

How Psychology Works

The scientific model is based upon a **hypothetico-deductive** system. This might sound complicated, but actually, it's one of those examples of scientists creating a difficult name for a simple idea. Basically, it works like this:

1. Observe something about the world
2. Come up with a theory about the world
3. From the theory, develop a testable hypothesis
4. Test the hypothesis; observe results
5. Use results to modify theory....and round and round we go!

The purpose of this activity is to take you through the stages above, starting from an observation, to see how the process works in action.

Observation

When students are asked to give a presentation, their performance often doesn't match expectations based on their performance at other activities in class. People sometimes say that this is because they are affected by the audience.

Activity

Through discussion with a partner and then with the whole group:

1. Think of some explanations for this observation – if possible linking in to psychological perspectives.
2. Devise a testable hypothesis
3. Design an experiment to test the hypothesis, using a pack of cards and a stopwatch as your only lab equipment.
4. Discuss the problems you've had in designing the experiment, and the solutions you've found; compare your design to other group members and evaluate and modify each others' designs to produce the best design you can.
5. What are the possible outcomes for this experiment?
6. What would each possible outcome tell you about your initial theory?
7. What further research would you need to do to develop your theory, and what would this tell you?
8. Can you think of other examples from Psychology that demonstrate this cycle?

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Notes to teachers

This relatively simple activity can really get students thinking about issues relating to experimental design, even before they have very much formal knowledge. You can use questions during the group work to make them think carefully about issues such as:

- Who should be the participants? (representative sampling, etc)
- Within or between participants and why?
- Who should be the audience? What will they do?
- How do you create an audience-free situation?
- How do you operationalise “performance” as a variable?
- Why would you choose a one- or two-tailed hypothesis?
- What else do you need to do to ensure a fair test? (control of confounding and extraneous variables).

If you frame your questions using everyday language, you can then use the students’ answers to introduce the terminology of experimental design (see the associated matching activity and glossary of terms). Alternatively, you can ask students to use the terms from the glossary within their design outlines. You will also find that students find their own level with this activity, so you can have more sophisticated discussions with groups who have a good grasp of the underlying concepts than you might have with those who are new to the area or are struggling a little. There are no “correct” designs, so all ideas are worth discussing, but in general, students will come up with a plan based around some kind of card-sorting task, and time taken to complete the task.

With regard to outcomes, there are three possible findings. Firstly, it could be that overall, there is an improvement in the presence of an audience (an audience facilitation effect). Secondly, there could be a deterioration in performance. Thirdly, there may be no overall difference between the two conditions; this could imply that the audience has no effect, but it could also be the result of variation within the results (if some people get better and some people get worse, then the overall results will look like there is no change), so it’s a good way to get more able students to think about the meaning of a non-significant difference.

Theoretically, students might come up with ideas relating to peer pressure, or competitiveness, from a social psychology perspective, or with ideas about physiological arousal, or stress, from a biological perspective. They may also discuss individual differences: some people will be affected differently than others in this situation. The experiment they’ve designed above will probably only tell them what happens in the presence of an audience, not why, so future research would need to focus on hypotheses about why, and test these. They might do a correlation study to look at performance and heart rate, for example, to test the biological explanation.

Finally, this exercise should illustrate the way in which scientific knowledge evolves over time; we investigate ideas, develop hypotheses and theories, and this leads to more questions to be answered. Science is not fixed, nor is it foolproof.

Designing Experiments

Experiments are just one way of investigating psychological phenomena. The experiment provides a **controlled** way of asking and answering questions about psychology. They allow the researcher to:

- Investigate causal relationships between variables
- Control other variables which might affect the results or conclusions of the investigation
- Replicate, or repeat, previous research to check findings and conclusions independently

The first step in an experimental study is to develop a **research question**. For example:

- Does the presence of an audience affect performance on a cognitive task?

The researcher then uses existing knowledge from prior research or observation to formulate a **hypothesis** about the effect of one variable on another. The hypothesis might be directional (**one-tailed**), or non-directional (**two-tailed**). For example:

- The presence of an audience will increase the speed of completion on a card-sorting task (one-tailed)
- The presence of an audience will have an effect on the speed of completion of a card-sorting task (two-tailed).

