Chapter 8

Where's the proof?

Finding and evaluating sources of evidence

Learning outcomes

This chapter offers you opportunities to:

- recognise the difference between primary and secondary sources
- understand what is meant by a literature search
- understand concepts such as authenticity, validity, currency, reliability, relevance, probability, and controlling for variables, as applied to research evidence
- identify ways of evaluating samples used in research projects
- recognise potential weaknesses in oral testimony

Introduction

We do not always need to be an expert in a subject to evaluate an argument. In many instances, we will still be able to evaluate whether the reasons support the conclusion and whether the line of reasoning is ordered in a logical way.

However, in order to evaluate many arguments, we have to know whether the evidence used to support the reasoning is true. This means that we need to go to other sources, either people or material resources, to check the facts that underlie the reasons given.

Evidence may be convincing in one context, such as in everyday conversation or a magazine, but not in others, such as in a court of law or for academic or professional writing. In the latter cases, it is expected that greater efforts are made to check that evidence is all that it appears to be.

Primary and secondary source materials

Most types of evidence can be divided into one of two categories:

- primary sources: the 'raw material' for the subject, such as data and documents;
- secondary sources: materials such as books and articles based on, or written about, primary sources.

Primary source materials

Primary source materials are those that originate from the time and place of the events being investigated. Primary sources can include:

- contemporary letters, documents, prints, painting and photographs;
- newspapers, books and materials published at that time;
- TV, film and video footage from the time;
- recordings of radio broadcasts;
- remaining body parts, sources of DNA, finger prints and footprints;
- artefacts such as tools, pottery, furniture;
- testimonies of witnesses;
- the raw data from experiments;
- autobiographies;
- material on the internet if the internet or materials on it are the focus of the study;
- individual responses to surveys and questionnaires.

Secondary sources

Secondary sources are any materials written or produced about the event, usually some time later. These include:

- books, articles, web pages, documentaries about an event, person or item;
- interviews with people reporting what they heard from witnesses;
- biographies;
- articles in magazines;
- papers and reports using the results of surveys, questionnaires and experiments.

Crossing between categories

Whether something is a primary source depends on how far it was part of the events at the time. Secondary sources in one circumstance may be primary sources in another. For example, a biography is normally a secondary source, but may reproduce copies of original letters that are primary sources. The biography of a prime minister is a secondary source of information about the political leader but could be a primary source about the life of the author. Magazine articles written in the 1950s were secondary sources when published, but are primary sources for present-day research into life in the 1950s.

Activity: primary sources

What are the main primary sources for your subject?

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Searching for evidence

Critical thinking generally requires an active approach to seeking out the most relevant evidence to support your own arguments, and to checking the evidence used by other people.

Checking other people's evidence

When you are reading, or watching a programme, or listening to a lecture, you may encounter a line of argument that is so interesting or relevant that you want to discover more. Alternatively, you may consider that the evidence cited does not sound very credible and you may want to check it for yourself. The higher the level of study or research, the more important it is to check the key evidence, especially if there is any doubt about its being reported accurately

Use the references

When reading articles and books, you will see a short-hand reference in the text such as '(Gilligan, 1977)' and a more detailed list of references at the end of the text. These references provide the details you need in order to find that source for yourself.

Good references enable any reader who wishes to do so, to check whether:

- the source material really does exist;
- the author represented the source material in an accurate way, and the source really says or contains what the author claimed;
- the source contains any additional information that readers can use for their own projects.

When critically evaluating an argument, don't be afraid to go back to some of the sources and check whether these stand up to scrutiny. Often, it is not possible to form a judgement about an argument until you have more information about the subject.

Evidence for your own arguments

When looking for evidence to support your own arguments, the first questions you are likely to ask are:

- Has anything been written about this already?
- Where can I find that information?
- Which are the most relevant and authoritative sources for this subject?

For everyday purposes

If you need information for casual purposes, such as for a personal project or for contributing to a debate, you may need only to do one or two of the following:

- browse an introductory chapter of a book;
- use a search engine such as *Google* for information about the subject;
- read recent newspapers, or read papers on the internet, using a source such as *guardian.unlimited*;
- ask an expert in the area, such as a librarian;
- visit the web-site of relevant bodies, such as campaign groups, charitable bodies, or government sites.

For academic and professional purposes

If you are looking for material as background for a professional report or for academic work, you will need to conduct a 'literature search'. The rest of this chapter focuses on finding and critically evaluating potential sources of evidence.

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Literature Searches

A literature search gives you an overview of previous research on the subject. Usually, the larger the project, the more extensive the search. For smaller projects, or where there are word restrictions for the report or essay, careful selection is especially important.

Doing a literature search means:

- finding out what has been written on the subject (secondary sources);
- collating a list of the sources that are potentially relevant for your subject;
- paring down the list, selecting sources for initial investigation to check for relevance;
- browsing selected items to help you select the most useful sources;
- selecting the most relevant sources for more detailed investigation.

On-line literature searches

Many reputable sources are now available on line. If you know the names of journals, government papers or other relevant authoritative sources, enter these as part of your search. Otherwise, enter several key words to help pin-point exactly what you want. Your search will be more effective if you use a relevant search engine. If you are at university, your tutors are likely to recommend the most useful web-sites and search engines. Some useful starting places are given in the Appendix on p. 245.

Using abstracts

Browsing the abstracts of journal articles is a particularly useful way of gaining a sense of all the recent research in the field. The abstract summarises the main argument, research methods, findings and conclusions, which helps you decide whether the article is worth reading in depth. Note, especially, the section which summarises the background literature for that report. This can indicate important leads for your own project.

