clearly.
- **Histogram**: this represents the mean or median visually, as well as the distribution of the data. The peaks of the different histograms will be at different positions, indicating the mean or the median position.

Histograms are useful for understanding the distribution of your data. By looking at the shape, you can get a sense of whether the data is approximately normally distributed or skewed (**Figure 1**):

- **Normal distribution**: a **bell-shaped curve** with data symmetrically distributed around the mean.
- **Positively skewed**: the **tail** of the histogram is stretched to the right (higher values).
- **Negatively skewed**: the **tail** is stretched to the left (lower values).

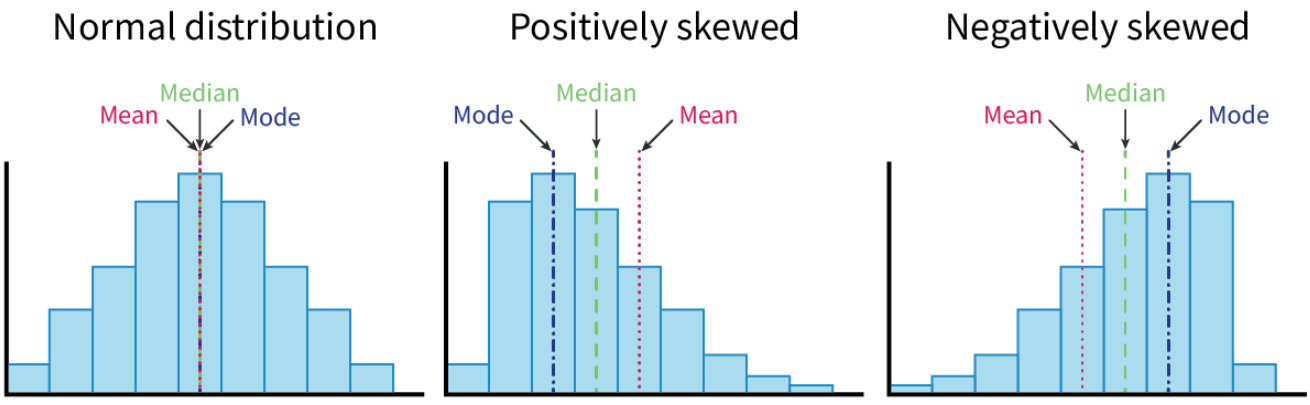

Figure 1. Create a histogram of your data set to check if it is normally distributed.

More information for figure 1

Three histograms representing different types of data distributions. The first histogram on the left is labelled Normal distribution. The bars form a symmetrical curve, with the mean, median and mode all aligned at the centre. The second histogram in the middle is labelled Positively skewed, and the bars form a curve, with its highest point towards the left side and a long tail extending to the right. In this distribution, the mode is furthest to the left, the median is in the middle and the mean is furthest to the right. The third histogram on the right is labelled Negatively skewed, and the bars form a curve, with its highest point towards the right side and a long tail extending to the left. In this distribution, the mode is furthest to the right, the median is in the middle and the mean is furthest to the left.

Student view

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Box plots are also useful for understanding distribution (**Figure 2**):

- **Normal distribution**: the **median** is near the centre of the box, and the **whiskers** are of roughly equal length on both sides.
- **Skewed data**: the **median** will be closer to one edge of the box, and one whisker will be longer than the other.

