Chapter 1

Abstracts

In this chapter you will:

■ learn what an abstract is  
  (Section 1.1)
■ be aware of different types of abstract  
  (Section 1.2)
■ get used to using abstracts from literature searches  
  (Section 1.3)
■ practice writing an abstract  
  (Section 1.4)
■ critique an abstract and identify common errors  
  (Section 1.5)

1.1 What is an abstract?

When you are first asked to search for or write an abstract as an undergraduate student you may well not know what your tutor is asking for. Within the context of writing, the word ‘Abstract’ means ‘a summary’ or ‘an abridgement’ (Oxford English Dictionary, 2000). Therefore, an abstract is a short summary of your work. In the context of a journal article an abstract is the first section of an article that you will see. With this in mind an abstract should provide the reader with a good idea of the key aims, general methods undertaken, the key findings and the most important take-home message. Abstracts are therefore a powerful tool in informing readers about the work that has been undertaken.

As well as abstracts being the first section of any journal article you may read they are also most likely to be the first part of a journal article that you come into contact with when undertaking a literature search. This is especially true as a result of the range of internet-based search engines with links to electronic journals that are available to today’s students. When reading an abstract you should be able to obtain enough information to determine whether the study is related to your own research area and if it is of use to you. Alternatively, the abstract may provide you with enough information to decide that the study is not appropriate for your needs or that it is not what you thought it would be about from the title. Conversely, when writing an abstract it is essential to be able to clearly communicate the key points of the study to the reader.

Following the abstract there will usually be between three to ten keywords (Peh and Ng, 2008), which are used to aid search engines in their searching patterns and are usually not contained within the title. Ideally these terms should be standard terms contained within Index Medicus (ICMJE, 1997), which is a comprehensive index of journal titles and conventional or accepted search terms for accessing information.
1.2 Different types of abstract

When reading the literature during your studies you will come across a range of abstract types. The format of each type will depend upon whether you are writing a dissertation, a journal article or submitting your work for a conference. For undergraduate laboratory reports an abstract is not usually required, whereas for final-year projects this is an important component of the dissertation. The following sections provide an overview of the types of abstracts you are most likely to read or be asked to write.

1.2.1 Abstracts in journal articles

Within the journals you are most likely to consult there are a range of abstract formats, which differ depending on the journal’s specific requirements. Some journals require a brief abstract of 100–150 words (e.g. Journal of Sport and Exercise Psychology) or up to 200 words (e.g. Journal of Sports Sciences), whereas others allow slightly longer abstracts of up to 250 (e.g. Journal of Biomechanics) or 275 words (e.g. Journal of Strength and Conditioning Research). Other journals require what is termed a ‘structured abstract’ with specific headings within them relating to the ‘Introduction’, ‘Methods’, ‘Results’ and ‘Conclusions’ sections of a study (e.g. Medicine and Science in Sports and Exercise). There may also be more specific aspects that are required such as ‘Purpose’, ‘Study Design’ (e.g. British Journal of Sports Medicine) or ‘Outcome Measures’.

Theoretically the structured abstract approach ensures certain aspects of the study design and main outcomes are clearly and consistently reported, thus aiding literature reviews and extraction of information (Squires, 1990). The type of abstract required usually depends upon the journal you plan to submit your work to or any specific guidelines provided for your project. Either way a well-written abstract should provide all the information you need to appreciate what was done and the key findings as well as to determine whether you should read the rest of the article. Both structured and non-structured abstracts should therefore contain similar types of information. As noted earlier they usually follow the general structure of a scientific report itself, i.e. Introduction, Method, Results and Discussion, often termed the ‘IMRAD’ principle (Alexandrov and Hennerici, 2007; Hartley, 2000; Pamir, 2002). However, no one type of abstract is better than another as long as the key points of the work done is provided. Structured abstracts simply provide more specific prompts for content and, when reading them, they may be easier to glean key information from.

1.2.2 Abstracts in dissertations

Abstracts for dissertations are essentially the same as those for journal articles in that they inform the reader of what was done and the key findings. Abstracts are not usually presented within laboratory reports, however, so you should consult your coursework guidelines as to what your tutor expects. Just as abstracts will differ between journals the requirements of universities and colleges for dissertation abstracts also differ. In general, abstracts for dissertations will have either a specific word length (e.g. 500 words) or should fit comfortably onto one page (approximately 300 words for Times Roman, font size 12 and double-spaced text).
Abstracts

1.2.3 Abstracts for conferences

A further form of abstract is that of abstracts submitted to conferences. The majority of researchers will endeavour to present their research findings at a conference or other scientific meeting in order to disseminate their work. This provides a range of networking and feedback opportunities and is often one of the initial goals for postgraduate students prior to submitting their work as a journal article for publication.

For a researcher’s work to be accepted for presentation at a conference, whether as an oral presentation or as a scientific poster, authors will have to submit an abstract. As for journal articles the submitted abstract will undergo a peer-review process. Peer review involves a number of reviewers assessing the content of the abstract. If it is of the desired standard and relevant to the theme of the conference, then it may be accepted for presentation.

As with journal articles there are a range of abstract formats specific to each conference with guidelines usually provided through the conference website. This is an important point of reference for all potential presenters regarding abstract format, length and other specific requirements. In addition to requiring some form of abstract, conferences may also provide the opportunity for extended abstracts or short articles to be submitted. These are usually published separately within special issues or supplements of appropriate journals. Either way, presenting an abstract is usually a precursor to the authors writing a full journal article after having gained valuable feedback from the conference delegates.

1.3 Using abstracts

Many first-year university students are most likely not to have come into contact with abstracts prior to their degree studies. Indeed, Hartley (2004) notes that undergraduate students simply do not have the same experience of reading journal articles that researchers, academics and postgraduate students have acquired. Therefore it is likely to take undergraduates much longer to appreciate the key information presented within an abstract. Consequently, before getting to grips with writing abstracts it is important to first become accustomed to both searching for and reading abstracts as well as assessing the information contained within them. This approach will hopefully get you accustomed to the level of information presented in an abstract prior to writing one.

1.3.1 Searching for literature and extracting information

The tutors on your research methods modules have probably told you about the different ways to search for literature. Search engines such as Medline, Sports Discuss and Google Scholar, to name but a few, are all useful for finding academic information and journal articles. For the first exercise in this chapter log on to your recommended/preferred academic search engine. Search for journal articles in an area of your choice or the area of interest for the specific laboratory report that you are working on. At this stage you may want to refer to the ‘Introduction and Literature Review’ chapter where literature searching is covered in greater detail (see Section 2.3). If you have already undertaken this process please move on to Exercise 1.1.
Many academic and non-academic search engines will readily provide the abstract of your chosen articles. Indeed, in many instances this may be all the information that is required. For example, you may just want to give an example of an athletes’ maximal oxygen uptake (\( \text{VO}_{2\text{max}} \)), an example of how personality has been measured or the differences in performance time after a nutritional intervention. This is fine but remember that after reading the abstract you should always read the full article (Foote, 2006a, 2009a) to ensure that you fully appreciate the design and content of the research undertaken. Reading the full article will mean that you are more likely to gain more information about the study and your particular area of research. When referencing your sources some universities request that you specifically state when only the abstract has been used.

**Exercise 1.1: Extracting information from an abstract**

Choose one of the abstracts you have found in your literature search and use the IMRAD principle to determine the key aspects of the study. Read the abstract you have obtained and complete Table 1.1. Each abstract should include information relating to each of the headings provided so you should be able to pick out the key points of the study quite easily. If you have obtained a structured abstract this process should be more straightforward.

**Table 1.1 Key points derived from each section of an abstract**

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<th>Abstract component</th>
<th>Key point</th>
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<td>Introduction/aims</td>
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<td>Participants</td>
<td></td>
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<tr>
<td>Method</td>
<td></td>
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<tr>
<td>Results</td>
<td></td>
</tr>
<tr>
<td>Discussion/conclusion</td>
<td></td>
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</tbody>
</table>
1.4 Writing an abstract

Although abstracts are generally a short summary of your project don’t be mistaken into thinking that they will not take you a significant amount of time to write. Writing an abstract can be difficult, especially if you have a lot that you want to say but not many words to say it in. Writing concisely and informatively within a constrained word limit is often much more difficult than using a large number of words. It is therefore good practice to learn to write concisely. Unfortunately this is not a skill that many researchers or students initially hold and it does take practice. However, writing does improve with experience. For many undergraduate students the abstract is written quickly as an afterthought, usually just before binding and submitting the final version of their dissertation. When writing your abstract always bear in mind how informative you expect abstracts to be when searching the literature and remember that this will be the first section seen by your assessor or reviewer!

1.4.1 Background to writing an abstract

Writing an abstract means to extract and summarise (Alexandrov and Hennerici, 2007). A number of researchers concerned with educational and scientific writing have examined the effectiveness of (structured) abstracts for the reader as well as providing advice and guidance for writing them (Hartley, 2000, 2004; Squires, 1990). However, these points are just as important for non-structured abstracts, as well as for writing in general, so are worthy of note here. You may also want to refer to the section on ‘General Writing Tips’ later in this text (see Section 6.3).

Hartley (2000) noted that there are three important aspects to consider when assessing the clarity of structured abstracts: the language or readability of the abstract, the sequence of information or structure of the abstract and the typography or presentation. When considering the first point, avoid the use of complex terminology or jargon for key concepts so that they can be understood by readers who are not subject experts (Hartley, 2000). You should also write in the past tense. The second point relates to providing a logical flow of information within the text and is consistent with the IMRAD principle (Alexandrov and Hennerici, 2007; Hartley, 2000; Pamir, 2002). The third point is concerned with the format of your abstract, and is therefore of most interest to journal editors. Table 1.2 considers in more detail the content that should be contained within each part of an abstract. After consulting Table 1.2 complete Exercise 1.2 to help you to appreciate how to get the key points of your study across succinctly. As abstracts are not usually expected in a laboratory report this exercise is more suited towards students writing up their final-year projects who have a sizeable data set to analyse and report.
Exercise 1.2: Writing an abstract

For the data you have collected in your project or one of the data sets provided in Appendix 1 try the following exercises.

Exercise 1.2a

With reference to Tables 1.1 and 1.2 write a summary of your research in approximately 400 words. You may find it useful to first consult Table 1.2 and then complete Table 1.1 which we used in Exercise 1.1 to determine the key information in a given abstract, but this time you are writing your abstract and need to ensure that you provide what you think is important.

Exercise 1.2b

Once you have completed Exercise 1.2a, try to reduce the length of your abstract to approximately 200 words.