Deciding whether to use a secondary source

Examine secondary sources critically to decide whether, for your purposes, they are likely to be sufficiently:

- well researched
- trustworthy
- recent
- relevant.

This is especially important if you are considering purchasing books or borrowing them from a library, as it helps you to avoid unnecessary costs and time delays.

Basic questioning of the evidence

Critical thinking is a questioning process. When evaluating evidence, ask such questions as:

- How do we know this is true?
- How reliable is this source?
- Are the examples given truly representative of the whole area?
- Does this match what I already know?
- Does this contradict other evidence?
- What motive might this person have for saying this?
- What are we not being told?
- Are any other explanations possible?
- Do the reasons support the conclusion?
- Is the author's line of reasoning well substantiated by the evidence?

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Reputable sources

For academic study and for professional life, evidence is roughly divided into 'reputable sources' (or 'authorities') and then everything else. A reputable source is basically one that:

- has credibility: it can be believed with a high degree of certainty;
- is likely to give accurate information;
- is based on research, first-hand knowledge or expertise;
- is recognised in the field or academic discipline as an authority.

Journal articles

Articles in journals are usually regarded as the most reputable sources as, in order to be published, they have to be reviewed and selected by other leading academics. This is known as 'review by peers'. There is a great deal of competition to get published in leading journals, so articles that succeed in passing such a peer review are generally well regarded.

Subject differences

A reputable source for one subject may not be a reputable source in another field of study. Each academic discipline has its own conventions. For some subjects, such as in science, law, medicine, and accountancy, 'hard' data such as facts and figures are generally regarded as superior forms of evidence. On the other hand, in subjects such as art, music and psychotherapy, qualitative evidence can be regarded as more important: 'feeling the subject' may be more valuable than 'number-crunching'. However, this is not a hard and fast rule, and it can depend on the nature of the subject being studied and the evidence that is available.

Questions to consider

When deciding whether a text is worth reading, consider:

- Has it been recommended by a source you trust, such as your tutor or a reputable journal or a review in a quality newspaper?
- Is there a clear line of reasoning, with supporting evidence?
- Does it include a detailed list of references, or a bibliography, indicating thorough research?
- Does it provide clear references to its sources of information, so that other people could check these? If not, this may not be a suitable text for use in academic contexts.
- Does it use source materials that look reputable, such as journals and relevant books, rather than the popular press?

Using recognised 'authorities'

Older sources, especially those regarded as authorities, may have made a significant contribution to the area of study. It is important then to check:

- exactly how the source contributed to knowledge in the field – don't dismiss something just because it sounds old;
- which parts of the original arguments and evidence are still applicable, and which are not;
- how later research used the source as a stepping stone to further findings – and in what ways the original ideas have been refined or superseded;
- more recent authorities, to see whether the source is still exerting an influence on research.

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Authenticity and validity

Authentic evidence

Authentic evidence is of undisputed origin. This means that it can be proved that it is what it is claimed to be, or that it really was written or produced by the persons claimed. It isn't always possible to check for authenticity when hearing or reading an argument, but it is possible to maintain an open mind about whether the evidence is likely to be authentic.

Activity: authenticity

Consider whether each of the following references is likely to be authentic or inauthentic.

1 A medieval illuminated manuscript found in the stacks of a cathedral library.

2 A medieval illuminated manuscript that turns up in a local second-hand bookshop.

3 A collection of 1000 autographs of Elvis Presley being sold over the internet.

4 An unpublished diary written by Shakespeare, in the possession of a second year student.

5 Letters written by Napoleon Buonaparte, dated 1809, contained in a large collection of French Revolution memorabilia.

6 A set of 5 previously unknown Van Gogh paintings discovered in a garage on a housing estate.

7 Decaying remnants of a Viking ship found in recently drained marshland.

8 Letters and art-work written by prisoners in the nineteenth century, in the care of a prison governor.

The answers are on p. 146.

Validity

Valid evidence meets the requirements agreed, or the conventions that are usually followed, for the circumstances. What is valid will vary depending on the circumstances. Evidence may not be valid if, for example, it is not authentic, if it is incomplete or if it isn't based on sound reasoning.

Examples

(1) A defendant confessed to a crime but the confession wasn't considered valid because it became evident that the defendant had been forced to make it. Legal requirements would not regard a confession exacted under duress as valid evidence of committing a crime.

(2) To gain a particular qualification, students were required to write eight essays as their own work. Although one student handed in eight essays on relevant subjects, the examiners found that three were too similar to essays available on the internet. These were not accepted as valid evidence of the student's own work, so the requirements of the qualification were not met.

(3) An athlete argued that she was the fastest runner in the world. Although she had reliable evidence of her running times, these were not considered valid evidence that she was the fastest runner, as they were gained in unusually favourable wind conditions.

(4) A report claimed that people who smoke are more likely to drink alcohol. The evidence wasn't considered valid as all the participants who smoked were selected in places that sold alcoholic drinks, whereas non-smokers were selected in the street. This meant that the selection of participants was already weighted in favour of the smokers being more likely to drink alcohol. This doesn't meet agreed research conventions, which aim to avoid weighting the evidence.

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Currency and reliability

Currency

If a source is described as 'having currency', this means it is still relevant *in the present*. This may be because:

- It was published recently.
- It was updated recently.
- It has been produced in a new edition that takes account of the latest research.
- The material covered is relatively stable and unchanging over time, so that it remains relevant for a long time. Examples of this would be anatomy, biographies, or descriptions of how machinery used to work in the past.