These hypotheses are both examples of **experimental hypotheses**, in that they predict that the **independent variable** (IV, the variable manipulated by the experimenter, in this case the presence of an audience) will have an effect on the **dependent variable** (DV, the variable measured by the experimenter, in this case the time taken to complete the task). The researcher also needs to formulate a **null hypothesis**, which predicts that the IV will not have an effect on the DV. For example:

- The presence of an audience will have no effect on the speed of completion of a card-sorting task.

The purpose of an experiment is to decide whether to accept or reject the null hypothesis. In other words, it determines whether we can safely say that the IV has had an effect on the DV, or not.

In an ideal world, an experiment should involve a manipulated IV, a measured DV, and all other variables should remain the same. In practice, this is actually quite difficult to achieve. It is most likely in the **laboratory experiment**, in which the experiment is conducted in a controlled, artificial environment, although this can lead to the criticism that the experiment can lack **ecological validity** (that is, may not be a good reflection of what happens in real life). Other types of experiment are the **field experiment**, in which a single variable is manipulated to observe the effect on behaviour in a natural environment (such as a high street or shopping centre), and the **natural** or **quasi-experiment**, in which the effects of a naturally occurring IV are measured (for example, experiments investigating sex differences). Field experiments may be prone to a lack of control, and it can be difficult to ensure that they are ethical, because it is difficult to obtain informed

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consent from participants. Quasi-experiments may be problematic because the experimenter cannot manipulate the IV, and there may be associated **confounding variables** (see below).

Even in a laboratory experiment, problems can arise due to **extraneous variables** and **confounding variables**. Extraneous variables are those which are not controlled by the experimenter, and are not part of the experiment. For example, room temperature, lighting, and noise, could all be considered to be extraneous variables. Extraneous variables become confounding variables if they differ systematically across experimental conditions. For example, in our audience effect experiment, if the room temperature was always higher in the presence of an audience than in the absence of an audience, then it becomes difficult to determine whether any effect on performance that is found is caused by the IV (audience) or the confounding variable (room temperature).

There are three main types of confounding variables to look out for when designing an experiment:

- **Participant variables** – these are characteristics of the participants that might influence the experiment. For example, imagine an experiment looking at sex differences in the driving behaviour of new drivers. It may be that men tend to pass their driving tests at a younger age than women. If this is the case, the sample of men will be younger on average than the sample of women. Are differences in driving behaviour the result of different sex? Or of different age? Other participant variables might include intelligence, educational background and personality factors.
- **Experimenter (or investigator) effects** – these are variables that are introduced (usually inadvertently) by the experimenter. For example, an experimenter may smile when he or she sees the participants behaving in the way they expect in a particular experimental condition, thus reinforcing that behaviour and making it likely to occur again. Alternatively, when reading instructions, the experimenter may give clues as to what is expected through voice tone and body language, again influencing the participants' behaviour. Differences between the experimental conditions might be caused by the IV, but they might equally be caused by the experimenter.
- **Situational variables** – these are characteristics of the environment in which an experiment takes place. For example, in our audience effect experiment, if the room temperature was always higher in the presence of an audience than in the absence of an audience, then it becomes difficult to determine whether any effect on performance that is found is caused by the IV (audience) or the confounding variable (room temperature).

Controlling confounding variables is an important part of designing a good experiment. We will now look at ways to control each of the types of the confounding variables mentioned above.

Perhaps the best way to control **participant variables** is to use a **repeated measures** (or within participants) **design**. This means that each participant takes part in all of the experimental conditions. For example, in our audience effects experiment, each participant would complete the task in the presence of an audience and in the absence of

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an audience. This allows the experimenter to be sure that the differences between the conditions are not the result of different participants taking part in different conditions. Another advantage is that each participant gives more than one score, so fewer participants are needed altogether. However, this design introduces another potential confounding variable, the **order effect**. Order effects arise when participants have to repeat a task. They may get better, due to **practice**, or worse, due to **fatigue**. To overcome this problem, experimenters use counterbalancing, whereby half of the participants do the experiment in one order, and the other half do the other order. For example, in our audience effects experiment, half would do the task in the presence of an audience first, and then in the absence of an audience, while the other half do the task in the absence of an audience first, and then in the presence of an audience.

