Chapter 16
Results

What key skills are needed when writing the Results?

Not all journals require a separate Results section, often it is integrated with the Discussion, under the section title Results and Discussion.

If you have a separate Results section then the standard procedure is to present them with little or no interpretation or discussion. This means that the Results is generally the shortest section in a paper.

The key skill is first to decide what results are representative, and then to organize them in a sequence that highlights the answers to the aims, hypotheses or questions that you set yourself at the beginning of the paper. In many disciplines this involves the use of figures and tables, which are commented on in the text. In other disciplines, findings are only reported in text form.

You should also mention any important negative results here.

From an English point of view the key skill is in reporting your results simply and clearly. If the referees of your paper cannot understand your results, then your contribution to the current knowledge base will be lost.

A. Wallwork, *English for Writing Research Papers*,
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Typical complaints of referees

At times this paper reads like a thesis. The authors seem to have included all their results, with the consequence that I am not sure which findings are significant and which are not. However, I also suspect that some contradictory findings have not been included. So although I generally recommend brevity, this should not include leaving out key findings that do not support the authors' line of logic.

The Results section is too long and much of it is then repeated in detail in the Discussion. Moreover, most of the empirical results are rather obvious. That X = Y is hardly surprising. I cannot see any new or important aspects of this study.

Rather than highlighting the results that are significant or relevant, the authors have merely repeated in the text everything that they have put in their figures and tables, which in themselves seem to include every piece of data that the authors have elaborated in the last three years. This makes for very tedious reading. Moreover, I felt that I was not given the tools to understand for myself the significance of their data.

16.1 How should I structure the Results?

The Results should answer the following questions.

1. What did I find?
2. What did I not find?
3. What did I find that I was not expecting to find? (e.g. that contradicts my hypotheses)

A typical structure is to follow the order you used for the protocols or procedures in your Methods. You then use figures and tables to sequence the answers to the above questions.

16.2 How should I begin the Results?

There are two typical ways to begin the Results. The first is to give a general panorama of your surveys, experiments etc. without repeating the details you gave in the Methods section, as in the three examples below:

> Overall, the results presented below show that …
>
> The three key results of this empirical study are: …
>
> The following emergent themes were identified from the analysis: …

The most common way is to simply go directly to your results, often by inviting readers to look at one of your figures or tables, either in the first sentence or very shortly after:

> Figure 1 shows the mass spectra obtained from an analysis of the two residues. The first residue reveals a .. (Fig. 1a)
>
> A total of 34 wheat genotypes (Table 1) were screened for … Responses to increased sunlight varied significantly (Figure 1) …
>
> An analysis was made to look for … To do this, the average times of x and y were compared … Figures 1–3 show the differences between …

16.3 How should I structure the rest of the Results? How should I end the Results?

Before you begin writing, arrange your figures (tables etc.) in the most logical order for your readers, and which supports your initial aim or hypothesis that you stated in your Introduction. Then associate key findings with each of your figures, excluding any results that are not relevant in supporting your research hypothesis.

Note that 'not relevant' does not include results that contradict your hypothesis (Sect. 16.4).

The rest of the section then consists in commenting on these figures one by one. Maeve O'Connor in her book *Writing Successfully in Science*, recommends the following structure.

1. Highlight those results (including those from controls) that answer your research question
2. Outline secondary results
3. Give supporting information
4. Mention any results that contradict your hypothesis and explain why they are anomalous

16.4 Should I report any negative results?

Yes!

Dr Ben Goldacre, a campaigner against the suppression of negative data in medical papers, says:

> When you get a negative result, it feels as if it's all been a bit of a waste of time. It's easy to convince yourself that you found nothing, when in fact you discovered a very useful piece of information: the thing that you were testing doesn't work.