It is always worth checking whether a source is still up to date: new research can appear on any topic at any time.

'Currency' is a term that is applied to secondary sources. Primary sources are contemporary to an event, so may be relevant or not relevant to a topic, but questions of currency are not usually appropriate.

Seminal works

Seminal works are those that are so original or far-reaching in their findings that they continue to exert an influence for a long time. A seminal work could be a text, a film, music, art, architecture or commercial design, or any other item that had a strong impact on the thinking and research in a discipline over time. It helps our understanding of our subject discipline if we have first-hand experience of the seminal works that influenced its research base and theoretical perspectives. We are in a better position to recognise the theoretical perspective informing other research, and to recognise the influence of those works in later works.

Reliability

Evidence is reliable if it can be trusted. This may be because the source of the evidence is:

- someone you know to be trustworthy;
- a recognised expert;
- a person with no vested interest in the outcome;
- a reputable source (see p. 129).

Reliability also refers to whether the evidence is stable over time, so that it can be used to make reasonably secure predictions. In other words, if you have evidence that something worked once, is this sufficient to show that it will work next time?

Example

Climatic conditions are relatively stable for large areas and time-periods and can be used to predict general trends in temperature or rainfall. On the basis of evidence of climatic change, we can predict that the Sahara region is likely to remain hot and dry for many years. Weather, on the other hand, changes quickly, and is less reliable for making predictions. It will rain in the Sahara, but it is hard to predict when or how much rain will fall.

Replication

In more scientific writing, you may see references to the results being 'replicated' or 'not replicated'. This means that the results of a survey or experiment were re-tested to see whether they held true. If they didn't, the original outcome might simply have been the result of chance.

It is useful to know whether research was repeated and the findings replicated. If the outcomes were similar, this increases the probability that the findings are reliable.

Activity

Which works are considered seminal for your area of research or the subjects you are studying this year?

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A summary of your background reading, or reasoning based on secondary sources, is normally required as an early section in a report and for dissertations and doctoral theses.

Which sources should I refer to?

It is usually the case that there is a great deal to say about the source materials, but there are word restrictions that limit what can be said. This means you need to consider very carefully the sources to which you will refer.

Be selective

- Include sources regarded as the leading authorities on the issue.
- Refer in brief to any other sources. Select evidence that demonstrates the main pathway, or set of stepping stones, leading up to your own project.

Sources contributing to your argument

The main source materials to which you refer should be those that contribute most to supporting your own line of reasoning. There may be one or two seminal works that you refer to in some detail, a small selection of key works that you cover at some length, and several others that you refer to in passing. It is important, when writing academic reports, to show you can discriminate appropriately between the most relevant sources and those of peripheral importance.

Passing references

References to other research add weight to your own reasoning. A passing reference may be a major study in its own right, but contribute only background detail to your own argument. Usually, you would use a passing reference to support a step in your line of reasoning or to substantiate a minor point in your argument. You do this by either:

- writing a sentence summarising the research findings and naming the source and date; or
- writing your point and then adding a reference in brackets.

Examples

Miles (1988) argues that British Sign Language is a language in its own right.

Sign languages are also languages with their own traditions (Lane, 1984; Miles, 1988).

What should I say about sources?

Most writing tasks have word restrictions. You will usually need to allocate most of your word allowance to critical evaluation of the argument and your sources of evidence, and very few words, if any, to describing them. If you are uncertain of the difference between descriptive and analytical writing, see pp. 54–60.

When selecting sources, ask:

- Did this contribute a major theoretical perspective to the discipline?
- Has this changed thinking in the subject, or made a significant contribution to the questions debated in the discipline?
- Does this provide a contribution to the path of research evidence that leads up to my own project? If so, how? Is this a direct or an indirect link? Is it a key contribution that needs to be discussed or a lesser contribution requiring a passing reference?
- Does this source challenge what was said before or provide an alternative way of thinking about the issue?
- Does it use research methods that are novel or that I could use for my project?

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Relevant and irrelevant evidence

Relevance and irrelevance

Relevant evidence is that which is necessary to give a good understanding of the issues. An author can provide evidence that:

(1) supports the conclusion;
(2) is relevant to the subject, but which may not be relevant to the conclusion: in this case, the evidence might even contradict the conclusion;
(3) is relevant neither to the conclusion nor to the subject.

Example 1

People need to improve their understanding of how language works so that they can use it more effectively. Research studies (Bloggs, 2003; Bloggs, 2006) show that the study of a foreign language improves our understanding of the structure of language, providing a way of comparing different language structures. Therefore, people who only speak one language should be encouraged to study a second language.

Here, the research evidence about the benefits of studying a foreign language is relevant to the conclusion that people who speak only one language should be encouraged to study a second language.

Example 2

People need to improve their understanding of how language works so that they can use it more effectively. Research studies (Bloggs, 2003; Bloggs, 2006) show that many people cannot describe the different components of their own language. A surprising number of people have difficulties remembering the rules even of their mother tongue. Therefore, people who only speak one language should be encouraged to study a second language.

Here the evidence that people have difficulties in their own language could be interpreted to suggest that people who have difficulties with one language should not be encouraged to learn a second. The evidence is relevant to the debate, but does not support the argument. Further information would be needed to support the conclusion.