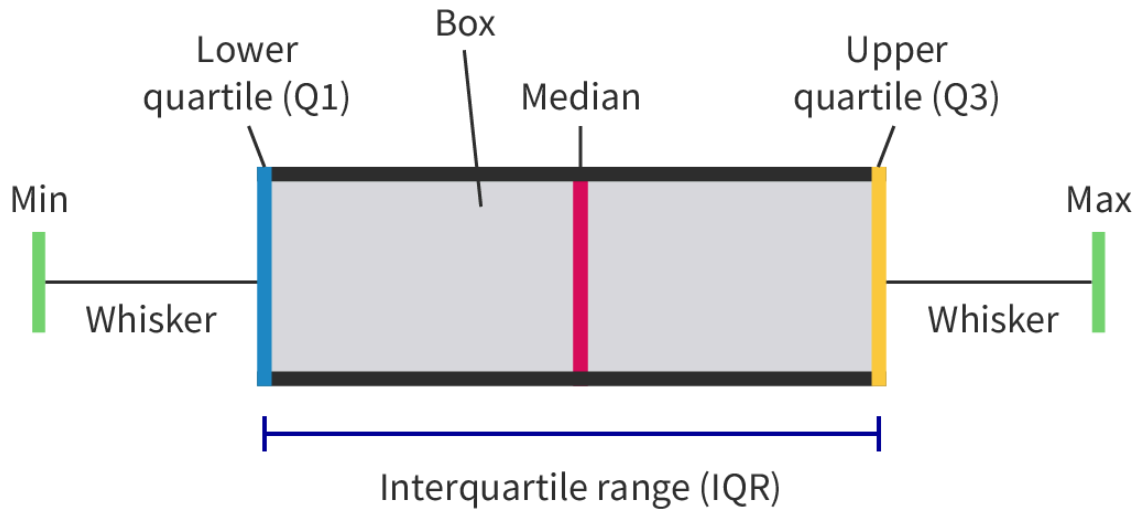

Figure 2. Box plots are useful for visually representing your data.

More information for figure 2

A labelled diagram showing what the parts of a box and whisker plot represent. The box is a rectangle in the centre of the diagram. The location of its left-hand side shows the lower quartile, or Q1. The location of its right-hand side shows the upper quartile, or Q3. Its length from left to right represents the interquartile range, or IQR. A vertical line inside the box shows the value of the median. There are two horizontal lines on either side of the box, which are the whiskers. The whisker on the left-hand side goes from minimum to lower quartile. The whisker on the right-hand side goes from upper quartile to maximum.

In the next section, you will look at different statistical tests, which are appropriate for different types of distribution. Many of these tests assume that your data is normally distributed. If it is not, you will use tests that do not assume normal distribution.

Inferential statistics

Inferential statistics are used to determine if your results are due to chance or because you manipulated your IV. We use inferential statistics to test hypotheses and make accurate predictions. Some of the most commonly used tests of inferential statistics are described in **Table 1**.

- Parametric tests are appropriate for data sets that both resemble the normal distribution and use the interval level of data for the DV.
- Non-parametric tests are more appropriate for any data not meeting those requirements.

Generally speaking, if you have a small sample size (less than 30 participants), your experiment will use a non-parametric test. However, a histogram or box plot will give you a good indication if your data is normally distributed or not. Alternatively, an online Kolmogorov-Smirnov test (https://statskingdom.com/kolmogorov-smirnov-test-calculator.html) can be used.

Student view

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Making connections

Revisit **section 1.1.4** (/study/app/psychology-new/sid-540-cid-763690/book/what-is-the-difference-between-causation-and-correlation-id-49354/) and **section 1.1.5** (/study/app/psychology-new/sid-540-cid-763690/book/how-is-quantitative-data-transformed-into-credible-evidence-for-a-psychological-theory-or-claim-id-49355/) for a detailed explanation of the purpose of inferential statistics. In your experiments, it is important that you are able to interpret the outputs of these statistics to draw accurate conclusions and evaluate your experiments.

In these sections, you learned specifically about p values and significance. Remember that a p value tells you how likely it is that your results happened by chance.

- If the p value is small (0.05 or less), it means the results are unlikely to be due to chance, so you might say there is a real effect of your IV on your DV.
- If the p value is large, it means the results could easily be due to chance, so you do not have strong enough evidence to say that your IV had an effect on your DV.

Table 1. The different types of parametric and non-parametric tests.

Parametric tests (datasets that have normal distribution)		Non-parametric tests	
Independent samples t-test	Compares the mean scores for two separate groups of participants (i.e. independent samples), for interval level data.	**Mann-Whitney U test**	Compares the mean scores for two separate groups of participants (i.e. independent samples), for ordinal or interval level data. This test works by ranking the data and comparing the ranks.
Paired samples t-test	Compares the mean scores for participants in matched pairs or repeated measures designs, for internal level data.	**Wilcoxon signed-rank test**	Compares the mean scores for participants in matched pairs or repeated measures designs, for internal level data.
		Chi-squared test	Compares observed values for nominal or ordinal data, and compares them to the expected values if the null hypothesis were true.

There are many free calculators online, such as VassarStats (http://vassarstats.net/) or Social Science Statistics (https://www.socscistatistics.com/), which you can use to run these tests on your data.