The alternative to a within participants design is an **independent measures** (or between participants) **design**. Here, each participant only takes part in one experimental condition. For example, in our audience effects experiment, one participant will complete the task in the presence of an audience, and another participant will complete the task in the absence of an audience. This design removes any possible problems due to order effects, and also makes it less likely that the participant will guess the reason for the experiment (experimenter effect). However, more participants are needed, and there may be problems with participant variables; the experimenter would have to be careful not to allocate people with particular characteristics to one group. This is usually achieved by **random allocation** to groups.

Sometimes, a compromise is made, and a **matched pairs design** is used. This means that each participant only takes part in one condition, but that another participant who has been matched on key characteristics takes part in the other condition. For example, if a 17 year old girl takes part in the condition with an audience present, another 17 year old girl takes part in the condition with an audience absent. This helps to reduce participant variables, although it does not eliminate them completely, and ensures that order effects are not a problem.

Experimenter (investigator) effects can be overcome in several ways. Often, **written instructions** are used, so that the experimenter cannot influence the participants through what they say. Sometimes, a **double-blind design** is used, whereby neither the experimenter nor the participants know who is in which condition.

It is impossible to account for all **situational variables** that might affect an experiment, and so ensure that they do not become confounding variables. However, researchers usually try to make sure that experiments take place in comfortable temperatures, good lighting, and quiet environments. In addition, the tests in different conditions are usually conducted in the same room, and at the same time of day, to avoid creating confounding variables. If environmental conditions are crucial to the experiment, then extra control (such as air conditioning or sound proofed rooms) may be used.

A final issue to take into account when designing an experiment is whether or not a design is ethical. Full information about ethics in research can be found on the BPS website.

Activity: Designing Experiments

A: Asking Research Questions

When we conduct psychological research, our starting point is a research question. Research questions need to be specific and testable. For each of these questions, say whether it is suitable for testing using scientific research methods, and give a reason.

1. Is abortion on demand bad for society?
2. Do people talk more after they have eaten than they do when they are hungry?
3. Does jogging lead to a positive mental attitude?
4. Are the incomes of professional workers related to their grades during their A level courses?
5. Which emotion is stronger: love or anger?

Extension activity: If you decide a question is not suitable in its current form, suggest an improvement that would improve its suitability. How could you rephrase the question to make it testable?

B: Types of Research Methods

Here is a list of some of the principle research methods used by psychologists. Your task is to match each with one of the following examples of research (by putting the appropriate letter next to the example, and explain why.

- A. Case study
- B. Naturalistic observation
- C. Laboratory observation
- D. Survey
- E. Psychological test
- F. Experiment

1. Sally is a professor who is interested in the relationship between the brain weight of rats and their speed in learning to find their way through a complex maze. Every afternoon, she gives her 50 rats 10 trials in the maze, counting the number of wrong turns each rat makes on its way through the maze. At the end of the experiment, she will measure the weight of the brain of each rat and look for a relationship.

2. Ben is counselling Jack in a small room in the neuropsychiatric hospital. Ben is a doctoral student in clinical psychology, and Jack is his client. Jack was admitted to the hospital when he came to the student health clinic complaining that he hears voices shouting obscenities at him. After each session with Jack, Ben writes a report describing Jack's verbal and non-verbal behaviour and his interpretations of the behaviour.

3. Lucy is training to be a psychometrician. She, like Ben, is working at the neuropsychiatric hospital. Her job is to administer a battery of tests to new patients. She

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will send the results, along with her summary and interpretation of them, to the patients' clinical psychologist or psychiatrist.

4. Janet is testing the hypothesis that colour preference can be influenced by associating a colour with a pleasant experience, like eating. This afternoon, she is delivering a supply of red, yellow, green, blue and white nursing bottles to the mothers of newborns who have consented to let their babies be participants in her research.

5. Bob is a teacher who will teach AS psychology for the first time next term. He has chosen some films to show in his class, and is now preparing a questionnaire to administer to his students after each film. He thinks that getting the students' reactions to the films will be helpful next time he teaches them.