Example 3

People need to improve their understanding of how language works so that they can use it more effectively. Research studies (Bloggs, 2003; Bloggs, 2006) show people can recognise concepts in a foreign language even when there is no word for that concept in their mother tongue. Therefore, people who only speak one language should be encouraged to study a second language.

Here, the evidence about recognising concepts in a foreign language is loosely related to the topic about languages. However, it has a completely different focus. It has no apparent relevance to the debate about using language effectively or the conclusion that people should learn a second language in order to use language more effectively.

Relevance to the conclusion

In considering whether evidence is relevant, your main focus should be on whether the conclusion would be different if that evidence (or reason) was different or not available?

Check

When evaluating an argument, check:

- Is the evidence relevant to the topic?
- Is it needed to substantiate the reasoning?
- Does it make a difference to the conclusion?
- If so, does it support it or contradict it?
- Is the evidence needed to substantiate interim conclusions?

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Activity: Relevant and irrelevant evidence

Activity

For each of the following passages, identify whether the evidence and reasons are relevant to the conclusion. Then read the *Commentary* opposite.

Passage 8.1

Ice Age

Winters are getting colder. Opinion polls show that most people think there is a new Ice Age on the way. Therefore, we need to take measures to ensure that fuel resources are managed so that nobody is left to suffer from extreme cold during forthcoming winters.

Passage 8.2

Mr Charlton was given information, in confidence, that the price of shares in MKP2 Oils would rise suddenly if news of the new promotion reached the press before the share price was adjusted. Mr Charlton bought 50,000 shares in MKP2 Oils and leaked news of the promotion to the press. As a result, he made ten million pounds personal profit. We can conclude that Mr Charlton abused the trust of the company and cheated it financially.

Passage 8.3

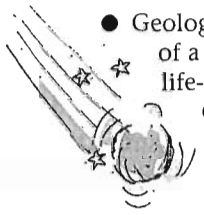
Major catastrophes, rather than gradual evolution, may be the main cause of change. Such a view did not seem plausible in the past as it was assumed that the process of geological change took place in a gradual way, just as it appears to today. However, evidence now suggests that change can be rapid and extreme. Geological evidence indicates that an enormous meteor collided with the earth several hundred million years ago, making most life-forms extinct. Geological science now attracts more funding than it did in the past. Archaeological evidence suggests that sudden changes in the environment brought about the rapid collapse of ancient civilisations.

Commentary

For Passage 8.1, the first reason, that winters are getting colder, is relevant to the conclusion about managing fuel resources. However, no evidence is given to substantiate this reason. The evidence from polls shows opinions, not facts, and this does not support the conclusion. An opinion is still only an opinion, even if held by a lot of people. The validity of an argument or of evidence does not normally rest on a majority decision.

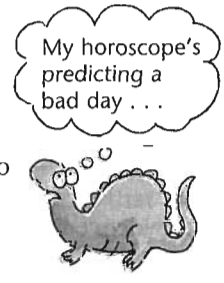
For Passage 8.2, all of the evidence given is relevant to the subject and to the conclusion that Mr Charlton abused the trust of the company and cheated it financially. He betrayed a secret to the press so that he could make money at the company's expense.

In Passage 8.3, the conclusion is that major catastrophes, rather than gradual evolution, may be the main cause of change. The relevant pieces of evidence given to support this are:



- Geological evidence about the effects of a meteor collision in making life-forms extinct.
- Archaeological evidence about the effects of sudden environmental change leading to the fall of ancient civilisations.

The section about the plausibility of this view in the past is useful background information, but does not provide evidence to support the conclusion. Information about funding for geological science is not relevant to the conclusion.



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Representative samples

Most research topics cannot be tested using very large numbers of people or circumstances. This would usually be too expensive, time-consuming, complicated to organise and unnecessary. Instead, surveys and research projects rely on selected samples. A representative sample is one which gives due consideration to the potential variety of relevant groups and circumstances.

Example

Four animal charities wished to know the views of the public on whether pets taken overseas should be held in quarantine before being allowed to re-enter the country. Each one selected the sample in a different way.

Sample 1
Charity 1 chose 1000 dog-owners from across the nation. The survey was balanced to ensure that roughly equal numbers were interviewed in every part of the country.

Sample 2
Charity 2 chose 1000 dog-owners from across the nation. The survey was balanced to ensure that more people were included in the survey in parts of the country which had large populations, and fewer representatives were questioned if the population was low.

Sample 3
Charity 3 chose 1000 pet-owners from across the nation. The sample was chosen to ensure that a broad range of pet-owners were included, including owners of snakes, budgies and tropical spiders.

Sample 4
Charity 4 chose 1000 people, representing a variety of pet-owners and people who do not own pets. The sample was selected from every county, weighted to include more people from heavily populated areas.

Differing principles of sample selection

Each of these samples selected participants according to a different principle. Sample 1 ensures that all geographical areas are represented equally, whereas sample 2 is more concerned that the sample is representative of population size. Sample 3 aims to ensure that different kinds of pet-owners are represented, whereas sample 4 is representative of both pet-owners and non-pet-owners.

Depending on the aim of the research, any of these methods of selection may be appropriate. For example, if it were known that 99 per cent of pets affected by quarantine were dogs, and that people from poorly populated rural areas were particularly affected, then the approach in sample 1 would be the most appropriate choice. Otherwise, a weighting according to population size is preferable.