Of course, you may have got negative results for other reasons:

- your hypothesis was incorrect and needs to be reformulated
- you had a bad experimental design and / or low statistical power

As Dr. Donald Dearborn, of Bates College, comments:

> Your results may be of importance to others even though they did not support your hypothesis. Do not fall into the trap of thinking that results contrary to what you expected are necessarily "bad data". If you carried out the work well, they are simply your results and need interpretation. Many important discoveries can be traced to "bad data".

Negative data are frequently commented on in the Discussion (Sects. 17.12 and 17.13).

16.5 What tenses should I use when reporting my Results?

Your results are things that you found before you started writing the paper. They therefore relate to past events, consequently the PAST SIMPLE is used to report them, often in a mixture of the active and passive forms.

Below are some results from a medical paper. The author, medical doctor Caroline Mitchell, interviewed GPs (i.e. doctors) and nurses in the British National Health Service (NHS) to discover practices (in this case what is known as a *care model*) relating to depression. The indented parts in inverted commas are quotations of what the doctors and nurses said (I have only reported the beginnings of the quotations).

> The care model, *was seen* as a credible and holistic approach to the management of depression. GPs were keen to avoid 'over-medicalising' and over-prescribing of antidepressants:
>
> > "The big difference to the way we manage is having the mental health worker here more often, because …"
>
> However, there was a perceived failure of the NHS to provide adequate services to support adherence to the guideline. One GP *commented*:
>
> > "It's interesting when you look at the sort of treatments that …"
>
> GPs and mental health workers *described* very limited access to specialist input for patients with more complex, treatment-resistant or recurrent depression. One incident *was described* by a GP:
>
> > "I tried recently with a gentleman who has been on antidepressants for four or five years, …"

Dr Mitchell uses the PAST SIMPLE throughout but switches between the active and passive forms. When the topic is the most important element she uses the passive (*the care model was seen, one incident was described*). When it makes more sense to use a human subject, she uses the active (*one GP commented. workers described*).

16.6 What style should I use when reporting my Results?

When describing her results (Sect. 16.5), Dr Mitchell uses an impersonal style. This serves to add an element of objectivity to her findings. For instance, she does not say

S1. We found that doctors viewed the NHS as having failed to provide adequate services.

Instead she says:

S2. There was a perceived failure of the NHS to provide adequate services.

However, both S1 and S2 are accepted styles.

Note how the quotations in Dr Mitchell's text act like the figures and tables of other types of paper, by providing evidence for what is expressed in the sentences that precede them.

Here is an extract from another paper (Sect. 13.4), which again uses an impersonal style.

> Three levels of feedback *were looked* at for differences on task persistence. Differences between positive, negative, and no feedback conditions, were minimal and showed no significant findings … There were larger differences both between genders and in the interaction between gender and feedback conditions. Tables 1 and 2 *show* the averages for these gender differences. Figure 6 *shows* …

Note how the author uses the passive (*were looked at*) rather than the active (*I / we looked at*). This usage may either reflect the author's wish to remain in the background and let his results speak for themselves, and / or because he is following his journal's requirements. However, he uses the active when referring to figures and tables (*Figure 6 shows*).

16.7 Can I use a more personal style?

Here are some extracts from a Results section in a paper by economist, Andrea Mangani, regarding differences in content between online and print newspapers in Italy. The extracts highlight a much more personal style of reporting results:

> Collecting the data was quite difficult … On the other hand, the statistical analysis is rather simple. Table 2 shows … Notice that the difference between online and print variety increases during the daytime; this means that the diversity in online content tends to decrease from 09.30 to 17.30. We wondered whether the smaller degree of online variety depended on …

This kind of writing is less formal and helps the reader to become more involved in the research process. Andrea tells readers of his difficulties in collecting the data, but the ease of which he managed to analyze these data. He draws his readers' attention to the significance of his data (*Notice that* …). His readers are also involved in his thought and decision processes (*we wondered whether*). The result is a paper that reads a little a like a story, and is much more enjoyable to follow and therefore easier to digest.