To help you, an example of a longer abstract such as for a dissertation and a shorter abstract such as for a journal article have been provided (see Example abstract 1 and 2).
Example abstract 1: Maximal oxygen uptake lab, approximately 400 words

Assessment of maximal oxygen uptake during running, cycling and arm cranking

The aim of this study was to determine the maximal oxygen uptake during running, cycling and arm cranking. Ten healthy none specifically trained males (age 19 (2.6) years; height, 1.79 (6.7) m, body mass, 71.2 (7.1) kg) volunteered to participate in this study which had received University Ethics Committee approval. Participants undertook three incremental exercise tests to volitional exhaustion in order to determine maximal oxygen uptake ($\dot{V}O_{2max}$). The protocols were undertaken either during treadmill running (TR; Powerjog), cycle ergometry (CE; Monark 813E) and arm crank ergometry (ACE; Lode). The TR protocol involved an initial speed of 8 km.h$^{-1}$ with increases in 2 km.h$^{-1}$ every three minutes at a gradient of 1%. The CE protocol involved an initial power output of 70 W with further increases in power output of 35 W every three minutes whereas the ACE protocol involved an initial power output of 50 W and increases of 20 W every 2 min. Both CE and ACE were undertaken at 370 rev.min$^{-1}$. Expired gas samples were taken during the final minute of exercise. Heart rate was continually monitored throughout all tests. Ratings of perceived exertion (RPE) for cardiovascular strain were recorded in the last 15 s of each exercise stage. One way analysis of variance (ANOVA) demonstrated a significant difference between protocols ($P < 0.05$). Tukey post hoc analysis indicated that the $\dot{V}O_{2max}$ during TR (58.5 ± 6.1 ml.kg$^{-1}$min$^{-1}$) was similar to that achieved during CE (53.4 ± 5.4 ml.kg$^{-1}$min$^{-1}$; $P > 0.05$). During the ACE protocol participants obtained peak rather than maximal oxygen uptake ($\dot{V}O_{2peak}$) values with the mean $\dot{V}O_{2peak}$ being lowest during this mode of exercise than for TR and CE (38.7 ± 6.4 ml.kg$^{-1}$min$^{-1}$; $P > 0.05$). Maximal heart rates were similar during TR and CE (194 ± 5, 186 ± 5 beats.min$^{-1}$, respectively) but not different between exercise modes ($P > 0.05$). Peak heart rate during ACE was lower than for both TR and CE (179 ± 6 beats.min$^{-1}$; $P < 0.05$). RPE at volitional exhaustion followed a similar pattern to heart rate with lower values during ACE than for TR and CE (17.6 ± 2.3, 20.0 ± 1.2 and 18.8 ± 2.7, respectively; $P < 0.05$). The results of this study demonstrate that arm crank ergometry elicits lower peak oxygen uptake, heart rate and RPE than for treadmill running and cycle ergometry. The lower values for ACE are likely due to development of peripheral fatigue rather than to cardiorespiratory fatigue.

Word count: 386
1.4 Writing an abstract

You can see from the example abstracts provided that there is a considerable amount of information presented in less than 400 words. Consider each aspect of Table 1.1 in conjunction with the example abstracts and use them to guide your writing and assess whether you have included enough information in your own abstracts. Can you get a good idea of what was done in the study and what was found? Figures 1.1 and 1.2 may help you decide.

Although many dissertation abstracts are not required to be as short as the 200 words suggested in Exercise 1.2b, some journal articles are. The exercise just completed will help you to appreciate writing concisely and reduce your word use. If you found this difficult, consider what your research question or research hypotheses were and your main findings. This is essentially what was in Table 1.1. These are the questions you were trying to answer and the information you were trying to find out. You may also find it helpful to try the exercise in reverse by first writing out your key findings in around 100 words and then gradually increasing your word count up to 200 or 400 words as required. Ensure that you include the important aspects suggested in Table 1.1.

**Example abstract 2: Maximal oxygen uptake lab, approximately 200 words**

**Assessment of maximal oxygen uptake during running, cycling and arm cranking**

The aim of this study was to determine maximal oxygen uptake during treadmill running (TR), cycle ergometry (CE) and arm crank ergometry (ACE). Ten healthy none specifically trained males volunteered to participate in this study which had received University Ethics Committee approval. Participants undertook three incremental exercise tests to volitional exhaustion in order to determine maximal oxygen uptake ($V_{O2max}$). Expired gas samples were taken during the final exercise stage of each protocol. Heart rate and ratings of perceived exertion (RPE) were recorded in the last 15 s of each exercise stage. The $V_{O2max}$ during TR (58.5 ± 6.1 ml.kg$^{-1}$min$^{-1}$) was similar to that achieved during CE (53.4 ± 5.4 ml.kg$^{-1}$min$^{-1}$; $P > 0.05$) with both being greater than for ACE (38.7 ± 6.4 ml.kg$^{-1}$min$^{-1}$; $P > 0.05$). Maximal heart rates were also similar during TR and CE (194 ± 5, 186 ± 5 beats.min$^{-1}$, respectively) with both being greater than for ACE ($P < 0.05$). RPE was lowest during ACE ($P < 0.05$). The results of this study demonstrate that arm crank ergometry elicits lower peak oxygen uptake, heart rate and RPE than for treadmill running and cycle ergometry. The lower values for ACE are likely due to development of peripheral fatigue rather than cardiorespiratory fatigue.

**Word count: 195**

You can see from the example abstracts provided that there is a considerable amount of information presented in less than 400 words. Consider each aspect of Table 1.1 in conjunction with the example abstracts and use them to guide your writing and assess whether you have included enough information in your own abstracts. Can you get a good idea of what was done in the study and what was found? Figures 1.1 and 1.2 may help you decide.

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Example abstract 1: Maximal oxygen uptake lab, approximately 400 words

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The results of this study demonstrate that arm crank ergometry elicits lower peak oxygen uptake, heart rate and RPE than for treadmill running and cycle ergometry. The lower values for ACE are likely due to development of peripheral fatigue rather than to cardiorespiratory fatigue.

Word count: 386

Figure 1.1 Annotated abstract for Exercise 1.2a

Example abstract 2: Maximal oxygen uptake lab, approximately 200 words

Assessment of maximal oxygen uptake during running, cycling and arm cranking

The aim of this study was to determine maximal oxygen uptake during treadmill running (TR), cycle ergometry (CE) and arm crank ergometry (ACE). Ten healthy male specifically trained males volunteered to participate in this study which had received University Ethics Committee approval. Participants undertook three incremental exercise tests to volitional exhaustion in order to determine maximal oxygen uptake (VO2max). Expired gas samples were taken during the final exercise stage of each protocol. Heart rate and ratings of perceived exertion (RPE) were recorded in the last 15 s of each exercise stage. The VO2max during TR (58.5 ± 8.1 ml kg⁻¹ min⁻¹) was similar to that achieved during CE (53.4 ± 5.4 ml kg⁻¹ min⁻¹; P > 0.05) with both being greater than for ACE (38.7 ± 6.4 ml kg⁻¹ min⁻¹; P > 0.05). Maximal heart rates were also similar during TR and CE (194 ± 5, 186 ± 5 beats min⁻¹, respectively) with both being greater than for ACE (P < 0.05). RPE was lowest during ACE (P < 0.05). The results of this study demonstrate that arm crank ergometry elicits lower peak oxygen uptake, heart rate and RPE than for treadmill running and cycle ergometry. The lower values for ACE are likely due to development of peripheral fatigue rather than to cardiorespiratory fatigue.

Word count: 195

Figure 1.2 Annotated abstract for Exercise 1.2b
1.5 Critiquing an abstract and common errors

When asked to undertake a critique of a piece of work or a scientific study, most students focus upon negative aspects. Indeed, from an assessors’ perspective these are often the key points that are immediately obvious and likely to be commented upon. However, noting positive aspects, which may not be explicitly obvious, is just as important (see Chapter 2, Section 2.8). To demonstrate some common errors that students regularly exhibit when writing abstracts, and to make you aware of some key aspects to avoid, an example of a poorly written abstract is provided in Exercise 1.3.

Exercise 1.3: Critiquing an abstract

Read the abstract and use Table 1.3 to note how many errors you can spot or improvements that could be made. Try to find ten. However, there are at least 15 more immediate points to consider (see Table 1.4), but there may be more! Within your critique you should always consider the required word length and the information required from each section of the study.

Example abstract 3

Title – Lab report

O2max is really important. It is the most important factor to show fitness levels in different people. We tested ten students to see if there was a difference in their values. Treadmill testing gave the largest values (58.417) and arm exercise the lowest. Exercise on the bike was a greater value than arm cranking. The VO2max values for the three tests were different (58.417, 53, 38.7 ± 6.4 ml.kg⁻¹.min⁻¹). Heart rate (194.12 bpm, 186, 178.7) was recorded in the last seconds of the exercise stage whereas Douglas bags were recorded at the end of each test. Our results show that treadmill testing is best.

Table 1.3 Points to improve/abstract errors

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<td>10.</td>
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</tbody>
</table>
Abstracts

Table 1.4 Potential errors within example abstract 3

1. Title does not inform the reader of what was done. Each lab that you undertake will have aims or a specific title.
2. VO\textsubscript{max} is not defined and no subscript is used.
3. Third-person past tense not used.
4. No participant characteristics provided.
5. No indication of the protocols used prior to results.
6. No units for values provided.
7. Too many decimal places for variables presented.
8. Inconsistent decimal places given.
9. Terminology of ‘bike’ incorrect, should read ‘cycle ergometer’.
10. Timing of heart rate measures and Douglas bag collections (method) given after some results already stated.
11. Decimal values used for heart rates, units wrong and not reported correctly.
12. States values were different but there is no indication of tests used or P values, or the direction of any differences.
13. Awkward wording throughout.
15. Concluding statement – why is treadmill testing best, and what is meant by this?

1.6 Chapter summary and reflection

This chapter has provided an overview of different types of abstracts and how you may extract information from them. We also considered how to plan and write an abstract using the same tools as for extracting information from them. This means that when you are writing your abstract you will hopefully include what you consider to be important for the reader to know. You will also find the chapters of this text relating to the methods and results sections of dissertations helpful in reporting the key aspects required for your abstract. To assess your understanding of abstracts answer the following questions:

- What is an abstract?
- What different types of abstract are there?
- What information is contained within an abstract?
- How should you approach writing an abstract?
- What are the common errors when writing abstracts?

1.7 Further activities

Go to the website of a journal that you regularly read or are aware of. Find the author guidelines and consider the advice given for writing and presenting abstracts.

Consult the methods and results chapters of this text to provide guidance in reporting key aspects of these sections of a dissertation within your abstract (see Chapters 3 and 4).

If you are submitting a conference abstract consult the conference website for example abstracts or look at journals where special editions have published previous abstracts for that conference.
Chapter 2

Introductions and literature reviews

In this chapter you will be able to:

- appreciate the role of an introduction  
  (Section 2.1)
- differentiate between an introduction and a literature review  
  (Section 2.2)
- undertake a literature search  
  (Section 2.3)
- extract and use information from literature sources  
  (Section 2.4)
- practice writing an introduction  
  (Section 2.5)
- critique an introduction  
  (Section 2.6)
- plan and write a literature review  
  (Section 2.7)
- critique a journal article  
  (Section 2.8)
- develop your aims, objectives and hypotheses  
  (Section 2.9)
- identify common problems when writing introductions  
  (Section 2.10)

2.1 An introduction to introductions

All types of scientific report will have some form of introductory section. Although the structure and length of these may differ the function of introductions is essentially the same: to move the reader from what is known about an area to what is unknown or to move the reader from general to specific information (Foote, 2006b). For a dissertation or scientific journal articles the introduction will end with the research question and hypothesis, whereas for an undergraduate lab report it is likely to end with the aims and objectives of the specific lab class.

Foote (2006a) considers a scientific article’s introduction to be as important as the need to make a good impression in a job application. Indeed, imagine reading an introduction to a journal article or lab report where the author does not clearly present the information or effectively develop their experimental aims and objectives. Would you continue reading or give the report many marks? The following sections will consider how an introduction may differ between lab reports and dissertations as well as how your introduction may be integrated within a literature review.