If a wide variety of pets were subject to quarantine, then the approaches taken in samples 3 and 4 would be more representative of those affected. Samples 1–3 assume that people without pets do not need to be consulted, whereas sample 4 is more representative of the population in general. Sample 4 is more typical of the kinds of sample you will see in research projects and in articles. Usually, samples need to be representative of several different perspectives.

Check

When reading the 'Methods' section of research papers, articles and reports, check whether the most appropriate sampling method was used. If a group was not represented in the sample, then the findings may not be applicable to it.

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Activity: Representative samples

Activity

Consider the following passages and decide in what ways the sample used in each is representative, and the ways it is not. Then read the *Commentary* opposite.

Passage 8.4

The experiment aimed to prove that eating carrots improves night vision in people under the age of 45, excluding children below school age. The sample consisted of 1000 people; 789 were women and the rest were men. For each sex, 25 per cent of participants were from the different age groups, 6–15 years, 16–25 years, 26–35 years and 36–45. Participants ate three capsules of carrot extract every day for ten weeks.

Passage 8.5

The survey set out to discover whether consumers preferred soap perfumed with almond essence or soap perfumed with aloe vera. The sample consisted of 1000 people. Of these, 503 were women and 497 were men; 50% of the sample were aged between 25 and 40, and the rest were aged between 41 and 55.

Passage 8.6

The research project tested the hypothesis that people who receive 6 sessions of counselling following a bereavement are less likely to take time away from work in the following twelve months than people who do not receive counselling. The sample consisted of 226 participants, in two groups that were matched for age, sex and ethnicity. Group 1 consisted of the 37 participants who opted to receive six sessions of counselling. Group 2 consisted of those who opted not to have counselling.

Commentary

The sample in Passage 8.4 is representative of the age group it set out to test, as it has taken care to ensure a good age distribution. It is not representative in terms of gender, as it includes far more women participants than men. It does not appear to be representative of people with different kinds of eye-sight, which would be important for this experiment.

In Passage 8.5, the sample is representative in terms of gender. Although the numbers of men and women are not exactly the same, the difference is small and not likely to be significant. The sample is not representative in terms of age. The survey does not state that the intention is to discover the preferences of people of a particular age range. It is not representative of people aged under 25 years or over 55 years. It is not clear whether the sample represented people from different economic, social, racial or geographical backgrounds.

In Passage 8.6, the two groups were 'matched' for age, sex and ethnicity. This means the sample was chosen so that a similar proportion of each of the two groups were men and women, from similar age groups and backgrounds. That is useful for ensuring the findings are not the result of differences in the composition of the groups. However, we do not know whether the samples were representative in terms of age, sex or ethnicity. For example, each group might consist entirely of white women aged 25–30. No details are given about whether the sample is representative in any other way, such as by type of job, geographical area or relationship with the deceased person. Most importantly, as only a small number of people received counselling, this is not a balanced sample.

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Certainty and probability

Certainty

Arguments cannot always be proved with 100 per cent certainty. Chapter 7 looked at how necessary and sufficient conditions may need to be met in order to prove a conclusion. In many circumstances, it is difficult to prove that sufficient conditions have been met, as there are so many exceptions to the rule.

Reducing uncertainty

Uncertainty is not very satisfying and does not help in decision-making. Academics aim to reduce uncertainty in a number of ways, including:

- selecting reputable sources which are more likely to be credible;
- critically analysing the evidence, looking for the kinds of flaws outlined in previous chapters;
- calculating the level of probability;
- increasing the level of probability as far as they can.

Probability

When evaluating an argument, the audience needs to decide on a general level of probability. This means deciding whether the evidence is likely to be credible and authentic and, if so, whether the conclusions are likely to follow from the line of reasoning and its supporting evidence. Any conclusion may lie on a spectrum from impossible, to possible, to probable, through to certain. As Chapter 10 shows, academic writing is reluctant to express certainty, even when it has taken significant steps to ensure a highly probable finding.

Probability spectrum
Impossible — possible — probable — certain

Calculating the level of probability

The level of probability is related to the likelihood that something occurred because of the reasons given, compared with how far the outcome could have occurred by chance. If you throw a coin a hundred times so that it lands flat, there are only two options for the way it can fall, heads or tails. The probability is that the coin will land on heads about 50 times and tails about 50 times. This outcome is not certain, but it shouldn't surprise us if it occurs.

To win the lottery, the chances are much less probable. If there are 14 million options for the winning set of numbers, and you have only one set of numbers, the chances of your set being selected are one in 14 million.

Statistical formulae or specialist software can be used to calculate how likely it is that a particular outcome occurred by chance or coincidence. This can be expressed as 'The probability of this happening by chance is . . .'

- less than one in 10
- less than one in a 100
- less than one in a 1000.

Expressing levels of probability

You are likely to see probability expressed as:

p = <0.1 (less than a 1 in 10 chance that the outcome could have occurred by chance)
p = <0.01 (less than a 1 in 100 chance)
p = <0.001 (less than a 1 in 1000 chance)
p = <0.0001 (less than a 1 in 10,000 chance).

The words 'The probability of this happening by chance' are abbreviated to 'p ='.
The words 'less than' are abbreviated to <.
The numbers are usually expressed as decimals smaller than the number 1.

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Sample sizes and statistical significance

Sample size

The larger the sample size, the greater the degree of probability. The smaller the sample size, the more likely it is that the outcome could have occurred by chance. The appropriate size of sample varies.

An appropriate sample size depends on:

- how essential it is to reduce the element of coincidence;
- whether it is a question of health and safety: a very small sample may suffice to prompt action;
- how necessary it is to be representative of many ages, backgrounds and circumstances;
- the funding available;
- how likely it is that a smaller sample will give reliable results.