Two more things to note:

- Andrea uses the PRESENT SIMPLE when interpreting his data (*online content tends to decrease*). This is very common when referring to data that clearly indicate a certain trend.
- Although Andrea was the sole author of the paper and conducted the research entirely by himself, he refers to himself as *we*. This is quite common in some journals where the use of the first person singular (*I*) is considered too informal.

Andrea's reader-friendly style may also be appropriate in the Discussion section.

16.8 How can I show my readers the value of my data, rather than just telling them?

Professor of ecology Ken Lertzman of the Simon Fraser University, gives the following advice in an excellent document available for download (page 313).

> Rather than telling the reader that a result is interesting or significant, show them how it is interesting or significant … show the reader what they need to know to come to their own conclusion about the result.

Ken gives two examples to highlight the difference:

S1. *The large difference in mean size between population C and population D is particularly *interesting*.

S2. While the mean size generally varies among populations by only a few cm, the mean size in populations C and D *differed by 25 cm*. Two hypotheses could account for this, …

In S1, the adjective *interesting* means something very definite for the author, but not for the reader who has not been given the tools to assess why the *mean size* is *interesting*. Such descriptive adjectives (*interesting, intriguing, remarkable*) are rarely helpful (see Sect. 9.4 for the dangers of such adjectives).

You need to give your readers sufficient information for them to be able to say to themselves: "wow that is interesting!" This is what S2 does by highlighting specific details (*differed by 25 cm*).

Adverbs such as *interestingly, intriguingly, remarkably* also suffer from the same problem. However, they can be used effectively if used at the beginning of a sentence, in order to attract attention to a key finding. So S2 becomes S3:

S3. *Interestingly*, while the mean size generally varies among populations by only a few cm, the mean size in populations C and D *differed by 25 cm*. Two hypotheses could account for this, …

However this technique should be used only once or twice in the whole paper, otherwise it loses its effect.

16.9 How should I comment on my tables and figures?

Dr Lertzman has similar ideas about 'showing not telling' with regard to figures and tables:

> When writing Results sections you should use the tables and figures to illustrate points in the text, rather than making them the subject of your text.

Following his advice, S1 should be rewritten as S2.

S1. *Figure 4 shows the relationship between the numbers of species A and species B.

S2. The abundances of species A and B were inversely related (Figure 4).

In S1 the author is merely telling readers what they can already see in the figure. S2 is much more helpful, because it focuses on the meaning that can be inferred from the figure. S1 forces readers to make their own interpretations (which may in fact be interpretations that you don't want them to make). S2 saves readers from making any mental effort and at the same time guides them towards the interpretation that you want them to have.

The OVs in the table below highlight some examples related to commenting on figures and tables.

	ORIGINAL VERSION (OV)	REVISED VERSION (RV)
1	As can be seen in Figure 1, levels of intolerance were highest during late adolescence.	Levels of intolerance were highest during late adolescence (Figure 1).
2	We can see from Table 2 that in the control group, values for early adolescence (13–15) were 6.5. On the other hand, values for mid adolescence (16–17) were 6.7.	Values for early adolescence were lower than for mid adolescence: 6.5 versus 6.7 (Table 2).
3	Figure 1 shows that levels of intolerance are 9, 15 and 20 during early, mid and late adolescence, respectively.	Levels of intolerance are highest during late adolescence (Figure 1).

Lack of conciseness is a frequent problem when describing data in figures and tables (Sect. 5.13). Avoid phrases such *as can be seen* (OV1) and *we can see* (OV2). Simply put the figure or table reference in brackets at the end of the sentence. OV2 also repeats information that should already be contained in the table, i.e. the respective age ranges for the three stages of adolescence.

To learn how to make concise references to figures and tables see Sect. 5.13.

RV2 combines the two sentences from OV2. Rather than just repeating the data in the table (as in OV2), RV2 interprets the data by comparing the results.

RV3 highlights that you do not need to reiterate each value from a figure or table. You just need to point out the key result or trend that the figure or table conveys.