6. Kate is an undergraduate psychology student. For her dissertation, she is investigating the nature of the audience for pornography. This afternoon, she is sitting in her car across the street from one of the pornographic bookshops in the area. She is taking notes on the sex, approximate age and ethnicity of the patrons as they enter and leave the shop.

Extension activity: discuss the ethics of each of these research activities.

C: Writing Hypotheses

Here are some testable research questions. For each question, write a hypothesis, and say whether the hypothesis is directional (one-tailed) or bidirectional (two-tailed). Where appropriate, identify the independent and dependent variable for each one.

1. Does caffeine increase alertness?
2. Does personality type influence the way in which people cross the street?
3. Is smoking related to people's attitude to risk?
4. Do males and females differ in their ability to detect when someone is lying?
5. Does age cause people's reaction times to slow down?

Extension activity: Think of a behaviour or psychological phenomenon that you have observed recently. Frame a research question that would allow you to investigate this phenomenon, and develop a hypothesis for it. Explain why you've chosen a directional or nondirectional hypothesis.

D: Formulating a Design

For one or two of the hypotheses that you formulated in section C, design a basic experiment to test it. You should include answers to the following questions:

1. How will you manipulate the IV?
2. How will you measure the DV?
3. Would it be better to use a repeated or independent measures design?

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4. What extraneous and confounding variables will you need to look out for, and how will you do this?

Extension activity: Choose someone else's design and evaluate it; can you identify a strength and a weakness in their design? Remember to be constructive when commenting on your peers' work.

E: Evaluation of Experimental Designs

Complete the table to show what are the main strengths and weaknesses of the different types of experimental design.

| Repeated Measures | | Independent Measures | | Matched Pairs | |
|-------------------|------------|----------------------|------------|---------------|------------|
| Strengths | Weaknesses | Strengths | Weaknesses | Strengths | Weaknesses |
| | | | | | |

Extension activity: Write a few sentences explaining how it is possible to overcome the problems of order effects.

Glossary of Terms

| | |
|---------------------------|---|
| Between participants – | An experimental design in which each participant gives a score in only one condition. See also independent measures. |
| Confounding variable - | A variable which changes systematically across the conditions in an experiment, making it difficult to tell whether differences between the conditions occur as a result of the independent variable or the confounding variable. |
| Control - | Take steps to minimise the effects of extraneous variables, to ensure that only the independent variable influences the dependent variable. |
| Counterbalancing - | A method of controlling order effects in repeated measures designs. Half of the participants complete condition A followed by condition B, and half of the participants complete condition B followed by condition A. Allocation of participants to a particular order is usually random. |
| Dependent variable - | The variable that is measured in an experiment. |
| Directional hypothesis - | A hypothesis which predicts that an independent variable will have an effect on a dependent variable, and specifies in which direction (eg, bigger or smaller) the change will occur. See also one-tailed hypothesis. |
| Double blind - | A type of experimental design in which neither the participants or the experimenter are aware of who is taking part in which experimental condition. Often used for clinical trials. |
| Ecological validity - | The extent to which experimental findings can be seen to represent what happens in real life. |
| Ethics - | The code of conduct according to which psychological research must comply. In the UK, ethical guidelines have been developed by the BPS, and all psychology research must follow these. Research must not cause harm or distress to any person. |
| Experiment - | A method of investigating psychology, in which an independent variable is manipulated, whilst all other variables are kept constant, in order to measure the effect on a dependent variable. |
| Experimental hypothesis - | A statement predicting that the independent variable will have a specified effect on the dependent variable. |
| Experimenter effect - | A type of confounding variable, in which the experimenter's behaviour may influence participants' performance on the dependent variable in a systematic way. See also investigator effect. |