2.1.1 Introductions in lab reports and journal articles

Depending on your level of study the introduction to your lab report will serve a number of purposes. However, all introductions require you to have read widely and to have reviewed the literature to some extent. The exercise accompanying this section will help you determine the type of information usually included within an introduction.
At the simplest level the introduction, as the name of the section implies, should introduce any key terms or concepts. For example, consider a first-year lab report relating the measurement of energy expenditure at rest and during exercise, probably using techniques for the first time. Here the reader, and certainly the assessor, will be expecting to see evidence of understanding and background reading rather than the development of a rationale for a Nobel-prize-winning research study. This is because undergraduate lab classes are generally designed to teach the skills and processes required for both your final-year project and professional career. It is your final-year project which is most likely to have a novel research aspect to it.

Introductions usually start with a more general or ‘introductory’ paragraph and become more specific as the introduction develops, culminating in the aims of your study (see Figure 2.1). Continuing with our energy expenditure example the introduction could take the form outlined in Figure 2.2. (It is important to note that the content of your introduction will clearly depend upon the contents and aims of the specific lab class. The following example is used purely to demonstrate a point.) Depending on the specific content required the flow chart in Figure 2.2 could demonstrate a general understanding of what energy expenditure is, how it can be measured (reflecting the methods used in the lab class) and what you would expect to find. From this the reader will hopefully be aware of whether the student understands the key concepts required. As the introduction progresses more specific details emerge relating to the specific activities undertaken within the lab class. These activities will be reflected in your aims and objectives (see Section 2.9). It is important to note that you should always follow the assessment guidelines provided by your tutor regarding the required content. Also consider the word count if one is stipulated. Whether you have been given specific guidelines or not you need to spend time planning the content of your introduction to reflect the aims of the class. If you are struggling to come up with key aspects of your lab report to include in the introduction you should consider the keywords contained within the title of your lab report, the aims or objectives and the key procedures undertaken in the methods.

As your lab classes become more complex throughout your degree studies, and certainly when writing journal articles, the introduction is used to serve the purpose of justification (Hopkins et al., 2009). This is generally required to justify your research.
question or, as it is often termed, ‘generate the rationale’ for your study. For example, you may need to justify the use of a particular group of participants or research design (Hopkins et al., 2009). The information you present should convince the reader that you have a sound reason for the study being undertaken. Whether you are writing an undergraduate lab report or writing up your fiftieth research paper all introductions must reflect the scientific question being asked and therefore what has been done within the study. A common error in lab report introductions is going ‘off topic’ – presenting what may be correct but irrelevant information. Although Exercise 2.1 focuses on journal articles, and the introductions to these differ from those of lab reports, the exercise is designed to help you consider the flow of information presented.

**Exercise 2.1: What is in an introduction?**

Choose a journal article relating to the area of your lab report or project. Make sure that it is a study which has collected some original data. Read the introduction and for each paragraph make a short note (one or two words only) of the key point that is being made or what aspect is being described. This approach could also be used when you are planning or proofreading your work.

**Paragraph 1:**  
**Paragraph 2:**  
**Paragraph 3:**  
**Paragraph 4:**

Ask yourself the following questions:

1. Is there a logical flow of information?
2. How do the key points you have noted above compare to the title of the article and the aims?
Also consider the point made earlier regarding the development of the rationale:
3. Why is it important to have done this study?
4. What did you know beforehand?
5. What is the new aspect to be investigated?

2.2 Introduction versus literature review

One important question often asked by final-year project students is “what is the difference between an introduction and a literature review?”. The answer relates to the type of the report you are writing. For shorter reports, such as undergraduate lab reports and scientific research studies, the introduction is as considered above: a short informative introduction to the area to establish your area of study or the research question. If you look at any published journal articles you should be able to see this (see Exercise 2.1). Although your introduction will contain references to previous research and briefly review the area, a ‘literature review’ per se is generally a much longer chapter within a thesis such as those written by final-year undergraduate and postgraduate students. Here the examiner is looking to establish that the student has a greater breadth and depth of knowledge, that there is a clear understanding of the chosen topic area and that the current, pertinent literature has been surveyed. For this reason undergraduate and postgraduate dissertations generally have both an introduction and a literature review, whereas lab reports only have an introduction. In final-year or postgraduate dissertations the introduction sets the scene for the study by giving an overview of the main topic of the thesis in two or three pages. The introduction would then be followed by the main literature review to provide a broader, in-depth review of pertinent literature. Figure 2.1 can now be expanded to demonstrate these differences (see Figure 2.3).

![Introductions in lab reports and dissertations](image-url)
2.2.1 Types of literature review

Within your literature search you will come across both original research articles and review articles. The latter are an ideal way to introduce yourself to a topic and also to see how literature reviews are structured. Literature reviews consist of a detailed and comprehensive narrative analysis of recent or evolving developments in specific topics (Ng and Peh, 2010a). Literature reviews may also help to consolidate data or opinions within a specific area or re-evaluate current knowledge in light of new findings or concepts. In this respect, literature reviews are often more up to date than textbooks (Green et al., 2001). Although review articles may synthesise information from previous studies they generally do not present new data. This is the main difference between ‘original’ journal articles and literature reviews. The former have methods and results sections whereas the latter do not. For undergraduate and postgraduate students your literature review needs to demonstrate that you understand the area and current theories as well as the underlying processes or mechanisms. Furthermore, and importantly, you also need to identify a gap (or gaps) in the literature which can then be developed into your research question and subsequently your aims and hypotheses.

Literature reviews can be further separated into ‘systematic’ and ‘narrative’ reviews. The latter are sometimes termed ‘non-systematic reviews’, although this does not mean that a systematic approach has not been undertaken or that they are any less worthy (Sandelowski, 2008). Within both the scientific and educational literature there are a range of articles providing guidance on how to approach writing both narrative (Green et al., 2001; Peh and Ng, 2010) and systematic (Ng and Peh, 2010a; Sandelowski, 2008; Wieseler and McGauran, 2010) reviews of literature, and on how to search scientific literature (Foote, 2009a). The purpose of this section is to provide an awareness of the different types of literature review and reviewing processes. As noted earlier, regardless of whether you are writing an introduction for a lab report or an article for a journal, a literature review is essential.

2.2.1.i Systematic literature reviews

Systematic literature reviews are often found in medical or clinical areas of research and are considered to be the cornerstone of evidence-based practice (Sandelowski, 2008). Such reviews help clinicians keep up to date with medical research findings and aid in the development of practical guidelines and policy decision making (Weiseler and McGauran, 2010). As the approach undertaken when writing systematic reviews is explicitly structured this process is considered to be the least biased and most rational way to search and report literature (Ng and Peh, 2010b). So how does a systematic review differ from other reviews? The key factor is the way in which the research studies are searched and subsequently included within or excluded from the review. For example, systematic reviews often relate to clinical trials where patient populations, age ranges, types of drugs or interventions employed, randomised control trials, double blind studies, etc. may all differ and significantly affect any clinical outcome. Ng and Peh (2010b) give the example of a literature search where 121 articles were retrieved from a given database. Fifty-one of these articles were excluded after reading the abstract. Of the 70 remaining articles, 42 were excluded as they did not fit the criteria for the review, leaving 28 articles to be included.
Owing to the importance of systematic reviews in shaping clinical practice, and in order to provide consistency in systematic reviewing, the ‘Preferred Reporting Items for Systematic Reviews and Meta-Analyses’ (PRISMA) statement was developed. The PRISMA statement provides a 27-item checklist for systematic reviews and is available online (www.prisma-statement.org) as well as being published through a number of journals such as the British Medical Journal (e.g. Moher et al., 2009). Many of the key components to be included in systematic reviews represent the range of possible subheadings included within structured abstracts (see Chapter 1, Section 1.2.1). Although this structured approach requires (and hopefully ensures) all key aspects of importance to clinicians and specific clinical outcomes are included, many of these factors are not key components for Sport and Exercise Science, which generally involves ‘healthy’ or non-clinical participants. However, the underlying principles for searching literature are essentially the same as for narrative reviews and it is certainly worth looking at the components of the PRISMA statement. A summary of the items presented in the PRISMA statement are shown in Figure 2.4. These will be considered later in this chapter (See Section 2.3 on literature searching). For details regarding the specific content of the PRISMA statement please consult the full document.

**Figure 2.4** Summary of PRISMA checklist for systematic reviews and meta-analyses

Source: based on Moher et al. (2009)

2.2.1.i Narrative literature reviews

Narrative literature reviews are the most commonly found form of literature review in Sport and Exercise Science. However, like systematic reviews, narrative reviews often provide a statement regarding the search terms used and any inclusion or exclusion criteria applied to the various research studies obtained. In contrast to systematic reviews no relevant report is excluded (Sandelowski, 2008) and authors must be careful...
to avoid bias and remain objective in their information extraction (Green et al., 2001). Narrative reviews therefore have the potential to be more wider reaching and inclusive than systematic reviews. However, regardless of whether you are writing a systematic or narrative review you first have to acquire your literature sources. Therefore, we will next address the basics of searching literature.

### 2.3 Literature searching

Your initial literature search will depend upon how familiar or experienced you are with a topic (Thomas and Nelson, 2001) and your current level of understanding of the area. Students who are not well grounded in a topic may benefit from reading appropriate textbooks and other sources of information (Thomas and Nelson, 2001). This approach is the most likely starting point for most undergraduate students, especially in their first year of study. For those students who are more confident in their understanding of their topic area reading a review article is a good first step. Not only will review articles provide up-to-date information at the time of publication, they will also give an overview of the area and recommendations for future research. In addition there is likely to be a long list of references to consult.

Through university modules on research methods, most students will have been made aware of the range of literature search engines and how to use them. Tutorials relating to this will often be available through your university or college library or through the education sections of medical journals, for example Greenhalgh (1997). Scientific search engines are a great way to get an idea of what literature is available on your chosen topic but also, depending on your university or college library subscriptions, this is a good way of obtaining electronic copies of journals. When you first obtain an article in a literature search it is likely that you will be able to access the abstract. This will give you an overview of the study and the key findings (see Chapter 1). Although it is always best to read the full article the abstract may give you some important and usable information. However, your search doesn’t have to be limited to electronic or web-based searches. Don’t forget that browsing the hard copies of journals on library shelves and in their reference lists is also a good way of finding information.

When considering the process of searching the literature a number of important factors should be considered (Foote, 2009a; Figure 2.5). First, consider the basics of undertaking literature searches, including determining the search terms to be used, databases to be searched, range of dates to search, type of articles to consider, etc. Second, the output of the search should be reviewed. Your resultant output may require your search terms to be refined to enable a more helpful search output or a manageable number of sources to be obtained. The third consideration is then the ‘explanation’, or analysing and explaining the literature in order to construct the review (Foote, 2009a). Thomas and Nelson (2001) suggest six steps to ensure a thorough and productive literature review. When combining these steps with Foote’s considerations you can see that although experienced and less experienced researchers may have different starting points for their searches they still undertake essentially the same processes (Figure 2.6). As you progress through your project it is also very important to update your searches as new and pertinent literature may be published while you are writing...
Introductions and literature reviews

Figure 2.5 Schematic representation of literature searching and writing
Source: based on Foote (2009a)

Figure 2.6 Schematic representation of literature searching
Sources: based on Foote (2009a) (left) and Thomas and Nelson (2001) (right)
up your project. As already noted, always read the full text of any article of interest and do not dismiss those articles that you can’t get free online. Most universities have excellent inter-library loan systems and many also allow students of other universities to access to their resources. This aspect is certainly worth checking out.