Another typical mistake is to repeat word for word the caption / legend to your figures and tables within the main text. Legends should be as short as possible and be sufficiently detailed to enable your readers to understand the figure or table without having to read your text. It is vital that you pay attention to legends as some readers may only look at your figures and tables, without even reading the paper itself!

16.10 What is the difference between reporting and interpreting?

If you have a separate Results section, then the experts recommend that you should not make any interpretations of your data. Deciding what constitutes reporting and what constitutes interpreting is not straightforward. RV2 and RV3 in Sect. 16.9

interpret the data only in the sense that they highlight the importance of the data for the readers but without adding any subjective comments.

This is not the case in S2 below, which along with S1 is taken from the biology website at Bates College in Maine, USA (see link on page 312 (15.3)).

S1. The duration of exposure to running water had a pronounced effect on cumulative seed germination percentages (Fig. 2). Seeds exposed to the 2-day treatment had the highest cumulative germination (84%), 1.25 times that of the 12-h or 5-day groups and four times that of controls.

S2. The results of the germination experiment (Fig. 2) suggest that the optimal time for running-water treatment is 2 days. This group showed the highest cumulative germination (84%), with longer (5 d) or shorter (12 h) exposures producing smaller gains in germination when compared to the control group.

In S1 the authors highlight the trend / difference that they want the reader to focus on, no subjective interpretation is given. On the other hand, in S2 the reference to optimality is a conceptual model to which the observed result is then tied.

This differentiation between objective reporting and subjective interpretation is not an easy skill to acquire. If you are worried that your Results section may contain elements of subjectivity that are not appropriate (in terms of your field of study, or the requirements of your journal), then you should consider showing it to someone with considerable experience in writing who can certainly be someone of the same nationality as this is not essentially a language issue.

However, if your Results and Discussion are combined into one section, then S2 would be perfectly acceptable.

16.11 How can I make it clear that I am talking about my findings and not the findings of others?

None of the RVs in Sect. 16.9 make reference to the author, e.g. RV3 says *levels of intolerance are highest* rather than *we found that levels of intolerance are highest*. This means that there is a possibility that readers will not be clear about whether these are your findings or another author's. In RV1 and RV2, this is not a problem because it is a convention to use the PAST SIMPLE (*were*) to talk about your findings. In RV3, the PRESENT SIMPLE (*are*) might seem to indicate that this is established scientific fact, but the reference to Figure 1 indicates that this is your finding and not someone else's.

In any case, you need to make 100% sure that readers will understand whose findings you are talking about. For more on this topic see Chap. 7.

16.12 Summary: How can I assess the quality of my Results section?

To make a self-assessment of your Results section, you can ask yourself the following questions.

- Have I expressed myself as clearly as possible, so that the contribution that my results give stands out for the referees and readers?
- Have I limited myself to only reporting the key result or trends that each figure and table conveys, rather than reiterating each value?
- Have I avoided drawing conclusions? (this is only true when the Results is an independent section)
- Have I chosen the best format to present my data (e.g. figure or table)? Have I ensured that this is no redundancy between the various figures and tables?
- Have I ensured that my tables of results are comprehensive in the sense that they do not exclusively include points that prove my point?
- Have I mentioned only what my readers specifically need to know and what I will subsequently refer to in the Discussion?
- Have I mentioned any parts of my methodology (e.g. selection and sampling procedures) that could have affected my results?
- Have I used tenses correctly? PAST SIMPLE for your findings (in the passive form), PRESENT SIMPLE (descriptions of established scientific fact)

Chapter 17
Discussion

What key skills are needed when writing the Discussion?

People read papers in different ways. Readers in a hurry, may read the title and then just look at the figures! Many begin from the part that they find the most interesting, which is often the Discussion.

Most authors find discussing their results to be the most difficult part of the paper to write. When referees reject a paper, it is very often due to a poorly written Discussion. As one of my PhD students commented:

> It is a 'grey zone' where I have to express my point of view without a specific or logical 'grid'. Writing the introduction is easier because you can be really helped by the articles that you have read.