Example

Clinical trials on a thousand volunteers indicate a success rate of over 95 per cent. Most patients made a complete recovery and, so far, few side effects have been identified. These trials offer hope of pain relief to a significant proportion of current patients.

Here, a thousand may seem like a significant number of people. However, that sample is unlikely to be representative of all those who may take the drug in future and of the circumstances which would ensure the drug was safe for them. If you needed to take the drug, you would be more reassured if you knew it had been tested on people who share similar circumstances to yourself, such as your blood group, age group, ethnic group, and people with similar allergies or medical conditions.

A study of heart attacks reported in *The Times* (31 August 2004) involved 29,000 participants in 52 countries over ten years. Other medical surveys may be much smaller. Opinion polls are usually based on surveys of about 1000 people.

Statistical significance

When there are very small samples, such as surveys which include fewer than 16 people in each category, it is hard to say that the outcome wasn't just a coincidence. When the sample is small, or the differences between groups are small, we say that these are 'not statistically significant'.

Look for

When evaluating evidence, look out for expressions such as: 'the results are significant at p = <0.0001 (see p. 137 above). This shows the level of statistical significance: a one in 10,000 chance. The more zeros after the decimal point, the more reliable the finding and the less likely it is that the result occurred as a coincidence.

If, on the other hand, you see an expression such as 'the results were not statistically significant', this means that the results, or the differences between two things, may just be a coincidence.

Small samples

A small sample may be necessary:

- when surveying people who are unusual in some way, such as people who are exceptionally successful or with rare medical or neurological conditions;
- if it is dangerous to gain larger samples, such as when working at depth under the ocean, travelling into space, exposed to chemicals, or living with extreme sleep deprivation;
- in unusual circumstances, such as large numbers of multiple births.

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Over-generalisation

Generalisations are useful as they help us to see patterns and to make judgements more quickly when this is needed. However, a generalisation should be well-founded, based on a reasonable sample.

An over-generalisation is one based on too small a sample to justify the generalisation.

Example

My first child slept through the night but the second one was a very poor sleeper. First-born children are better at getting to sleep than their younger brothers and sisters.

Here, the generalisation about first-born children is made on the basis of only two children. This is a database of two, which is a very small sample. If thousands of other first-born and second-born children showed the same sleeping pattern, then the generalisation might be valid. However, when only two children are involved, there is a large element of chance. The family next door might find that both their children sleep well.

Generalising from a single case

Generalising from a single case means forming a general conclusion on the basis of one instance. This is rarely acceptable.

Example

Some people say that calling people names because of the way they look is offensive. My friend is very overweight and people call him names for being fat. He says he doesn't mind as he finds horrible things to call back. This shows there is no harm in calling people names as they can just retaliate if they want to.

Just because one person appears not to mind offensive language, this does not mean that all other people will react in the same way.

An exception can disprove a rule

However, some generalisations can be made on the basis of a single instance, and be accurate. This is true, for example, when a general rule is already in existence, such as that objects, when dropped, will fall towards the ground. A single case that contradicts that rule would show that the generalisation wasn't universally true: for example, a helium balloon would rise. In such cases, the rule then has to be reconsidered and refined to account for the exception. Much of science and law has progressed by refinements to rules so that they are more accurate about the exact circumstances in which they apply.

Example

Clinical trials showed the drug to be very successful. However, this patient had a severe allergic reaction to the new drug. This means that doctors need to be aware that some people may react negatively to the drug.

Here, a single example is sufficient to necessitate a carefully worded generalisation. Over time, as more exceptions emerge, the generalisation will change to become more precise and accurate.

Example

This drug can create a severe allergic reaction in asthma sufferers and people taking the drug BXR2.

These examples illustrate that a small sample, even a single example, can disprove a theory based on a much larger sample. A single example can disprove a theory or rule. When this happens, the rule or theory has to be re-examined and reformulated to take account of the exception. However, it is also important to bear in mind that a generalisation means 'most of the time' and may be useful in helping to understand a situation despite the exceptions.

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Controlling for variables

What are 'variables'?

'Variables' are all those circumstances that might affect the outcome in intended or unintended ways. When evaluating evidence, it is useful to consider whether the author has taken steps to identify potential unintended variables and to prevent them affecting the outcome of the research.

Example

During trials in South Africa, the yield of grapes on a new vine was twice the usual level for red grapes. The yield produced twice the volume of wine. Cuttings of the vine were transported to California to an area with similar soil and rainfall. However, the vine didn't produce the same yields in California.

In this case, the producers controlled for some variables such as soil and rainfall, but these were not enough. In order to find out why the vine yielded more in one area than the other, the producers would need to grow it under controlled conditions, changing just one aspect of the conditions each time, until they isolated the special conditions that doubled the yield. Such variables might include:

- the total hours of daylight available;
- minerals and trace elements in the soil that had been overlooked;
- when the rainfall occurs during the growing process;
- the slope of the land;
- other plants growing nearby and their effect on insects and pests.

When you read research reports or journal articles, check what steps were taken to control for variables. In an article, this will be found in the section on methods. If the research doesn't take steps to control for variables, then the results may have been attributed to the wrong cause.

Control groups

One way of checking that the results support the conclusion is by using a control group. The control group is treated differently from the experimental group and provides a point of reference or comparison. If an experiment was testing for sleep deprivation, the experimental group might be denied sleep for 60 hours, whereas the control group might be allowed to sleep as usual.