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| | |
|------------------------------|--|
| Extraneous variable - | A variable which is not part of the experiment, but which may affect participants' performance on the dependent variable |
| Field experiment - | An experiment which takes place in a real-life setting, such as a café or a high street. The independent variable is manipulated by the experimenter, but no attempt is made to control other aspects of the environment. |
| Independent measures - | An experimental design in which each participant gives a score in only one condition. See also between participants. |
| Investigator effect - | A type of confounding variable, in which the experimenter's behaviour may influence participants' performance on the dependent variable in a systematic way. See also experimenter effect. |
| Independent variable - | The variable that is manipulated in an experiment. |
| Laboratory experiment - | An experiment which takes place in the controlled environment of a laboratory. An attempt is made to minimise the effects of all variables apart from the independent variable. |
| Matched pairs design - | An experimental design in which each participant gives a score in only one condition (see independent measures); however, each participant is "matched" with someone with similar characteristics in the other condition, to minimise participant variables. |
| Natural experiment - | An experiment in which the independent variable is not manipulated, but instead already exists in nature. Examples include age and sex. See also quasi-experiment. |
| Non-directional hypothesis - | A hypothesis which predicts that an independent variable will have an effect on a dependent variable, but does not specify in which direction (eg, bigger or smaller) the change will occur. |
| Null hypothesis - | A statement predicting that the independent variable will have no effect on the dependent variable. |
| One-tailed hypothesis - | A hypothesis which predicts that an independent variable will have an effect on a dependent variable, and specifies in which direction (eg, bigger or smaller) the change will occur. See also directional hypothesis. |
| Order effects - | A type of confounding variable that occurs in repeated measures designs. Participants who do the same or a similar task repeatedly may improve or deteriorate in their performance because of practice or fatigue, and this prevents certainty about whether any effect on the dependent variable is |

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caused by the independent variable. Order effects are usually controlled by counterbalancing.

- Participant variables - Individual differences between participants.
- Quasi-experiment - An experiment in which the independent variable is not manipulated, but instead already exists in nature. Examples include age and sex. See also natural experiment.
- Random allocation - Each participant has an equal chance of being allocated to a particular condition. This may be achieved by use of random numbers, or drawing names from a hat, for example, to decide which participants take part in which condition (or in which order, for repeated measures designs).
- Repeated measures - An experimental design in which each participant takes part in all experimental conditions. See also within participants.
- Situational variables - Environmental or other conditions which may influence participants' performance on the dependent variable. Examples include time of day, lighting and temperature.
- Two-tailed hypothesis - A hypothesis which predicts that an independent variable will have an effect on a dependent variable, but does not specify in which direction (eg, bigger or smaller) the change will occur. See also bidirectional hypothesis.
- Within participants - An experimental design in which each participant takes part in all experimental conditions. See also repeated measures.

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Vocabulary Activity

For each term below, write a definition in your own words. Try to do so without looking at your book or your notes, and only refer to your notes if you are really unsure. When you have finished, check your answers are correct.

| TERM | DEFINITION |
|---------------------------------------|------------|
| Between participants | |
| Confounding variable | |
| Control | |
| Counterbalancing | |
| Dependent variable | |
| Directional hypothesis | |
| Double blind | |
| Ecological validity | |
| Ethics | |
| Experiment | |
| Experimental hypothesis | |
| Experimenter (or investigator) effect | |
| Extraneous variable | |
| Field experiment | |
| Independent measures | |
| Independent variable | |
| Laboratory experiment | |
| Matched pairs design | |
| Natural experiment | |
| Non-directional hypothesis | |
| Null hypothesis | |

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| | |
|-----------------------|--|
| One-tailed hypothesis | |
| Order effects | |
| Participant variables | |
| Quasi-experiment | |
| Random allocation | |
| Repeated measures | |
| Situational variables | |
| Two-tailed hypothesis | |
| Within participants | |

Note to teachers: Many students struggle with the vocabulary associated with research methods. Encouraging them to define terms in their own words will check their understanding, and will also give them a personally meaningful resource that they can use in their future studies and revision. You could use the activity above as a peer learning exercise, encouraging students to work in pairs or small groups to produce definitions, or to check each others' work.

Matching Activity

Cut out each of the boxes in the table below. Each term in the left hand column has an equivalent term in the right-hand column: can you pair them up?

| | |
|-----------------------|----------------------------|
| Two-tailed hypothesis | Repeated measures |
| Within participants | Natural experiment |
| Quasi-experiment | Non-directional hypothesis |
| Between participants | Directional hypothesis |
| One-tailed hypothesis | Independent measures |

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Further Reading and Additional Resources

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