Although there is no *grid* (i.e. template) in which to insert your own text, there is a general pattern or structure to most Discussions. This chapter is designed to teach you various strategies to simplify the process of discussing your results. You will learn how to structure the Discussion and how to ensure that what you write will satisfy the typical requirements of the referees.

The secret is to sound both convincing and credible at the same time. You can do this by being positive about your own limitations, and constructive when discussing what you believe to be the limitations of others.

Another skill is to interpret your results without repeating them.

A. Wallwork, *English for Writing Research Papers*,
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Typical complaints of Referees

The Discussion fails to relate the findings and observations to other relevant studies, and there appears to be no discussion on the implications and limitations of these findings.

The main result of this study was that P = Q. However no exhaustive explanations are given. The authors simply limit the discussion on P by reporting previous findings that are already documented in several papers. I find this kind of discussion too speculative and limited.

The author claims improved efficiency and easy management. However, he did not include any experimental results showing how fast the new system would work (in terms of performance) compared to the traditional method. If the author does not chose to include the actual implementation, this defect can be pointed out in the limitation/future work section as a subsection in the Discussion section.

17.1 How should I structure the Discussion?

The Discussion should answer the following questions, and possibly in the following order. You can thus use the answers to structure your Discussion. This gives you a relatively easy template to follow.

1. Do my data support what I set out to demonstrate at the beginning of the paper?
2. How do my findings compare with what others have found? How consistent are they?
3. What is my personal interpretation of my findings?
4. What other possible interpretations are there?
5. What are the limitations of my study? What other factors could have influenced my findings? Have I reported everything that could make my findings invalid?
6. Do any of the interpretations reveal a possible flaw (i.e. defect, error) in my experiment?
7. Do my interpretations contribute some new understanding of the problem that I have investigated? In which case do they suggest a shortcoming in, or an advance on, the work of others?
8. What external validity do my findings have? How could my findings be generalized to other areas?
9. What possible implications or applications do my findings have? What support can I give for such implications?
10. What further research would be needed to explain the issues raised by my findings? Will I do this research myself or do I want to throw it open to the community?

Whatever your discipline you will need to answer all the questions above, with the possible exception of question 8 (your findings may only be very preliminary). Whether you answer questions 8–10 will depend on whether you have a separate Conclusions section, if so, the Conclusions may be a more appropriate place.

It may make sense for you to organize your Discussion following the same sequence as your presented your findings in the Results section. In this case, you discuss each survey, study or experiment, and interpret it within the overall scenario of the problem.

If you are a medical researcher, you will need to follow closely the appropriate guidelines (e.g. CONSORT, PRISMA, MOOSE, STROKE). Even if you are not a medical researcher these guidelines are still incredibly useful and you can find links to them at bmj.com. The Results and Discussion section of a medical paper typically has the following subsections:

1. Statement of principal findings
2. Strengths and weaknesses of the study
3. Strengths and weaknesses in relation to other studies: important differences in results
4. Meaning of the study: possible explanations and implications for clinicians and policymakers
5. Unanswered questions and future research

The above subsections equally apply to most other disciplines (if you replace *clinicians* with ‘others in my field’). In any case, check out your chosen journal’s website to see if they have similar recommendations on how to structure the Discussion.

17.2 How should I begin the Discussion?

Below are four possible beginnings for the same paper (see Sect. 13.4 for the paper in question).

(1) Remind readers of your goals, preferably in a single sentence:

> One of the main goals of this experiment was to attempt to find a way to predict who shows more task persistence.

(2) Refer back to the questions (hypotheses, predictions etc.) that you posed in your Introduction:

> These results both negate and support some of the hypotheses. It was predicted that greater perfectionism scores would result in greater task persistence, but this turned out not to be the case.

(3) Refer back papers you cited in your Review of the Literature:

> Previous studies conflict with the data presented in the Results: it was more common for any type of feedback to impact participants than no feedback (Shanab et al., 1981; Elawar & Corno, 1985).