- If your inferential analysis generates a p value lower than the significance threshold for the study (usually $p < 0.05$), then the null hypothesis is rejected and the result is said to be statistically significant.
- If the significance threshold is not met, and p is greater than 5%, then the result is considered non-significant and you have failed to reject the null hypothesis (or, you have retained the null hypothesis).

It is important to note that a non-significant result does not necessarily mean that the research hypothesis is rejected, because there is still the possibility it could be true.

Student view

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Practical tasks

Process your data

1. **Organise your data**

- Collect all data from participants and use a spreadsheet to record it accurately.
- Use columns that clearly identify participant ID, the condition of the IV each participant is in (for example, music or no music) and the DV (for example, scores on a memory test).

2. **Check for inaccuracies**

- Look for missing or inconsistent data. Are there any outliers?

3. **Calculate descriptive statistics**

Depending on your data, choose the most representative measure of central tendency (mean, median or mode) and spread (range, IQR or standard deviation).

For each condition:

- Calculate the measure of central tendency: mean, median or mode.
- Calculate the measure of variance: range, IQR or standard deviation.

4. **Use visuals to represent your data**

- Make sure you choose the most appropriate way to represent your data given the type of data you have.
- You should include a table (similar to **Table 2**) that summarises your descriptive statistics, including your measure of central tendency and measure of variance.
- You should also include a visual representation in the form of a figure, such as a box plot, bar graph or histogram.
- Ensure that your visual representation is labelled properly and includes both the IV and the DV.

Table 2. Sample table summarising descriptive statistics.

	Mean (number of words recalled)	Standard deviation
Experimental condition	2.31	1.89
Control condition	8.63	1.51

5. **Determine the statistical significance of your data**

- Researchers typically use a significance level of 0.05 (5%), meaning there is a 5% probability of the result occurring by chance if the null hypothesis is true.
- Choose a statistical test to compare groups or conditions, such as a Mann Whitney U, analysis of variance (ANOVA) or chi-square test, depending on the type of data you have, sample size and research design (see **Table 1**).
- Calculate the p value. This indicates the probability of obtaining the observed results if the null hypothesis is true.
- If the p value is less than α ($p < 0.05$), the result is considered statistically significant, suggesting the IV is likely to have influenced the DV.

Student view

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- Decide whether you can reject or fail to reject (accept) the null hypothesis:
  - If rejected then there is evidence for an effect or relationship between the IV and the DV.
  - If not rejected, then there is not sufficient evidence to support a significant effect of the IV on the DV.

Analyse your data

Compare the two conditions by looking at your results and answering the following questions.

1. Did your results support or contradict your hypothesis?
2. Describe any differences, trends or surprising outcomes in your data.
3. Were there factors that could have influenced your results (for example, small sample size, distractions)?

Internal assessment criteria

Data collection

- An appropriate and effective data collection tool to measure behaviour has been created.
- Decisions made when creating the data collection tool are explained and relevant to the aim or research question of the investigation.
- Potential challenges when collecting data are explained and relevant to the investigation.

Learning outcomes

By the end of this section, you should be able to:

- Identify and discuss how data is represented and analysed in different forms based on the design of the study and the nature of the data.
- Analyse and interpret different types of data tables, graphs and results.

3 section questions

Question 1

SL HL Difficulty:

A researcher finds that studying with music significantly reduces memory recall accuracy compared to a control group, with a p value of 0.03. What does this p value indicate?

1 The null hypothesis should be rejected. ✓

2 Studying with music has a 3% success rate in memory recall.

3 The null hypothesis should be accepted.

4 Studying with music is effective for exactly 3% of participants.

Explanation

A p value measures the probability of obtaining the observed results if the null hypothesis were true. A p value below 0.05 is typically considered statistically significant, meaning the null hypothesis is rejected.

Student view

Overview (/study/app/psychology-new/sid-540-cid-763690/c

Question 2

SL HL Difficulty:

1	Inferential	✓	statistics help to determine whether observed effects of the independent variable on the
2	dependent	✓	variable are real or due to chance.

Accepted answers and explanation

#1 Inferential

#2 dependent

General explanation

Inferential statistics (like a t-test or Mann Whitney U test) calculate the likelihood that the observed difference happened due to random variation rather than the effect of the IV.

Question 3

SL HL Difficulty:

Which of the following best describes the difference between the mean and the median?