**Exercise 2.2: Literature searching**

When searching for literature, note that if your search terms are quite general, such as ‘anxiety’, ‘performance’ or ‘carbohydrate ingestion’, you will have many thousands of results. You may find it easier to include more specific search terms such as the specific aspect of performance or sport you are interested in. Refining your search terms will provide a more specific and useable search output. Table 2.1 shows that although search results can initially be overwhelming they can then be constrained and reduced to those more appropriate to your needs. Searching for literature and getting to grips with appropriate search terms is a skill in itself. However, the more you search for information and the more you read around an area, the more likely you are going to be able to refine and undertake your searches successfully.

Within Table 2.1 are spaces for you to add your own search terms. Try different combinations of terms to obtain a useable output of potential articles. Once you have done this move on to the next section.

**Table 2.1** Likely outputs from one search engine for three topics in Sport and Exercise Science

<table>
<thead>
<tr>
<th>General search</th>
<th>Search terms</th>
<th>Number of articles found*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety</td>
<td>Anxiety</td>
<td>127 289</td>
</tr>
<tr>
<td>Performance</td>
<td>Performance</td>
<td>480 950</td>
</tr>
<tr>
<td>Carbohydrate ingestion</td>
<td>Carbohydrate ingestion</td>
<td>18 139</td>
</tr>
<tr>
<td>Your area of interest</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specific search</th>
<th>Search terms</th>
<th>Number of articles found</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety</td>
<td>Anxiety AND</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Tennis</td>
<td></td>
</tr>
<tr>
<td>Performance</td>
<td>Performance AND</td>
<td>463</td>
</tr>
<tr>
<td></td>
<td>Running AND</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Elite</td>
<td></td>
</tr>
<tr>
<td>Carbohydrate ingestion</td>
<td>Carbohydrate ingestion AND Marathon running</td>
<td>24</td>
</tr>
<tr>
<td>Your area of interest</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*From a typical scientific or academic search engine on any given date
2.4 Extracting information and using literature sources

Now that you have undertaken a literature search and obtained a range of information sources, what do you do with them? When you are using your various sources of information it is important to be able to extract exactly what you want from them. This may seem obvious, but when you haven’t used this type of information before it may not be as straightforward as you think. Furthermore, it is likely that within your literature review or lab report introduction you will be explicitly required to use scientific literature to back up your statements.

So, what information is important? This will depend quite simply upon what you require. Your needs may be quite broad, such as an example of how anxiety is measured or an example of a personality questionnaire. Conversely, your needs may be more detailed, such as an in-depth explanation of the mechanisms of fatigue or how anxiety differs between performers. Review articles will often include a table that summarises key research studies. This is a very useful way to consolidate your thoughts on the available literature and consistently assess the same key points from each article you have read. Indeed, when you are reading journal articles certain aspects may continually come to mind that may affect the results of a given study. For example, the participants studied, the protocols or methods used and the design of the experiment as well as specific measures taken can all affect the results obtained. With this in mind, summary tables are likely to include information regarding participants and methodological aspects. Consider these aspects with respect to the key components of a structured abstract (as noted in Chapter 1) and for systematic reviews. When using a summary table the reader can quickly assess different approaches taken within the area and how diverse these may be, which may be why there are differing viewpoints within a topic.

Whether or not you include a summary table in your thesis is down to personal choice and supervisory guidance. However, as a way of summarising what may be quite a daunting pile of research papers a summary table can very useful. A simple approach to summarising data will relate to your research question. For example, if your research question relates to the effects, on performance of a nutritional supplement, such as sodium bicarbonate or creatine phosphate ingestion, what is the general consensus? Here you would simply need to note for each research study that you read whether performance was improved, negatively affected or not affected at all. You might then want to find out if there was a consistent aspect in those studies that found enhanced performance. Examining the participant characteristics, exercise protocols, administration of the supplement, etc. may help pinpoint specific important factors. Similarly, you may be interested in the effects of anxiety on performance. You could again determine from your research articles those that showed performance to be affected by anxiety and those that did not. From here you may be able to determine a certain level of anxiety where performance is affected or whether certain groups of participants or certain types of skill are most affected by anxiety. You could of course obtain all this information from simply reading the research articles and remembering the facts, but you may find that summarising your data this way is helpful.

Exercise 2.3 will help you to assess how well you extract information and also give you some practice in determining what may be important in a given source of information. When recording information from literature sources, Thomas and Nelson (2001)
suggest considering, amongst other factors, the characteristics of participants, instruments and tests (including reliability and validity), testing procedures, treatments applied, study design, and statistical analysis and key findings. The list of factors that you may be interested in will be similar to those usually considered when critiquing studies (see Section 2.8). Indeed, there are a range of guidelines for critiquing scientific studies, such as a checklist sheet from Thomas and Nelson, the PRISMA statement, a peer-review checklist developed by Seals and Tanaka (2000) and an assessment checklist sheet for narrative reviews (Green et al., 2001). However, as many of these are designed for the peer review of journal articles they are possibly more complicated and consider more factors than you require at present. Consider what it is you really want to find out from a particular source. You may not need all that detail.

**Exercise 2.3: Extracting and using information**

Following this exercise are four abstracts relating to the maximal oxygen uptake example lab class we are using within this book. The abstracts were obtained from a Medline (PubMed) literature search using the following search terms: ‘Maximal oxygen uptake AND elite marathon runners’; ‘Maximal oxygen uptake AND elite cyclists’; and ‘peak oxygen uptake AND upper body exercise’. These are terms that you may use if interested in examining the aerobic capacity, fitness or physiological responses of athletes across exercise types. The abstracts give values or information relating to four different scenarios but can be combined quite fluently in a number of ways. These particular abstracts have been chosen simply because they provide information that can be used to help us demonstrate and practice the skill of extracting information, rather than for any other particular aspect. As with all sources it is up to you to critique them further and fully.

First make short notes on what you think the important findings are from each abstract. It is important to make notes in your own words rather than copying directly from the abstract or article. Once you have done this try and integrate the information you have highlighted. A worked example is also provided (see Table 2.2).

**Table 2.2 Example key points from each abstract**

<table>
<thead>
<tr>
<th>Abstract 1</th>
<th>Maximal oxygen uptake increased with competition distance. Values for 800–1500-m athletes were 72.1 ml.kg(^{-1})min(^{-1}) and for 5000–10,000-m group, 78.7 ml.kg(^{-1})min(^{-1}).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract 2</td>
<td>Compared maximal physiological variables in men and women. Physiologically, triathletes were most like cyclists. Maximal oxygen uptake was greatest for the treadmill test, then cycling and then arm exercise.</td>
</tr>
<tr>
<td>Abstract 3</td>
<td>VO(<em>{2})(</em>\text{max}) of hockey players did not change during a competitive season, although values did tend to increase over the season. Body fat reduced during the season. Muscular strength reduced during the season.</td>
</tr>
<tr>
<td>Abstract 4</td>
<td>Peak oxygen uptake during arm exercise was greatest for able-bodied athletes when compared to wheelchair athletes. Peak oxygen uptake was lowest in a tetraplegic athlete when compared to paraplegic athletes.</td>
</tr>
</tbody>
</table>
Introductions and literature reviews

Abstract 1: 

Abstract 2: 

Abstract 3: 

Abstract 4: 

Try and combine this information from each abstract into a summary sentence or paragraph. You may only be interested in one particular part of the abstract rather than the main results of the study, such as the VO_{max} values for a group of athletes rather than their body temperature responses (e.g. Price and Campbell, 1999).

Summary: 

How did you get on? It is important to note that there is no right or wrong answer to this activity as you will be presenting what you think is important. However, what you say or interpret has to be correct. The worked example following the abstracts shows a range of ways in which the information could be presented. This will differ depending on what you are trying to show.

Abstract 1

Physiological characteristics of elite runners from different racing events were studied. Twenty-seven middle- and long-distance runners and two 400-m runners belonging to the Swedish national team in track and field were divided, according to their distance preferences, into six groups from 400 m up to the marathon. The maximal oxygen uptake (VO2 max, ml × kg⁻¹ × min⁻¹) on the treadmill was higher the longer the main distance except for the marathon runners (e.g., 800–1500-m group, 72.1; 5000–10,000-m group, 78.7 ml × kg⁻¹ × min⁻¹). Running economy evaluated from oxygen uptake measurements at 15 km/h (VO2 15) and 20 km/h (VO2 20) did not differ significantly between the groups even though VO2 15 tended to be lower in the long-distance runners. The running velocity corresponding to a blood lactate concentration of 4 mmol/l (vHla 4.0) differed markedly between the groups with the highest value (5.61 m/s) in the 5000–10,000-m group. The oxygen uptake (VO2) at vHla 4.0 in percentage of VO2 max did not differ significantly between the groups. The blood lactate concentration after exhaustion (VO2 max test) was lower in the long-distance runners. In summary, the present study demonstrates differences in physiological characteristics of elite runners specializing in different racing events. The two single (but certainly inter-related) variables in which this was most clearly seen were the maximal oxygen uptake (ml × kg⁻¹ × min⁻¹) and the running velocity corresponding to a blood lactate concentration of 4 mmol/l.

Abstract 2


To better characterize the athletes who participate in ultraendurance triathlons, 14 triathletes in training for the Hawaii IRONMAN triathlon were studied. A physical and physiological profile was developed from anthropometric measurements and oxygen uptake during maximal exercise on a treadmill, cycle ergometer, and arm ergometer. A comparison of the maximal values among exercise modes and between males and females was made. A comparison of height, weight, and percent body fat of these triathletes with elite athletes from the sports of swimming, cycling, and running showed the physique of triathletes to be most similar to that of cyclists. Oxygen uptake at maximal exercise was, for males and females, respectively: 68.8 ml × kg⁻¹ × min⁻¹, 65.9 ml × kg⁻¹ × min⁻¹ on the treadmill; 66.7 ml × kg⁻¹ × min⁻¹, 61.6 ml × kg⁻¹ × min⁻¹ on the cycle ergometer; and 49.1 ml × kg⁻¹ × min⁻¹, 39.7 ml × kg⁻¹ × min⁻¹ on the arm ergometer. When comparing the highest oxygen uptake attained at maximal exercise in any one of the three exercise modes, the male triathletes are comparable to swimmers, but have a lower aerobic capacity than cyclists or distance runners. The female triathletes studied were able to attain oxygen uptake values greater than those previously reported for female athletes.
Abstract 3


Competitive field hockey requires a substantial amount of muscular strength, speed, and cardiovascular endurance. It is unknown how these parameters of physical fitness change between preseason conditioning to postseason recovery. Therefore, Division III female field hockey athletes \((n = 13)\) completed tests of muscular strength, body composition, and maximal oxygen uptake \((\text{Vo}_2\text{max})\) during each phase of their season. Muscular strength was assessed using 1 repetition maximum \((\text{RM})\) leg and bench press tests. Body composition was assessed by anthropometry \((\text{skinfolds} [\text{SKF}], \text{circumferences} [\text{CC}])\) and bioelectrical impedance analysis \((\text{BIA})\). Incremental treadmill testing was administered to assess \(\text{Vo}_2\text{max}\). \(\text{Vo}_2\text{max}\) was unchanged during the season, although a trend \((p > 0.05)\) was shown for a higher \(\text{Vo}_2\text{max}\) during and after the season vs. before the season. Upper- \((10\%)\) and lower-body strength \((14\%)\) decreased \((p > 0.05)\) during the season. Percent body fat \((\%BF)\) from BIA, fat mass \((\text{FM})\) from CC, and body mass index \((\text{BMI})\) were significantly lower \((p < 0.05)\) in-season and postseason vs. preseason. In conclusion, preseason training was effective in decreasing \(\%BF\) and increasing \(\text{Vo}_2\text{max}\), yet muscular strength was lost. Coaches should incorporate more rigorous in-season resistance training to prevent strength decrements. Moreover, these data support the superior levels of muscular strength and leanness in these athletes compared with age-matched peers.