(4) Briefly restate the most important points from your Results:

> While not all of the results were significant, the overall direction of results showed trends that could be helpful to learning about who is more likely to persist and what could influence persistence.

You could begin with any of 1–4 above, or perhaps use them all in combination. Next, you give readers a very brief statement of what you can conclude from your findings. You can then use this statement as a starting point for interpreting your findings and comparing them to what is already known in the literature.

Some experts recommend that you tell a story to help you build up your theory, where your variables, data or findings are like characters in a book. Your job as the author is to explain how these 'characters' relate to each other, and how each one has (or has not) its logical place.

17.3 Why should I compare my work with that of others?

Dr Greg Anderson and Dr. Donald Dearborn of Bates College (Maine, USA) give the following advice to their students:

> You may find crucial information in someone else's study that helps you interpret your own data, or perhaps you will be able to reinterpret others' findings in light of yours. In either case you should discuss reasons for similarities and differences between yours and others' findings. Consider how the results of other studies may be combined with yours to derive a new or perhaps better-substantiated understanding of the problem.

A good structure for doing this is:

1. Make a general statement regarding your findings
2. Mention another author's work that relates directly to your findings
3. Make a link between her/his work and your work
4. Clearly state how your work differs from her/his work
5. State the conclusions that can be drawn from your results in light of these considerations

17.4 How should I compare my work with that of others?

The following text is an example of how to compare your work with others in the Discussion. It comes from a paper entitled *Exploring Stock Managers' Perceptions of the Human Animal Relationship on Dairy Farms and an Association with Milk Production* by Catherine Bertenshaw and Peter Rowlinson. See page 313 for a link for downloading the full text. The authors did a postal survey of 516 UK dairy (i.e. milk) stockmanagers (i.e. farmers) about how they believed humans could affect the productivity, behavior and welfare of cows and heifers (young female calves that have not given birth). Nearly half said they called their cows by name – such cows had a 258 liter higher milk yield than those who that were not called by their name. About 10% said that a fear of humans resulted in a poor milking temperament.

Below is the beginning of the Discussion section:

(1) Our data suggests that UK dairy farmers largely regard their cows as intelligent beings, capable of experiencing a range of emotions. Placing importance on knowing the individual animal and calling them by name was associated with higher milk yields.

(2) Fraser and Broom [1997] define the predominant relationship between farm animals and their stock managers as fear.

(3) Seventy-two percent of our commercial respondents thought that cows were not fearful of humans, although their reports of response to an approaching human suggest some level of fear, particularly for the heifers. With both cows and heifers this would appear to be greater in response to an unfamiliar human. Respondents also acknowledged that negative experiences of humans can result in poor behavior in the parlor.

(4) Hemsworth et al. [1995] found that 30–50% of the variation in farm milk yield could be explained by the cow's fear of the stockperson, therefore recognizing that fear is important for animal welfare, safety, and production.

In (1), Catherine begins with an overall summary of her key finding and its implications. In (2) she mentions a previous study (by Fraser) in the same topic area and thus connects her findings with the literature.

Fraser's study gave contrasting results to what Catherine reveals in (3). However, in (3) Catherine also tries to account for some of what Fraser's found (*although … heifers*) and in (4) finds further confirmation of Fraser's findings in another study.

Catherine thus adopts a diplomatic approach in which she questions the findings of other authors in a constructive way. She uses their results either to corroborate her own results, or to put her results and their results in a new light.

Another useful skill that Catherine uses throughout her Discussion, is that she constantly clarifies for the reader between whether she is talking about her findings or those of other authors (Sects. 7.3, 7.4, and 7.7), or whether she is just talking in general,

(5) The elaborated responses reported in *our postal survey* contribute some examples of the capacities of cattle, and this contextual human insight may be useful for developing hypotheses for further study.