Example

A company claims that its SuperVeg juice reduces the incidence of colds and flu. 100 people drink a bottle of SuperVeg every day for a year, and a control group, also of 100 people, is given flavoured water in a SuperVeg bottle.

The flavoured water is known as a 'placebo'. Participants should not know which group they are in, as that can influence their response: participants might wish either to help the experiment along or to sabotage it.

Activity: Controlling for variables

Look again at passages 8.4–8.6 on page 136. For each example, identify what kinds of control groups or controlled conditions are needed.

The answers are on p. 146.

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Facts and opinions

Opinion

An opinion is a belief that is believed to be true, but which is not based on proof or substantial evidence. An opinion may be a personal point of view or held by a large number of people, even if it runs contrary to the evidence.

Example

Opinions

Facts

Facts are basically items of information that can be checked and proved through experience, direct observation, testing or comparison against evidence. However, as knowledge of an area increases, facts can later be disproved. A fact checked against reputable evidence generally carries more weight than personal opinion, but that doesn't mean it is true.

Example

Facts

The coroner stated that the time of death was between 2 a.m. and 4 a.m. in the morning. The body was found at 6.30 a.m. by the cook. The footman reports that there were six people in the house overnight. The butler reports that four other people have keys and could have entered the house and left again before 6.30 a.m.

The facts in the example above are:

- The time of death, as given by the coroner. That is likely to be reliable.
- The time the body was found by the cook; however, somebody else could have found the body earlier and remained silent.
- The footman reported certain information.
- The butler reported certain information.

The details of the reports by the footman and the butler may not be facts: these could be personal opinions, or they may have been lying.

False appeals to the 'facts'

People's opinions can vary about what is a fact and what is an opinion.

Example

The butler was in the house all night. His employer was murdered during the night. The butler says he was a loyal servant but maybe he wasn't. I think he was lying and that he had some sort of vendetta against his employer. The facts say he is the murderer.

In this case, the facts appear to be:

- The butler was in the house all night.
- His employer was murdered during the night.
- The butler says he was a loyal servant.

These do not prove that the butler was either a loyal servant or a murderer: either or even both could be true. However, note that the author states his opinion, that the butler is the murderer, as if it were a fact.

Expert opinion

'Expert opinion' is based on specialist knowledge, usually acquired over time or based on research or direct experience. It is often used in court to help a judge or jury to understand the issues. Experts are often asked for their own judgements. This, in itself, is not taken as 'proof', as even experts can be wrong.

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Eye-witness testimony

Eye-witness testimony

Eye-witness testimony may be useful in a number of circumstances, such as:

- people who saw or experienced accidents, crime and disasters first-hand;
- people who lived through historic events including the more distant past;
- clients' accounts of experiences and/or services received;
- patients' accounts of their experiences.

Levels of accuracy

Untruth

Personal testimonies can provide invaluable evidence, but they are not always accurate.

Interviewees may not reveal the true case because they:

- may want to be helpful, so say what they think the interviewer wants to hear;
- may not like the interviewer;
- may be trying to protect somebody;
- may not remember anything, but like the attention of being interviewed;
- may have a vested interest in the outcome, so benefit from concealing the truth;
- may be being bullied or intimidated and be scared of speaking out;
- may have promised to keep a secret.

If using interviews to gather evidence, remember that the interviewee may have complex motivations for presenting the picture that they give.

Lack of expertise and insider knowledge

The witness may lack information such as expert knowledge or details of why something was taking place which would enable them to make sense of what they saw. They may have seen a camera crew filming a fight in the street as they passed by one afternoon. However, they would not necessarily know whether they were watching a real fight at which a camera crew happened to attend, or whether the fight was staged deliberately for a TV drama. It may also be the case that the interviewee misunderstood what was asked of them.

The limits of memory

Loftus, in *Eyewitness Testimony* (1979), demonstrated, for legal use, how unreliable the memory can be. In one experiment, participants were shown a film of an accident and some were then asked how fast a white car was travelling when it passed a barn. A week later, 17 per cent of those who had been asked this question reported that they had seen a barn in the film, even though there had been no barn. This compared with only 3 per cent of the other viewers. Common memory mistakes include:

- Errors in perception: making mistakes about what you have seen and heard.
- Errors in interpretation: misinterpreting what you have seen.
- Errors of retention: simply forgetting.
- Errors of recall: remembering the event inaccurately. Our memory may be altered by going over the event in our mind, discussing it, hearing other people's accounts, or hearing about similar events.
- Composite memories: our brain can blend aspects from several events into one, without us being aware this is happening.

Corroborating sources

It is usually necessary to find other sources of information that corroborate a witness testimony. This can include other witnesses but may also be, for example:

- official records from the time;
- other witness testimony;
- TV footage of the events;
- newspaper, police, social work or court records;
- photographs taken at the time;
- information about similar events that happened elsewhere but which might throw light on the event being considered.

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Triangulation

What is triangulation?

Triangulation means checking and comparing different sets of evidence against each other, to see whether they support and complement each other, or whether they contradict each other. This is especially important when relying on first-hand accounts.

Triangulation is something that most of us tend to do in everyday contexts to check whether something is true.

Example

John told his mother that his sister Mary hit him. John was crying and called Mary a bully.

John may or may not be telling the truth. Before his mother took action, she is likely to have triangulated the evidence by:

- listening to Mary's side of the story;
- looking for evidence that John was hit;
- considering John and Mary's usual ways of recounting events;
- checking for alternative explanations.