1 The mean is affected by extreme values, while the median is not. ✓

2 The mean is always larger than the median in a data set.

3 The median is the sum of all values divided by the number of values.

4 The mean represents the middle score in a data set.

Explanation

The mean is sensitive to extreme values (outliers), while the median (the middle value) remains the same even if extreme values are present.

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Student view

Practical activity: Conclude and evaluate

C-4-5: Discuss the role of external variables in drawing conclusions about causality. C-4-7b: Analyse and interpret different types of data tables, graphs and results.

C-4-9: Discuss factors that should be considered when generalising findings to another population or context.

Teacher instructions

Goals

- To analyse and interpret different types of data tables, graphs and results.
- To discuss the role of external variables in drawing conclusions about causality.
- To discuss factors that should be considered when generalising findings to another population or context.

Facilitation guidance

In this section, students will draw conclusions and evaluate their experiments. Encourage students to apply their knowledge of experiments and their strengths/limitations to their own experiment. Ensure students are not discouraged if their results do not support their hypothesis. Instead, encourage them to use this as an opportunity to reflect on why this might be. For the task, get each group to evaluate each other's presentations and provide peer feedback. They can hold off sharing their own evaluation points until after they have received peer feedback.

Subtopic question(s)

During this subtopic, you will be working towards answering the following subtopic questions:

- What role can experiments play in understanding human cognition?

Now that you have conducted your experiment and processed your data, you can draw conclusions and evaluate it. In order to evaluate your experiment, you can look at several key aspects, including:

- your research design and methodology.
- whether it is reliable.
- its validity.
- its generalisability.
- any researcher and participant biases.

It is important to look at both the strengths and the limitations of your experiment. One aspect of experimental research in psychology is the control over variables. In your experiment, how well did you control the variables that could have impacted the results of your study? You should have taken measures to ensure that the impact of outside factors was reduced, so that a clear cause-and-effect relationship can be established. For example, conducting your experiment in the same room at the same time of day for both conditions can reduce the influence of environmental factors and also fatigue of participants. If you conducted your experiment with one condition in the morning and the other in the afternoon, participants may have been more alert in the morning, impacting the results. You should also think about extraneous variables that were unexpected, that may have influenced your results. If your experiment has a large number of extraneous variables or alternative explanations, then it may be low in internal validity.

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Concept

Bias

When evaluating your experiment, reflect on the role of **bias**. Both participant and researcher bias can affect validity of a study by unintentionally influencing results.

- Examples of participant bias include:
  - social desirability bias
  - demand characteristics
  - placebo effect.
- Examples of researcher bias include:
  - confirmation bias
  - leading questions.

Reflection questions

1. In what ways could participant bias or researcher bias have influenced your results?
2. Were you successful at attempting to control for bias? If not, how could you reduce it in future?

External validity refers to the extent to which your results can be generalised to other people and other settings or situations beyond the experiment itself. This is where you can assess your sample in comparison to your target population. If your sample represents your target population, you may be able to generalise the findings to this population. However, small and specific samples may not have good generalisability beyond the sample itself.

Psychology experiments can be criticised for being too controlled and not reflecting real-life situations. However, many experiments have useful applications, such as the gained understanding of the use of leading questions in the legal system, established from Loftus and Palmer's (1974) (https://doi.org/10.1016/S0022-5371(74)80011-3) research. Your experiment may also be useful and the findings might be applied to other situations.

You should also evaluate whether your experiment is reliable. Reliability is when an experiment can be repeated by other researchers to check if the results are the same. The reliability of your study depends upon how well-designed it was. This includes a standardised procedure, following a consistent step-by-step method so that other researchers can repeat it, and clearly defined variables. Your variables (for example, memory, stress, attention) must be precisely defined so that other researchers can measure them in the same way. For example, defining 'memory recall' as 'the number of words recalled from a list of 20 words after 10 minutes.'

When evaluating your experiment, be sure to include a balance of both strengths and limitations.

Paper 2 criteria

Application

- The knowledge and understanding of the concept are well developed.
- There are clear and detailed links between the concept and the class practical.