Abstract 4


STUDY DESIGN: Single trial, two factor repeated measures design. SETTING: England, Cheshire. OBJECTIVES: To examine the thermoregulatory responses of able-bodied \((\text{AB})\) athletes, paraplegic \((\text{PA})\) athletes and a tetraplegic \((\text{TP})\) athlete at rest, during prolonged upper body exercise and recovery. METHODS: Exercise was performed on a Monark cycle ergometer (Ergomedic 814E) adapted for arm exercise at 60% \(\text{VO}_2\) peak for 60 min in cool conditions \(\text{‘normal’ lab temperature; 21.5+/−1.7 degrees C and 47+/−7.8% relative humidity}\). Aural and skin temperatures were continually monitored. RESULTS: Mean \((+/−\text{S.D.})\) peak oxygen uptake values were greater \((p < 0.05)\) for the AB when compared to the PA \((3.45+/−0.45 \text{ l min}^{-1} \text{ and 2.00+/−0.46 l min}^{-1}, \text{ respectively})\). Peak oxygen uptake for the TP was 0.91 l min\(^{-1}\). At rest, aural temperature was similar between groups \((36.2+/−0.3 \text{ degrees C, 36.3+/−0.3 degrees C and 36.3 degrees C for AB, PA and TP})\)
2.4 Extracting information and using literature sources

Table 2.2 demonstrates some of the key information that could be taken from the abstracts provided. Please note that the importance of each key point will differ depending on what you are interested in reporting or stating. The examples below demonstrate some potential combinations of information. How you use the information will be determined by what you want to say in your introduction and the specific question that you are asking.

1. A general comment regarding measurement of maximal oxygen uptake:
   Maximal oxygen uptake values for a range of athletes have been determined (Astorino et al., 2004; O’Toole et al., 1987; Price and Campbell, 1999; Svedenhag and Sjödin, 1985).

2. Describing $\text{VO}_{2\text{max}}$ within a specific athlete group:
   Svedenhag and Sjödin (1985) determined the maximal oxygen uptake of a range of elite runners. Athletes ranged from those competing at distances of 400 m up to the marathon. The greatest values were seen for 5000 to 10 000 m runners (78.7 ml Kg$^{-1}$ min$^{-1}$).

3. Describing $\text{VO}_{2\text{max}}$ across sports:
   Maximal oxygen uptake values are greatest in distance runners when compared to cyclists and wheelchair athletes (O’Toole et al., 1987; Price and Campbell, 1999; Svedenhag and Sjödin, 1985).

TP athletes, respectively). During exercise, aural temperature demonstrated relatively steady state values increasing by 0.6+/−0.4 degrees C and 0.6+/−0.3 degrees C for the AB and PA athletes, respectively. The TP athlete demonstrated a gradual rise in aural temperature throughout the exercise period of 0.9 degrees C. Thigh skin temperature increased by 1.3+/−2.5 degrees C for the AB athletes ($P < 0.05$) whereas the PA athletes demonstrated little change in temperature (0.1+/−3.4 degrees C and −0.7 degrees C respectively). Calf temperature increased for the PA athletes by 1.0+/−3.6 degrees C ($P < 0.05$), whereas a decrease was observed for the AB athletes of −1.0+/−2.0 degrees C ($P < 0.05$) during the exercise period. During 30 min of passive recovery, the AB athletes demonstrated greater decreases in aural temperatures than those for the PA athletes ($P < 0.05$). Aural temperature for the TP increased peaking at 5 min of recovery remaining elevated until the end of the recovery period. Fluid consumption and weight losses were similar for the AB and PA athletes (598+/−433 ml and 403+/−368 ml; 0.38+/−0.39 kg and 0.38+/−0.31 kg, respectively), whereas changes in plasma volume were greater for the AB athletes (−9.8+/−5.8% and 4.36+/−4.9%, respectively; $P < 0.05$).

CONCLUSION: The results of this study suggest that under the experimental conditions PA athletes are at no greater thermal risk than AB athletes. A relationship between the available muscle mass for heat production and sweating capacity appears evident for the maintenance of thermal balance. During recovery from exercise, decreases in aural temperature, skin temperature and heat storage were greatest for the AB athletes with the greatest capacity for heat loss and lowest for the TP athlete with the smallest capacity for heat loss. Initial observations on one TP athlete suggest substantial thermoregulatory differences when compared to AB and PA athletes.
Elite distance runners demonstrate VO\(_{2\text{max}}\) values of over 70 ml.kg\(^{-1}\)min\(^{-1}\) (Svedenhag and Sjödin, 1985). Triathletes have demonstrated lower VO\(_{2\text{max}}\) values than this during cycling (68.8 ml.kg\(^{-1}\)min\(^{-1}\)) and lower values still during arm exercise (49.1 ml.kg\(^{-1}\)min\(^{-1}\); O’Toole et al., 1987). VO\(_{2\text{max}}\) is generally greatest during treadmill running and cycling with lower values observed for arm exercise (O’Toole et al., 1987; Price and Campbell, 1999; Svedenhag and Sjödin, 1985). Values may also change over a competitive season (Astorino et al., 2004).

Now that you have practised extracting and linking information from different sources it is time to put your introduction together. The next section will help you do this.

2.5 Writing an introduction

Whether you are writing a lab report or dissertation, or are embarking upon writing a research paper or review article, you need to have a good grasp of what has been previously reported in the literature. Most authors addressing the different stages of a research project (Eston and Rowlands, 2000) or manuscript preparation (Altinörs, 2002) highlight the importance of undertaking an initial ‘detailed survey’ of the literature. Indeed, being well read in your area is an important first step of the writing process (Hall, 2011). Having read a wide range of pertinent literature you will then need to synthesise the information to develop and finalise your research question. For lab reports this will be more directed based upon what you have done in your classes, although it is still important to read widely.

When writing an introduction a number of authors suggest a ‘three paragraph approach’ (e.g. Alexandrov, 2004; Foote, 2006a). This follows the ‘general to specific’ nature of introductions noted earlier with the information presented leading clearly on to the aims and hypotheses. Consider the first exercise in this chapter where you described each paragraph of an introduction using one or two words. We will use this principle in writing an introduction (Exercise 2.4).

Exercise 2.4: Writing an introduction

For the key aspects of your introduction plan out three paragraphs (you can of course use more). Start by considering the key aspects you need to cover based on your title, the aims of the study and the methods undertaken in your class.

Paragraph 1: ………………………………………………………………………………………………………………………………………………………………………………………………
Paragraph 2: ………………………………………………………………………………………………………………………………………………………………………………………………
Paragraph 3: ………………………………………………………………………………………………………………………………………………………………………………………………

Now expand each aspect using information from the literature to introduce each term, show how a term may be used or provide example values.
2.6 Critiquing an introduction

We noted earlier in the text (see Chapter 1) that when asked to critique a piece of writing it is important to note positive aspects as well as those that you consider could be improved. Being able to critique previous work is an important aspect of your research methods and scientific training and is considered in greater detail later in this chapter (Section 2.8). The skill of being able to critique your own work is of great importance and may help you to achieve better marks. Exercise 2.5 is designed to help you start critiquing introductions but you can also try it on your own work once you have prepared your first draft.

Exercise 2.5: Critiquing an introduction

In conjunction with Section 2.10 (‘Common problems in writing introductions and literature reviews’) read the example introduction provided and determine whether you think it would achieve many marks for a lab report assessment. Using the same skills that you used for critiquing abstracts in the previous chapter (Section 1.5, Exercise 1.3) note any good aspects or those that could be improved. Some useful comments are provided in Table 2.3.

Table 2.3 Points of critique for the example introduction

Overall the introduction is very short and does not provide information in a coherent way. There are also wording and referencing errors.

Paragraph 1
1. The paragraph refers to a previous study (Damavandi et al., 2011) but it is incorrectly referenced and provides little if any information. It would be better to provide appropriate definitions of ground reaction forces and background information to start with.
2. The ground reaction force definitions are vague and incorrect and are also not referenced.
3. The third sentence is very general. It would be useful to start the introduction if it contained more information.
4. From the fourth sentence the introduction begins to provide methods information.

Paragraph 2
1. Some more background information is provided but it lacks specific details. The reader will be unable to determine specific facts from what is reported or why it is important to cite this study in relation to the lab report.
2. More definitions of ground reaction forces are given but these should really be in the first paragraph.
3. It is good that some applications of measuring ground reaction forces have been attempted. However, these are not referenced and the specific details relating to what measurements would be useful and how the results could be used is missing.

Paragraph 3
1. Both the aim and hypothesis are provided. However, the aim itself does not relate to what is covered in the introduction. It would be expected that if your aim relates to ground reaction forces in walking and running that these are described and explained in the introduction. Provide examples of expected values.
2. Likewise, the hypothesis does not provide an indication of which forces may be greatest.
Example introduction for ground reaction force lab report

Damavandi M looked at ground reaction forces in exercise (2011). Ground reaction forces are forces that the body produces during exercise. Biomechanics is therefore very important for sport and exercise science. In this lab class we will look at different ground reaction forces. We looked at different running speeds and measured the ground reaction forces with a force plate. The data was analysed.

Lipfert et al. (2011). Examined ground reaction forces and developed a model of ground reaction forces in running and walking. This is useful for assessing values when you can’t measure them. Hall (1999) defines ground reaction forces in relation to Newton’s third law of motion. These forces differ between people who are rearfoot and midfoot strikers. It is therefore important to measure these forces for footwear and injury concerns.

The aim of this lab class was to measure ground reaction forces in walking and running. We hypothesized that they would differ between conditions.

2.7 Planning and writing a literature review

There are a range of texts relating how to write literature reviews across a number of disciplines (e.g. Hart, 1998; Ridley, 2008). There are also some general texts within the area of Sport and Exercise Science regarding undertaking final-year projects (Lynch, 2010) and research methods (Thomas and Nelson, 2001) which contain useful information regarding literature searches and report writing. However, as writing a literature review is not the sole purpose of this book the aim of this section is simply to provide some basic guidance.

As noted earlier a literature review is a much more in-depth way of demonstrating your understanding of an area compared to a lab report introduction. In addition, it must form a solid basis for your research study and provide the rationale or justification for your study. By this we mean that you have to show that there is a gap in the literature which has not been examined and that this is what you intend to study. You need to make it clear why your study is different from those that have been reported previously. However, just because something has not been done before is not a good reason to study it! Thomas and Nelson (2001) consider type III and type IV errors. The former relates to asking the wrong research question and the latter relates to solving a problem that is not worth solving. A thorough literature review should hopefully prevent these errors occurring – along with the fifth error of researching something that has already been reported. For example, there have been many studies assessing differences in personality on exercise behaviours or whether carbohydrate ingestion improves performance, so why is your research study different to all the others? Ask yourself whether someone could read your literature review and, without reading your aims, have a good idea of what your research question is likely to be. If the answer is yes then you have done a good job. If it is likely that someone could read your literature review and be left struggling to see what you wish to examine then the review is not clear. Furthermore, if your aims do not relate to what you have reviewed then you are again off topic and you will need to refocus your review. By carefully planning your review in the same way as planning an introduction (see Exercises 2.3 to 2.5) each section of the review should be related to your research question.