Example

A head teacher says that a school's record of achievement is better than ever, that most pupils succeed, and that this is because of improvements in teaching at the school.

This statement could be triangulated with:

- published government records over several years to check for general improvement over time at all schools;
- comparing the school's achievement rates with the average for all schools;
- comparing the school's achievement rates with those of schools of a similar type. For example, if the school was situated in an area of high economic deprivation, it is likely to be more appropriate to compare it with schools in similar areas.

You might also wish to investigate whether there are any other reasons for changes to the school's rates of achievement. For example, if the school had started to set difficult entry tests, this might have attracted a very different type of pupil to the school and excluded those less likely to achieve. The improved achievement rates might be because the pupils were different and not because of improvements in teaching.

Comparing like with like

When triangulating information, it is important to check that the different sources used are also referring to the same subject and interpreting words in the same way. If not, you may not be comparing like with like. For example, the head teacher in the example may be talking about sports achievement, not academic, so this would require triangulation with a different set of sources, such as sports records not government records.

Activity: Triangulation

What kinds of evidence would be needed to triangulate the following sources:

(1) A person at the bus stop mentioning that cheap tickets will be available at the door, on the night, to see a band that you really like?

(2) A report by a car manufacturer that new brakes fitted in their latest model of car were safer than other brakes available?

(3) A chapter in a book that argued that, in the past, there were very severe legal penalties for begging?

Answers on p. 144.

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Evaluating a body of evidence

When you are researching a subject, or producing an academic assignment, you are likely to refer to many sources of evidence. However, you are not likely to evaluate all of these in the same way.

You can evaluate some sources:

by browsing, to evaluate whether they are sufficiently relevant to your research topic and sufficiently reputable for the level of research;

by focusing on the most relevant items, evaluating how these support specific aspects of your line of reasoning;

by selecting and carefully evaluating a relatively small number of key sources, weighing the arguments, and looking for flaws and gaps in the evidence;

by comparing and contrasting different sources, checking for inconsistencies.

The following activity gives you the opportunity to work with a set of short texts to practise discriminating appropriately between them. These texts are also used as the basis for further activities in Chapters 9 and 11.

Activity : identifying reputable sources

Read through the texts on pp. 201–5.

(a) Identify which are the most reputable sources of evidence. Categorise these as:

- Very reputable
- Fairly trustworthy
- Little authority

(b) For which texts might the authors have a vested interest in the outcome?

(c) Which are the most reliable sources for indicating what internet users believe about copying electronic music?

The answers are given on p. 165.

Answers: Triangulation (p. 143)

(1) You would probably want to contact the venue to find out if there really were cheap tickets available on the night.

(2) This could be triangulated with reports from other manufacturers about how their brakes were tested and the results, as well as reports in trade magazines. There may also be general information in consumer magazines about different braking systems. If you knew anybody who had bought a car with the new brakes, you could ask their opinion. If you can drive, you would want to try out the braking system for yourself.

(3) If the book provides references, you can check the original sources to see if they were reported accurately. You would expect to see references to specific 'poor laws' on begging, and the dates of these. You can also check other books to see if these contradict or support the chapter in the book. However, several books may refer to the same secondary source, which itself might be incorrect. Where possible, it is useful to check the primary sources, or published versions of these, for yourself.

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Summary

This chapter has looked at some key concepts in evaluating evidence from the point of view of both conducting your own projects, and examining the evidence used by other people.

If you are conducting your own research, whether for a project, report or essay, you will need to ensure that you collect and select the most appropriate evidence, and subject it to critical scrutiny. This chapter introduced the principles of making a literature search. It looked at ways of whittling down a large number of potential sources of evidence to a manageable number for deeper scrutiny. It also showed how to recognise the difference between primary and secondary sources.

When using secondary sources as evidence to support your own arguments, you need to be able to understand the evidence base used by those sources and have criteria you can use to evaluate it. For example, you need to be alert to whether the evidence is what it is claimed to be, checking that it is authentic, accurate, reliable and up-to-date. You also need to understand its significance in terms of probability and the methods taken to ensure reliable findings. When first starting to analyse materials critically, it can seem as though there are a great many aspects to check. However, many of these, such as selecting reputable sources, become automatic. Others are useful to hold lightly in mind whenever you hear or read an argument. It is often useful, and sometimes necessary, to go back to the original sources or published versions of these, to check for accuracy. If sources are well referenced, this makes the task of checking for details much easier.

The earlier section of the chapter looked at ways of analysing individual sources to check for aspects such as their reliability and validity. Later sections of the chapter looked at using one source to check another. Cross-comparison, or triangulation, is something that many of us do naturally in our everyday lives. However, many people take at face value what they read or hear in one source, without checking how this compares with what other sources say. Comparing materials doesn't necessarily lead to the truth, but it often shows where there are different points of view and therefore room for error and further investigation. You will find that some of the concepts introduced in this chapter will be more relevant for your subject than others. Each academic subject has well-established research methods that develop specialist skills for analysing source materials. Some will use:

- carbon-dating to check the age of materials;
- knowledge of medieval Latin and allegory in order to read and interpret original documents;
- advanced skills in semiotics in order to interpret the meaning of texts;
- specialist equipment to make precise measurements in your subject or detect micro-organisms;
- statistical approaches and formulae to analyse the kinds of data relevant to your subject.

Such advanced skills are likely to be taught within the subject. However, for most subjects, the basic skills in critical thinking will also apply.

Information on the sources

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