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Practical tasks

Drawing conclusions

Now that you have processed and analysed your data, you can draw conclusions and evaluate your experiment. Create a short presentation to share with the class. Include the following:

- Your research question and hypothesis.
- A description of your key findings, including patterns or differences that you observed in the data. Use specific numbers to support this.
- Whether your results support or contradict your hypothesis and existing research/psychological theories. Include whether your results were statistically significant or not.
- Alternative explanations for your results – for example, if there was something you think could have affected the outcome, such as variables you did not control for.

Evaluation

Evaluate your experiment (give its strengths and limitations).

- You could address the following:
  - Controls: Were there any uncontrolled variables?
  - Sample: Were there any characteristics of the sample that could have influenced the results?
  - Participant and researcher bias: Did participant behaviour or researcher expectations influence results? Did your choice of research design influence the presence of bias?
  - Methodology: Were your variables clearly defined and measured? Did the way you constructed your materials influence your results?
  - Is there an additional method that could have been used?
- Discuss how your findings could be applied in real-world contexts, such as studying techniques, and could your experiment be used to inform local or larger scale policies?
- Suggest improvements for future research. What could you do to address any limitations?
  - Suggest an **alternative research method** to further study your topic. What perspectives or insight would this method offer that your chosen method did not address?

Share your presentation, and evaluate another group's presentation to get another perspective.

HL Extension

Culture

Gutchess and Rajaram (2023) (https://doi.org/10.3758/s13423-022-02227-5) argue that there is an overrepresentation of samples and researchers from WEIRD (Western, Educated, Industrialised, Rich and Democratic) cultures in cognitive psychology. They reviewed cognitive psychology journals from 2016—2020, finding that only approximately 7% of articles consider culture in their research. This limits our understanding of human cognition and the potential variability in these processes between cultures.

Reflection questions

Reflect on your sample and the nature of your experiment.

1. Do you think **culture** could be a source of bias in your results?

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2. To what extent can your findings be generalised to other **cultures?**

Reflecting on the process

- Reflect back on your process. What challenges did you have when conducting the research? How did you overcome these?
- What challenges did you face when processing the data collected for the experiment? How did you overcome these?
- If you were to repeat the process, what steps would you take to ensure credibility in your experiment?
- What did you learn about the experiment process? Why is the type of experiment you used beneficial in psychological research?
- Compare and contrast the experiment method with the survey method you used in your previous practical (in **subtopic 4.3** (/study/app/psychology-new/sid-540-cid-763690/book/the-big-picture-id-49147/)).
- How might the skills learned through this process be applied to other research contexts?
- Can you evaluate how the findings from this practical would transfer to other contexts?

Internal assessment criteria

Discussion

- Potential findings of the investigation are described in detail and the implication(s) for policy/practice are explained.
- One or more relevant examples of how researcher bias may affect the investigation are discussed.
- The usefulness of one relevant additional research method is discussed with reference to increasing the understanding of the area of investigation.

Learning outcomes

By the end of this section, you should be able to:

- Analyse and interpret different types of data tables, graphs and results.
- Discuss the role of external variables in drawing conclusions about causality.
- Discuss factors that should be considered when generalising findings to another population or context.

3 section questions

Student view

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Question 1

SL HL Difficulty:

Which type of validity refers to the degree to which the independent variable is truly responsible for changes in the dependent variable.

Internal ✓

Accepted answers
Internal

Also accepted
Internal validity

Explanation
Internal validity ensures that observed effects are due to the manipulation of the independent variable rather than confounding variables.

Question 2

SL HL Difficulty:

To ensure reliability in experiments, researchers often use standardised 1 procedures ✓ . This allows other researchers to 2 replicate ✓ the experiment.

Accepted answers and explanation

#1 procedures

#2 replicate

General explanation

When an experiment follows standardised procedures, other researchers can repeat (replicate) the study under the same conditions. If they obtain similar results, it strengthens the reliability of the original findings. Replication is essential in psychology to confirm that results are not due to chance or experimenter bias.

Question 3

SL HL Difficulty:

A researcher finds that participants in a memory experiment perform worse in the second condition due to tiredness. What type of bias is affecting the results?

1 Order effects ✓

2 Screw you effect

3 Participant bias

4 Experimenter bias

Explanation
Order effects occur in repeated measures designs when performance is influenced by the order in which conditions are experienced, such as fatigue or practice effects.