Don’t underestimate how difficult it may be to clearly justify your study. If you are struggling to get your ideas written down clearly try and explain your ideas to someone. Verbalising your thoughts may help focus your explanation. When my PhD
supervisor was confronted with various unclear paragraphs of text he would ask me to simply tell him what I meant. When I did, in one or two sentences, he would then ask; ‘Why didn’t you just write that?’ It may not be quite as easy as that all the time, and of course you will need to add your references and underlying theories or responses to explain your ideas, but it is certainly one method of clarifying your ideas. Many undergraduate and postgraduate supervisors, myself included, often repeatedly write questions or comments on students’ work such as ‘Why?’ or ‘How?’ to get them to try and clarify and rationalise their research questions.

2.7.1 Planning a literature review

Before putting pen to paper you need to know the literature relating to your research questions – you also need to know your research question! Many students (especially undergraduate students) know this well before they may understand the specifics of the area being studied. Don’t try and plan too much prior to reading the literature as you may find that your review plan changes dramatically as the story behind the underlying literature unfolds. Furthermore, literature reviews evolve as you undertake and write other sections of your project. This is also true when you are writing your discussion, as important components may come to light which you had not originally considered. You may then decide to add these areas to your review.

So, how do you start to plan your review? Consider the summary table you developed for your literature sources earlier in the chapter. From this you may find a pattern of responses or specific themes that you can use as subheadings (Hardy and Ramjeet, 2005). You will also need to critique the literature you have obtained. In addition, always have your research question in mind. Finally, ensure that you have read and summarised your research papers before attempting Exercise 2.6.

Do you remember the ‘three paragraph approach’ to writing introductions that we mentioned earlier? You may find it helpful to consider a similar approach to your literature review but this time, instead of three paragraphs, consider three sections (Figure 2.7). The first section should introduce the research area. Here, for example, you can state what areas the review will cover, if you undertook a systematic review

![Diagram](https://via.placeholder.com/150)

**Figure 2.7** Three potential sections for a literature review
Introductions and literature reviews

note what your search terms and criteria were (see Section 2.2.1.i), include why the area of study is important and list any potential applications for the results. It may also be useful to note the areas that you will be covering to give an overview of the reviews structure and content (Bem, 1995). If you always have your research hypotheses in mind this can give you significant direction in your planning.

The second section is the main body of the review. Unfortunately there is no easy answer as to how to plan this section as all reviews differ depending on what you are studying and what you intend to develop for your rationale. An important tip is not to try to cover everything but also not to limit yourself by only using one or two key references (especially if you only obtained recent electronic sources). In this section of your review a literature summary table can be very useful. Each factor that has emerged may help you devise the main headings and subheadings within the text. Here subheadings are essential so that the reader knows exactly what are they are supposed to be reading about. However, a common error here is when the text does not relate to the subheading. An error such as this can be overcome by careful proofreading and using the ‘one word descriptors’ for each of your paragraphs, as in Exercise 2.1, to ensure the content is relevant to the heading. An important point here is to note that for some research areas there may not be many articles relating to your research question. Students often struggle if there are no studies asking exactly the same research question that they have developed. This is not a problem – if there were similar studies why would yours be original? However, there will certainly always be a range of related studies from which you can develop your hypotheses. In addition, there are likely to be a number of key or opposing viewpoints on the subject area, and it is important to demonstrate that you know these and that you can back up and explain your decision.

The third and final section of the review should bring the review to a close, ending in a summary and your subsequent aims and hypotheses. Bem (1995) states that you should end a literature review with a bang rather than a whimper. What research has not been reported so far and which studies should be undertaken to bridge the gap in knowledge? Hopefully one of these suggestions will be related to your research hypothesis.

Exercise 2.6: Planning a literature review

Hopefully by now you will be happy with your research question and will be well read in the supporting literature. Consider the key themes within the literature and what factors have emerged as being important to the area. The suggestions in Section 1 and 3 below are simply to get you started in formulating or planning your review. For Section 2 revisit your literature summary table for key themes. Using these key themes is one approach that you may find useful. However, the content will vary with the area studied and your research question. Therefore, it is worth trying this approach even though you may use other methods to plan your literature review. You should always discuss the content with your supervisor.

Section 1
What areas will the review cover?
For systematic reviews, what search terms and criteria were considered?
Why is the area of study important?
What applications are there for the results of such studies?
2.7 Planning and writing a literature review

Section 2
Consider the key themes as subheadings.

Section 3
What research has not been reported so far?
What studies should be undertaken to bridge the gap in knowledge?
Aims and objectives.
Hypotheses.

If you are struggling trying to plan your review, you may find it helpful to work backwards from your research question by considering what would be useful to discuss from specific to general points.

2.7.2 Writing a literature review

Once the key planning of your review has been done you can begin writing in earnest. At this stage you will have ideally read the literature, critiqued the studies and written or at least be happy with your research hypothesis. Essentially you will be adding detail to each of your subheadings. Note that your headings may well evolve as your writing does and your focus becomes clearer. Some headings may disappear and others may appear. Much of your writing will relate to the reporting and critiquing of research studies (see Section 2.8) and developing your research question so it is important that you are happy with extracting information from your literature sources (see Exercise 2.3). You must also ensure that you produce a clear overview. Reviews at undergraduate level often become either catalogues of information involving long lists of studies without any integration of key points or summaries of information with few links made between them. Try to avoid such an approach and make sure that you integrate your key studies together clearly and logically (see Exercise 2.3). If no one has reported an aspect of the area you are interested in it is perfectly acceptable to state that. However, in this instance you may have to think a little more laterally to try and develop aspects of your rationale.

Bem (1995) provides a helpful overview of scientific writing when considering literature reviews submitted to the journal Psychological Bulletin. Although literature review articles may differ from undergraduate and postgraduate dissertations the key aspects of scientific writing are essentially the same. Bem notes that a key factor differentiating between those articles accepted and rejected for publication is that of good writing and further notes that the primary criteria for good scientific writing are accuracy and clarity. For accuracy, ensure that any information provided is correct. Your supervisor is likely to know the details of many of the studies you are citing, and may well have written some of them, so they will know specific results and explanations. For clarity, make sure you state enough information to give an idea of the direction or magnitude or any previous results. For example, stating that ‘ground reaction forces were different’ is not very enlightening. Stating that ‘ground reaction forces were greater during running than walking’ or adding an idea of the size of such changes or absolute values provides a much clearer message to the reader. General writing tips are covered later in this text and it is recommended that you read that chapter while writing your review (see Chapter 6). The critique aspect of using literature is considered in Section 2.8.
The ability to think independently and critically is a key aspect of higher education (Ryall, 2010) and is particularly important in the final year of degree-level study. However, students often find critical analysis difficult. How do you go about beginning your critique of an article? How can you critique something that is already published? This section will hopefully provide answers to these common questions and give some ideas of how to approach the critical appraisal of a journal article or any other information source. Postgraduate students may find journal clubs or research seminar series quite useful for the discussion or critique of various journal articles or research studies, including their own.

What is critical analysis? Ryall (2010) notes that a critical thinker is able to make judgements based on sound reasoning. These judgements will depend on what is important to you and the sound reasoning is likely to relate to previous research findings and your interpretation of them. Young and Solomon (2009) state that critical analysis is a systematic approach used to determine the strengths and weaknesses of a journal article to assess both its usefulness and the validity of the reported findings. Greenhalgh (1997) states that critical analysis is the assessment of methodological quality. Importantly, Coughlan et al. (2007) note that critical analysis is not a criticism but an objective and balanced scrutiny of a piece of work, not only highlighting its strengths and weaknesses but to also ascertain whether the source is trustworthy and unbiased.

The majority of definitions of critical appraisal or critical thinking, such as those above, note that both the strengths and weaknesses of a source should be considered. Critique is not just pointing out negative or ‘bad’ points, it is also a consideration of what is new, novel and ‘good’. Students can often be quite negative in critiquing work, but remember that if the research studies you read were truly ‘bad’ it is unlikely that they would have been published. Just because a study has not measured a variable that you are particularly interested in does not mean that it is bad, it probably just wasn’t of key importance or interest to the authors. Furthermore, any criticism of other authors’ work should be expressed in an objective manner (Wieseler and McGauran, 2010). Your critique should not be a demolition or ‘trashing’ of someone else’s work (Ridley, 2008; Young and Solomon, 2009). Consider how you would react if similar comments were passed on your work.

So how do you go about critiquing a journal article? You have already done this at a basic level in extracting what you thought was important from the abstracts (see Exercise 2.4) and in establishing where gaps in the literature exist for your project area. Exercise 2.4 also noted that what you think is important may differ from what someone else considers to be important. Part of a critique is taking this one step further. Some authors suggest focussing upon the methods sections (Greenhalgh, 1997) and a lot of critique does indeed focus on the ‘what did they do?’ aspects. Greenhalgh (1997) notes that most journal articles conform to the IMRaD principle, covering not only methods but the ‘why did they do it?’ (Introduction), ‘What did they find?’ (Results) and ‘What do the results mean?’ (Discussion) aspects. These other sections are also worthy of your critique.
2.8.1 Critical appraisal tools

There are a range of critical appraisal tools available in the literature which may help develop your critiquing skills. More seasoned academics are unlikely to use a structured profoma when critiquing or reviewing journal articles, instead relying predominantly upon their research and publishing experience. However, for less-experienced researchers published guidelines will be of much more value. Guidelines and advice have been produced for the critical appraisal of journal articles in both quantitative and qualitative research in nursing (Coughlan et al., 1997; Ryan et al., 2007), physiology (Seals and Tanaka, 2000), psychology (Hyman, 1995), medicine (Greenhalgh, 1997; Young and Solomon, 2009), general practice (MacAuley, 1994), public health (Heller et al., 2008) and physical therapy (Domholdt et al., 1994; Maher et al., 2004). Although all these guides are very useful, they were developed for specific research disciplines – there is no ‘gold standard’ procedure. Therefore, whatever process is undertaken must evolve with advances in methodological and non-methodological factors (Greenhalgh, 1997). To illustrate this point, when you read older journal articles or ‘classic’ studies and critique them for not using a particular technique, bear in mind that many techniques commonly employed today may not have been widely available at the time of writing. Differences also exist between quantitative and qualitative research processes and in the way the critique process should be approached for both (Ryan et al., 2007).

More general models of critical appraisal provide general concepts for the appraiser to consider. For example, Deane (2010) considers seven points for the general critique of information sources, including whether the evidence presented is convincing and what level of subjectivity or bias exists within the work (Table 2.4). Similarly, Young and Solomon (2009) provide ten questions to ask from a clinical perspective, including whether the study is relevant and adds anything new and if any conflicts of interest exist, which is an important consideration in clinical drug trials (Table 2.5). Other more detailed models provide a greater number of specific questions to be asked within each section of the article (Heller et al., 2008; Seals and Tanaka, 2000).