(6) Most respondents (78%) thought that cows were intelligent. (7) However, a *study by Davis and Cheek* (1998) found cattle were rated fairly low in intelligence. *They* suggested that the ratings reflected the respondents' familiarity with the animals. (8) The stock managers in *our survey* were very familiar with their cattle and had a great understanding of the species' capabilities, through working with them daily. (9) *Stockpersons' opinions offer* valuable insight into this subject, which could enable more accurate intelligence tests to be devised; for example, to test whether cows can count in order to stand at the feed hopper that delivers the most feed.

(10) Hemsworth and Gonyou (1997) doubt the reliability of an inexperienced stockperson's attitudes towards farm animals. *Our* survey found an experienced workforce (89.5% > 15 years).

In (5) Catherine concludes a paragraph by suggesting a future course of action. (6) is the first line of the next paragraph, so it is clear that the *respondents* are her respondents and not another author's.

In (7) she uses *however* to indicate that she is going to give some contrasting information. Her use of *they* clearly refers back to Davis and Cheek.

In (8) Catherine then clarifies for the reader that she is now focusing on her study. She does this again using *our*. If she had not inserted the phrase "in our survey", the reader would not know which stock managers she was talking about. Not making this distinction is an incredibly common error in Discussions and leads to total confusion for the referee and readers. In the literature *our* is often used, even if the style of the rest of the paper is impersonal (i.e. the passive is used, rather than *we*). Using *our* can be crucial in differentiating your work from others.

In (9), like she does in (5), Catherine makes a mini summary of what she has said in the rest of the paragraph. Her use of the SIMPLE PRESENT (*offer*) shows that she is talking about all stockpersons – not just those in her study or in Davis and Cheek's study. She also recommends a course for future action.

In (10) Catherine begins a new paragraph to indicate that she is now going to cover another subtopic. Good use of paragraphs is essential in signaling to readers that you are moving on to discuss something difference (Sect. 8.2). Catherine begins with a reference to the literature to establish to the new subtopic, and then

immediately moves on to her findings to make a contrast between inexperienced and experienced workers.

The rest of her Discussion is structured in a similar manner, in which she provides more conclusive evidence that calling a cow by its name, rather than problems connected with fear, is more likely to affect milk production. In each case, she makes it 100% clear to her readers why she has mentioned another person's work and how it relates to her work.

17.5 How should I end the Discussion if I do have a Conclusions section?

Discussion sections which also have a Conclusions may end as follows:

(a) Tell your readers if and how your findings could be extended to other areas. But you must provide evidence of this. If you repeated your experiment in a different context, would you get the same result?

We only a limited number of samples. A greater number of samples could lead to a higher generalization of our results …

Although this is a small study, the results can be generalized to ...

Our results may hold true for other countries in Asia.

(b) Suggest ways that your hypothesis (model, device etc.) could be improved on.

We have not been able to explain whether x = y. A larger sample would be able to make more accurate predictions.

A greater understanding of our findings could lead to a theoretical improvement in ...

(c) Say if and / or why you ignored some specific areas.

Our research only focuses on x, whereas it might be important to include y as well. In fact, the inclusion of y would enable us to …

We did not pay much attention to ... The reason for this was ...

(d) Admit what you have not been able to do and as a consequence cannot provide conclusions on.

Unfortunately, our database cannot tell the exact scale of Chinese overseas R&D investment. Consequently we cannot conclude that …

(e) Reiterate your reasons for choosing your topic of investigation in order to convince your readers of the validity of what you have said in the Discussion.

As mentioned in the Introduction, so far no one appears to have applied current knowledge of neural networks to the field of mass marketing fraud. The importance of our results using such networks thus lies both in their generality and their relative ease of application to new areas, such as counterfeit products.

The above endings (a–e) are not hugely different from the endings outlined in Sect. 17.4, and may simply be used in addition to, or as an alternative to, those endings.

17.6 How should I end the Discussion if I do not have a Conclusions section?

Whether or not you have a Conclusions section, your Discussion should end with a summary of the main points you want your readers to remember.