Student view

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Checklist

Learning outcomes

By the end of **subtopic 5.3**, you should be able to:

- Identify the appropriate selection of research methodology to investigate a psychological question.
- Describe the advantages and disadvantages of different research methodologies.
- Describe the potential effects of ethical considerations in psychological research.
- Discuss the advantages and disadvantages of different sampling techniques.
- Identify and discuss how data is represented and analysed in different forms based on the design of the study and the nature of the data.
- Analyse and interpret different types of data tables, graphs and results.
- Discuss the role of external variables in drawing conclusions about causality.
- Discuss factors that should be considered when generalising findings to another population or context.

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Collected research studies

Teacher instructions

These are the main research studies mentioned throughout this subtopic. However, this is not an exhaustive list, and you are encouraged to use other research studies that are relevant.

Students are not required to memorise all details of the studies but may wish to include them to support their explanations.

Summary	Evaluation
Loftus and Palmer (1974) (https://doi.org/10.1016/S0022-5371(74)80011-3) **Location of study** USA **Aim** To investigate whether the wording of questions about an event could create false memories, specifically of non-existent broken glass **Method** • Participants watched a video of a car accident. • They were asked about the speed of the cars using verbs such as 'smashed' or 'hit.' • A week later, they were asked if they had seen broken glass in the accident (there was none). **Results** Participants who heard 'smashed' were more likely to report seeing broken glass than those who heard 'hit' or those who were not asked about speed. **Conclusion** The phrasing of questions can distort memory, leading to the formation of false memories.	**Strengths** • Controlled experimental design allowed for clear cause-and-effect conclusions. • Practical implications for eyewitness testimony reliability. **Limitations** • Artificial laboratory setting may reduce ecological validity. • Participants may have been influenced by demand characteristics. **Ethical considerations** • Minimal risk involved, but participants may have experienced slight distress from watching accident footage. • Full debriefing was necessary to clarify the purpose of the study and eliminate any misconceptions.

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Summary	Evaluation
Landry and Bartling (2011) (https://www.mcneese.edu/wp-content/uploads/2020/08/AJPR-11-07-Landry-5-09.pdf) **Location of study** USA **Aim** To investigate how articulatory suppression affects recall of phonologically similar letters **Method** Participants were shown lists of dissimilar letters and asked to recall them. The experimental group performed articulatory suppression (repeating '1,2') until recall, while the control group did not. **Results** The experimental group showed reduced recall accuracy, indicating that articulatory suppression interfered with verbal memory processing. **Conclusion** The study concluded that articulatory suppression disrupts the phonological loop.	**Strengths** • The controlled environment allows for high internal validity, as variables like articulatory suppression were carefully manipulated. • The use of an independent group design minimises the risk of order effects and ensures that the results reflect the impact of articulatory suppression on memory. **Limitations** • The artificial nature of the task (recalling lists of letters) does not reflect real-world memory processes, lowering ecological validity. • Using university students limits the generalisability of the findings, as the sample may not represent the broader population. Ethical considerations • All researchers conducting studies within psychological research are expected to consider ethical guidelines. The experiment tested memory recall and all ethical requirements were adhered to. Research considerations • The use of the between group (independent measures) design was a limitation, as it introduced the confound of memory differences between the two groups. Participants were randomly assigned to the groups in an attempt to minimise this confound, However, a repeated measures design would strengthen validity.

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Summary	Evaluation
Maguire et al. (2000) (https://doi.org/10.1073/pnas.070039597) **Location of study** UK **Aim** To investigate whether structural differences in the brains of taxi drivers were associated with their extensive spatial navigation experience **Method** • Structural magnetic resonance imaging (MRI) scans were conducted on London taxi drivers and control participants. • The volume of the hippocampus was measured and compared between the two groups. **Results** • Taxi drivers had significantly larger posterior hippocampus and smaller anterior hippocampus compared to controls. • A positive correlation was found between years of taxi driving experience and hippocampal volume. **Conclusion** The hippocampus is involved in spatial memory and navigation, and its structure can change in response to environmental demands and experience.	**Strengths** • Non-invasive imaging technique provided precise structural data • Strong ecological validity due to the real-world expertise of taxi drivers **Limitations** • Correlational design cannot establish causation (for example, whether driving causes hippocampal changes or people with a larger hippocampus are more likely to become taxi drivers). • Small sample size limits generalisability **Ethical considerations** • Participants provided informed consent and were not subjected to harm. • Confidentiality of brain imaging data was maintained

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Student view