2.8.1.1 Critiquing and changing your professional practice

As noted above there are a large number of critical appraisal tools in the literature. Crowe and Sheppard (2011) compared 44 critical appraisal tools and concluded that users need to be careful about which tool they use and how they use it. The authors later developed their own critical appraisal tool (Crowe et al., 2011a, 2011b). With this in mind an important aspect of critical appraisal is whether you wish to assess the scientific

<table>
<thead>
<tr>
<th>Table 2.4</th>
<th>Seven questions to ask when critiquing an information source [Deane, 2010]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Does the source use primary evidence?</td>
</tr>
<tr>
<td>2.</td>
<td>Does the source use secondary evidence?</td>
</tr>
<tr>
<td>3.</td>
<td>Is the evidence convincing?</td>
</tr>
<tr>
<td>4.</td>
<td>What are the author’s credentials?</td>
</tr>
<tr>
<td>5.</td>
<td>What assumptions does the author make?</td>
</tr>
<tr>
<td>6.</td>
<td>What subjectivity or bias is evident in the source?</td>
</tr>
<tr>
<td>7.</td>
<td>Is the language emotive?</td>
</tr>
</tbody>
</table>

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Introductions and literature reviews

rigour of an article (i.e. its quality or internal reliability) or how applicable the work is to your own practices (i.e. its value or external validity) (MacAuley, 1994; Maher et al., 2004). The majority of undergraduate and postgraduate students in Sport and Exercise Science are probably critiquing with respect to scientific rigour as they are generally, but not exclusively, writing an academic piece of work. Conversely, students in areas such as Sports Therapy, and certainly professionals currently in practice, are more likely to be interested in how a piece of research may affect their treatments or clinical practices. The choice of critical appraisal tool is therefore extremely important. The following paragraphs will consider some aspects of both these forms of critical appraisal.

To help assess whether the scientific evidence considered will affect clinical behaviour or the practical approach to treatment, MacAuley (1994) developed the ‘READER’ aid to critical appraisal. This aid was initially developed for general practitioners with limited time to undertake extensive reviews of the literature (MacAuley, 1994). The ‘READER’ acronym stands for Relevance, Education, Applicability, Discrimination, Evaluation and Reaction, the main tenets of which are shown in Table 2.6. Each component is given a score and the usefulness of the information is graded according to the total score. This scale has been shown to be valid and reliable and has been used in a range of educational scenarios for general practitioners (Bleakley and MacAuley, 2002; MacAuley, 1996; MacAuley and McCrum, 1999; MacAuley and Sweeney, 1997; MacAuley et al., 1998).

The main reason for introducing this scale here relates to the ‘Relevance’ component. A key factor of the component stresses that the article is assessed within the reader’s own context, highlighting that what is useful for one reader may not be useful for another. Also, your needs may differ over time and in different situations. This is especially true if it has the potential to change your behaviour. Similar tools and appraisal advice have been provided for public health (Heller et al., 2008) and physical therapy (Domholdt et al., 1994; Maher et al., 2004). Students of Sports Therapy may find these useful for the practical aspects of their courses. Even though the focus of these appraisal tools is towards that of potentially altering professional practice they still involve assessing the appropriateness of research questions and hypotheses, study design and the interpretation of results (Heller et al., 2008), as well as the scientific or clinical basis of the work. Don’t forget that changing professional practice

<table>
<thead>
<tr>
<th>Table 2.5 Young and Solomon’s ten questions to ask when critically appraising a research article (Young and Solomon, 2009)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Is the study question relevant?</td>
</tr>
<tr>
<td>2. Does the study add anything new?</td>
</tr>
<tr>
<td>3. What type of research question is being asked?</td>
</tr>
<tr>
<td>4. Was the study design appropriate for the research question?</td>
</tr>
<tr>
<td>5. Did the study methods address the most important potential sources of bias?</td>
</tr>
<tr>
<td>6. Was the study performed according to the original protocol?</td>
</tr>
<tr>
<td>7. Does the study test a stated hypothesis?</td>
</tr>
<tr>
<td>8. Were the statistical analyses performed correctly?</td>
</tr>
<tr>
<td>9. Do the data justify the conclusions?</td>
</tr>
<tr>
<td>10. Are there any conflicts of interest?</td>
</tr>
</tbody>
</table>

### Table 2.6 MacAuley’s READER aid to the critical appraisal of research articles (MacAuley, 1994)

<table>
<thead>
<tr>
<th>Component</th>
<th>Main factor(s) and scoring system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relevance</td>
<td>The article is assessed within the reader’s context</td>
</tr>
<tr>
<td></td>
<td>1. Not relevant to general practice</td>
</tr>
<tr>
<td></td>
<td>2. Allied to general practice</td>
</tr>
<tr>
<td></td>
<td>3. Only relevant to specialised general practice</td>
</tr>
<tr>
<td></td>
<td>4. Broadly relevant to all general practice</td>
</tr>
<tr>
<td></td>
<td>5. Relevant to me</td>
</tr>
<tr>
<td>Education</td>
<td>Context of behaviour modification</td>
</tr>
<tr>
<td></td>
<td>Could it change your behaviour?</td>
</tr>
<tr>
<td></td>
<td>1. Would certainly not influence behaviour</td>
</tr>
<tr>
<td></td>
<td>2. Could possibly influence behaviour</td>
</tr>
<tr>
<td></td>
<td>3. Would cause reconsideration of behaviour</td>
</tr>
<tr>
<td></td>
<td>4. Would probably alter behaviour</td>
</tr>
<tr>
<td></td>
<td>5. Would definitely change behaviour</td>
</tr>
<tr>
<td>Applicability</td>
<td>Can the research be done in the reader’s own practice?</td>
</tr>
<tr>
<td></td>
<td>Can you identify with the practice or circumstances?</td>
</tr>
<tr>
<td></td>
<td>1. Impossible in my practice</td>
</tr>
<tr>
<td></td>
<td>2. Fundamental changes needed</td>
</tr>
<tr>
<td></td>
<td>3. Perhaps possible</td>
</tr>
<tr>
<td></td>
<td>4. Could be done with reorganisation</td>
</tr>
<tr>
<td></td>
<td>5. I could do that tomorrow</td>
</tr>
<tr>
<td>Discrimination</td>
<td>Is the message valid?</td>
</tr>
<tr>
<td></td>
<td>1. Poor, descriptive study</td>
</tr>
<tr>
<td></td>
<td>2. Moderately good, descriptive study</td>
</tr>
<tr>
<td></td>
<td>3. Good descriptive study but methods not reproducible</td>
</tr>
<tr>
<td></td>
<td>4. Good descriptive study with sound methodology</td>
</tr>
<tr>
<td></td>
<td>5. Single-blind study with attempts to control</td>
</tr>
<tr>
<td></td>
<td>6. Controlled single-blind study</td>
</tr>
<tr>
<td></td>
<td>7. Double-blind, controlled single-blind study with method problem</td>
</tr>
<tr>
<td></td>
<td>8. Double-blind, controlled single-blind study with statistical deficiency</td>
</tr>
<tr>
<td></td>
<td>9. Sound scientific paper with minor faults</td>
</tr>
<tr>
<td></td>
<td>10. Scientifically excellent paper</td>
</tr>
<tr>
<td>Evaluation</td>
<td>If epidemiologically sound, paper should be considered seriously</td>
</tr>
<tr>
<td>Reaction</td>
<td>Scoring category (NB: the research is not necessarily ‘bad’, just not for your current needs)</td>
</tr>
<tr>
<td></td>
<td>24+ Classic paper which should make an immediate impact on practice</td>
</tr>
<tr>
<td></td>
<td>20–23 Paper is of value and filed for immediate access</td>
</tr>
<tr>
<td></td>
<td>15–19 Paper may be of interest</td>
</tr>
<tr>
<td></td>
<td>&lt;15 Paper failed to fulfil the criteria</td>
</tr>
</tbody>
</table>

*Source*: Adapted from MacAuley, D. (1994) READER: an acronym to aid critical reading by general practitioners, *British Journal of General Practice*, 44(379), 83–85, Figure 1.
is not just limited to people working in clinical areas or with patients. The professional practice of sport and exercise scientists includes assessing why you use certain exercise protocols, questionnaires or data collection and analysis techniques. All of these may be affected by what you read in the literature.

2.8.1.ii Critiquing scientific rigour
Most students writing dissertations and compiling literature reviews are probably concerned with the scientific rigour of journal articles. Here, experience in research and writing is invaluable. However, most students will not have developed these skills to a large extent as they are in the early stages of their subject-specific research training. Many of the suggested critique questions within the various published critical appraisal guidelines parallel the advice given for writing literature reviews and the other sections of lab reports, dissertations and research studies. Seals and Tanaka (2000) developed a guide for critiquing scientific articles based upon the forum of postgraduate research seminars. The contents of the guide (Table 2.7) relate to most areas of sport and exercise science whether examined from physiological, psychological or biomechanical perspectives. If we compare this to the general model of critical appraisal the underlying themes are identical, it is the specifics that change with respect to subject discipline.

In conclusion, critical appraisal can take many forms and is specific to the needs of the reader at that time and the task they are set. All of the examples provided and guidelines given are essentially the same but focus on different aspects of critique. For example, Deane’s (2010) questions are more general and assess the type of information source reviewed and its validity, whereas Young and Solomon’s (2009) questions cover more discipline-specific considerations. Although MacAuley’s (1994) critique is focussed mainly on the applicability of research to practice and the potential to change professional behaviour, as with Young and Solomon, the methodological aspects have a large emphasis on the overall score. In this context many reviewers would also have considered the specific points raised by Seals and Tanaka (2000) in evaluating methodological components. Similarly, any scientist assessing the rigour of an experimental design may subsequently decide to use that method. As long as you keep these guidelines and comments in mind, your critical appraisal skills will develop as you read and assess more information sources. Consider the aspects of each model presented here (but note that there are many more available) in relation to the stage of research you are at and put them into practice with the next article you read. Your critique skills and application of knowledge will then quickly develop.

**Exercise 2.7**
For a journal article obtained from your literature search use the different appraisal methods provided in this chapter to do the following:

1. Determine whether the article is useful for your literature review.
2. Critique the article using the specific criteria of Seals and Tanaka (2000).
3. Determine whether the article will affect what you do with respect to your research design.
### Table 2.7 Critiquing a journal article (Seals and Tanaka, 2000)

<table>
<thead>
<tr>
<th>Section</th>
<th>Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title</td>
<td>Does title accurately reflect the purpose, design, results and conclusions of the study?</td>
</tr>
<tr>
<td>Abstract</td>
<td>Succinct, clear, comprehensive summary of the main text of the paper? Content consistent with that presented in the main text? Data or other key information presented here but not in the main text (or vice versa)?</td>
</tr>
<tr>
<td>Introduction</td>
<td>Succinctly states what is known and unknown about the topic? Functional, biological and/or clinical significance established? Specific experimental question, goal or aim to be addressed stated? Previous studies strengths and limitations described? Clear how experimental approach will provide unique insight?</td>
</tr>
<tr>
<td>Methods</td>
<td>Participants adequately described? Population appropriate for the research question? Participant number sufficient? Population used allow extensive or limited generalisability? Assignment of participants to conditions randomised? Ethical issues and consent described? Design allows hypothesis to be rigorously tested scientifically? Proper control groups/conditions included? Confounding factors controlled? Method described insufficient detail to be repeated? Measurement techniques reliable, precise and valid? Rationale for measures explained? Appropriate data calculation and analysis? Statistics appropriate for the study design? Statistical assumptions tested/violated? Alpha level clearly stated?</td>
</tr>
<tr>
<td>Results</td>
<td>Data reported in a clear, concise and well-organised manner? Where necessary are standard deviations and standard errors reported (any excess variability)? All data presented? Any data presented on any measurement not described in the methods? Are all the figures and tables needed? Tables and figures properly labelled with correct units and scaled appropriately? Any repetition of data in figure and tables? Is the data within the expected range? How do group differences compare to measurement variability?</td>
</tr>
<tr>
<td>Discussion</td>
<td>Major new findings clearly described and properly emphasised? Key conclusions adequately supported by the experimental data? Is there any alternative way to interpret the data? Significance of the results described? How do results extend previous knowledge? Observations for previous studies described in the context of present results? Statements supported by appropriate references? Data discussed with insight beyond previously? Unique aspects and other experimental strengths properly highlighted? Experimental limitations described so as to interpret the results appropriately? Suggestions for future work?</td>
</tr>
</tbody>
</table>

2.9 Aims, objectives and hypotheses

At the end of the introduction or literature review you will need to state the aim(s) of your experiment. Your aims should follow on smoothly from your literature review and be based on logical reasoning (Thomas and Nelson, 2001). If you have written a clear and informative literature review the reader should have a good idea of what you intend to study or at least where the gaps in the literature exist. Your aim may further be considered to be something that is achievable or a ‘resolvable question’ (Hopkins et al., 2009). The aim is often expected to be followed by your scientific hypotheses; this is especially true for undergraduate and postgraduate theses. In many cases the aim will be very similar to your title as this reflects what you are investigating. The objectives of a study are often required for final-year projects and essentially relate to what you will do to achieve your aims.

The hypothesis relates to what you think will happen in your study. This should be based upon the information present in your introduction or literature review and therefore previous knowledge. There are two key hypotheses usually presented: the null hypothesis, which states there is no difference between conditions; and the alternative or experimental hypothesis, which states the change in direction or magnitudes of change you expect to find. The null hypothesis is what we are testing statistically. Hence, you may read that researchers have ‘rejected their null hypothesis’ when a statistically significant result is obtained. A common error is to state that there will be a difference between your conditions but not stating the direction in which you think it may occur. Another common error is stating hypotheses which are not consistent with or that contradict what you have stated in the introduction or literature review.

Many students write their aim and hypotheses of their study quite quickly without much thought for their importance. However, never underestimate how important they are as they underpin everything that you do. Each section of your dissertation has an important link to your aims and hypotheses. For your methods, consider what you are actually testing. Does your study design reflect the question you are actually trying to answer? Do the variables measured reflect the responses in question? For your results, does your analysis examine the appropriate differences or relationships postulated? Within your discussion, are you actually explaining your results with your aims in mind? If not, then you may be off topic. It seems obvious that you would discuss your data in relation to your key research question but this is seldom the case in many first drafts of theses. Table 2.8 gives examples of aims, objectives and hypotheses for the three lab class examples used throughout this text.

Exercise 2.8: Writing aims and hypotheses

Based on the examples given in Table 2.8, write the aims and hypotheses for your lab report or dissertation. Are they consistent with title of your report?

Title: ..............................................................................................................................
..............................................................................................................................

Aims: ..............................................................................................................................
..............................................................................................................................
..............................................................................................................................
2.9 Aims, objectives and hypotheses

Objectives:

Null Hypothesis:

Alternative Hypothesis:

Table 2.8 Examples of aims, objectives and hypotheses for the three lab class examples used throughout this book

<table>
<thead>
<tr>
<th>Lab class</th>
<th>Aim</th>
<th>Objectives</th>
<th>Null hypothesis</th>
<th>Alternative hypothesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximal oxygen uptake</td>
<td>To determine maximal oxygen uptake in running, cycling and arm ergometry.</td>
<td>To measure maximal oxygen uptake during treadmill running, cycling and arm ergometry.</td>
<td>There will be no differences in maximal oxygen uptake between exercise modes.</td>
<td>Maximal oxygen uptake will be greatest during treadmill running and lowest during arm ergometry.</td>
</tr>
<tr>
<td>Ground reaction forces</td>
<td>To determine ground reaction forces during walking and running.</td>
<td>To measure ground reaction forces using a force plate.</td>
<td>There will be no differences between ground reaction forces between walking and running.</td>
<td>Ground reaction forces during running will be greater than those during walking.</td>
</tr>
<tr>
<td>Anxiety on performance</td>
<td>To determine the effects of anxiety on basketball shooting performance.</td>
<td>To measure basketball shooting performance.</td>
<td>There will be no differences in basketball shooting performance in high and low anxiety conditions.</td>
<td>Basketball shooting performance will be worse in high anxiety conditions.</td>
</tr>
</tbody>
</table>
2.9.1 A note on titles

Having considered the introduction, literature review, aims and hypothesis it would be remiss of us not to consider the actual title of your report! For a lab report this is most likely to be provided in the lab schedule and should describe what has been done within the class – don’t just give it the title ‘Lab report’. However, for a final-year project your title will probably be determined by you and should reflect your study aims. Most journal guidelines state that a short informative title should be provided, with some authors suggesting that the title should be between 10 and 15 words (Coughlan et al., 2007). However, as Thomas and Nelson (2001) note, a title that is too short may not be very helpful, particularly if it contains ‘waste’ words such as ‘An investigation of’ or ‘A study of’. Conversely, a title that is too long can become cumbersome and awkward. Consider one of our example lab reports measuring ground reaction forces. A title of ‘An examination of ground reaction forces measured from a force plate during walking and running at different speeds on a treadmill in Sports Science students’ is too long. A better attempt might be ‘Ground reaction forces during treadmill walking and running’. The latter title cuts out extraneous information regarding how the ground reaction forces were measured and who the participants were. However, if the participant population studied was key to the research question then it should be contained in the title, such as ‘…in men and boys’. You should make sure that your key research question is addressed in a clear way.

Your title should not be ambiguous or lead the reader into thinking that you are measuring something different to what you actually are. For example, Seals and Tanaka (2000) give an example of a hypothetical cross sectional study of blood pressure in two groups of people, those with low or high sodium intake. A title such as ‘Effects of sodium intake on blood pressure’ would be misleading as the study did not involve participants consuming sodium prior to their blood pressure being measured. However, for such a study with a cross sectional design the authors consider ‘Blood pressure in humans with low and high sodium intake’ to be a much more appropriate title.

2.10 Common problems in writing introductions and literature reviews

If you follow the guidance provided throughout this chapter you will hopefully have fewer errors in your work. However, there are some common mistakes related to the advice above which are worth emphasising. The following points should be read in conjunction with the chapter on ‘Referencing and general writing tips’ (see Chapter 6).

2.10.1 No clear rationale developed

A lack of focus in your introduction or literature review can be a key problem (Foote, 2006a). Many students do not clearly identify their research question or the rationale for their study and instead provide a general account of facts relating to the overall subject. Indeed, Greenhalgh (1997) notes that, amongst other reasons, journal articles are often rejected by reviewers because the studies do not address an important scientific issue, or because the study was not original, or just because they were badly written. Similarly, Peh and Ng (2010) note the common problems with (invited)
literature reviews include a lack of critical evaluation, problems or unresolved areas not being highlighted – which may even be the reason for your own study – and no clear overall message. All of these points are related to developing and clearly communicating the reason for your study. Constructing a clear rationale is therefore not just a problem for undergraduate and postgraduate students.

2.10.2 Writing ‘off topic’
This particular error is often linked to no specific rationale being developed and is a common error in the introductions to lab reports. If your writing is going ‘off topic’ you may still be presenting correct information but it is not relevant to your report area or what was done. In order to counteract this error always have your research question or aims in mind and keep asking yourself ‘is this section related to my report?’ Students often include statements relating to the methods that are to be undertaken or the tests used. Unless your study is specifically focussing on protocol or procedure development save this information for the methods section. A similar problem exists in writing literature reviews. Here it is most likely that you will initially have various sections that do not help explain your research question or relate to the topic in hand. Don’t be worried about deleting large portions of text or sections you have written if they do not relate to your key aims. You can always save it in a different file in case it is useful for another assignment and it will certainly be useful for background knowledge.

2.10.3 Aims, objectives and hypotheses
A key problem with stating the aims of a study or lab report is that they don’t relate to what you have presented in the literature review or introduction. If you consider that these statements are setting the scene for your work and providing the scientific reason for the study the aims must be consistent with these. Even when the aims relate to your rationale a common error is that they have no direction. This means that based on what you have stated happens in the introduction or literature review you should have an idea of how your treatment will affect the variables measured. Based on your logical reasoning would you expect a value to increase, decrease or have specific effects?

2.10.4 Under- or over-referencing
Most students know, or are at least taught, that you should always reference the information sources that you use in your work. A common problem, however, and not just in lab reports or projects, is the underuse and overuse of references. With respect to under-referencing, although most lecturers will know which sources the key information you present has come from it is still of paramount importance to acknowledge who has done the work. Stating where your information has come from is of key importance in avoiding plagiarism (for more on this see Chapter 6). You should also remember that your lecturers will know the sources they used within their lectures so don’t just cite these, it shows that you haven’t looked for other sources yourself. An account with few or no references rings alarm bells that students do not know how to reference or have not used previous literature to develop their research questions or describe their aims.
The opposite of the underuse of references is the overuse of references. This is also a common problem (Foote, 2006a). Although it is essential to reference all your statements and the facts presented, you do not need to cite every study that has investigated or noted your given point. Depending on what you are reporting, choose one or two references which are the most recent, those which are considered influential studies or those which have utilised a similar protocol or technique. As with avoiding using over-wordy or ‘flowery’ language, don’t try to impress by using a large number of references. The person marking your work can see how many sources you have used by looking at your reference list. Just as writing a large number of words is not always better than a shorter concise passage, using a large number of references is not always worth more marks. The appropriateness, interpretation and use of your references are what is important. In addition, consider how the readability is affected by excessive referencing. Too many references in each sentence will certainly affect the flow of your writing.

2.10.5 Overreliance on one or two studies
You may find that one key reference, probably a textbook or review article, will cover all your needs for the range of factors you wish to write about in your introduction. In this case, even though you have referenced appropriately, the same authors will be cited in every sentence, or in a large number of sentences, within a paragraph, which will make you appear over-reliant on just these one or two sources. This is usually more of a problem in the earlier years of your study before you get to grips with using journal articles. However, learning to paraphrase and extract the information you need should reduce this problem. Use original journal articles whenever you can.

2.10.6 Text and subheadings
It is a good idea to use subheadings in your literature review. Subheadings are not required within the introductions of lab reports as this section is limited to a few paragraphs, and in a thesis it is just a few pages. A common error here is when the text does not provide the information that the subheading suggests it should. This can easily be checked when proofreading your work by writing in the margin just one key word that the paragraph covers. If this word does not match the heading, then you should change either the heading or the content.

2.11 Chapter summary and reflections
In this chapter we have considered how to access and extract information to develop a scientific rationale for your introduction or literature review. The focus and content of your introduction or review will depend on the level of study and the requirements of your report. For undergraduate lab reports you will be demonstrating an understanding of key principles and techniques rather than developing a rationale for a novel research study.

Undergraduate and postgraduate dissertations generally have both an introduction and a literature review, whereas lab reports only have an introduction. For final-year projects, you need to consider what the gap in the literature is that has led to your
research question, or more simply, what is your area of interest and what hasn’t been reported previously? Your rationale should therefore be based upon a critical appraisal of the literature. Once you have identified a gap or gaps in the literature these can be developed into your research question and subsequently your aims and hypotheses. To assess your understanding of introductions and literature reviews answer the following questions:

■ What is an introduction?
■ How does an introduction differ from a literature review?
■ What is critical appraisal or critiquing an article?
■ What is a systematic review?
■ How do you generate your research question?
■ What are the common errors in introductions and literature reviews?

2.12 Further activities

Go to the website of a journal that you regularly read or are aware of. Find the author guidelines and consider the advice given for writing and presenting introductions. See how these differ for review articles in the same journal or for journals specialising in reviews.

Use the critical appraisal tools to evaluate or critique journal articles as you undertake your background reading.