Catherine Bertenshaw concludes her Discussion (Sect. 17.4) in the classic way by stating:

(1) what her findings imply

> The attitudinal information from our survey shows that farmers hold cows in very high regard.

(2) what her recommendations are

> These results create a positive profile of the caring and respectful attitudes of UK farmers to their stock, and this image should be promoted to the public further recommendation.

(3) how her research could be continued

> A 56% response rate suggests the respondents are a good representation of UK stock managers. Further on-farm interviews, observations, and animal-centered tests are needed to confirm the inferences made from the data collected in this postal survey.

Many Discussions end in the same way as Catherine's, particularly those that have no Conclusions section. Catherine's paper does in fact have a Conclusions section, but it is only 70 words long and provides an overall summary of her data, and what she thought the implications of her findings might be.

17.7 Active or passive? What kind of writing style should I use?

Before you begin writing, look at your chosen journal to see whether authors use an active/personal or passive/impersonal style (Sect. 7.1). Also, check with the journal's style guide.

In the Discussion you will constantly be comparing your work with other author's. In your head you know what you did, and you know what other authors have done. But the reader doesn't. You need to make a very clear distinction, so that in every sentence the reader is 100% clear about whose work you are referring to (Sects. 7.3, 7.4, 7.7, and 7.8).

Passive sentences do not reveal the author of the action and so the reader will not understand if you are referring to your findings or another person. So, to avoid ambiguity, where possible use active sentences.

The table below shows five examples. The first two make it 100% clear to the reader whose work is being talked about. The other three are in order of decreasing clarity. In the final example the reader has no idea whose work is being discussed - this is a very typical mistake in papers and is a very dangerous way of referring to the literature.

EXAMPLE	COMMENTS
In 2010, *we confirmed* that complex sentences reduce readability [25].	*We* clearly indicates that you are referring to your own work.
In 2011, *Carter suggested* that complex sentences could also lead to high levels of stress for the reader [36].	*Carter*, who is another author, is the subject of the verb. Thus it is clear to the reader that this is not your work.
In 2011, *it was suggested* that complex sentences could also lead to high levels of stress for the reader [Carter, 36].	The passive form means that the reader is not sure until the end of the sentence if it was you or another author. A long literature review or Discussion full of sentences like this is very heavy and annoying for the reader.
In 2011, *it was suggested* that complex sentences could also lead to high levels of stress for the reader [25].	Readers cannot know who made the suggestion unless they go to Ref. 25 and see if it was you or someone else.
In 2011, *it was suggested* that complex sentences could also lead to high levels of stress for the reader.	There is no reference. Readers cannot be sure if you made the suggestion or someone else.

17.8 How can I give my interpretation of my data while taking into account other possible interpretations that I do not agree with?

In a paper that won him an Ignobel Prize, Magnus Enquist made a case for the fact that chickens are able to discriminate between good looking and ugly human beings. Here is an extract of the Discussion section of his paper, *Chickens prefer beautiful humans*.

> (1) We cannot of course be sure that chickens and humans processed the face images in exactly the same way. (2) This leaves open the possibility that, while chickens use some general mechanism, humans possess instead a specially evolved mechanism for processing faces. (3) We cannot reject this hypothesis based on our data. (4) However, there are at least two reasons why we do not endorse this argument. First, it is not needed to account for the data. We believe that the existence of a task-specific adaptation can be supported only with proofs for it, rather than with absence of proofs against. Second, the evolutionary logic of the argument is weak. (5) From observed chicken behaviour and knowledge of general behaviour mechanisms we must in fact conclude that humans would behave the same way with or without the hypothesised adaptation. There would thus be no selection pressure for developing one.

His strategy for anticipating possible objections to his argument is to:

- admit that he might be wrong - sentence (1)
- put forward an alternative interpretation (2)
- reiterate that his data could be used to confirm this alternative interpretation (3)
- give reasons for not agreeing with this alternative interpretation (4)
- propose his own conclusion (5)

See Sects. 8.10, 9.11 and 9.12 to learn the skills reported above.

17.9 How can I bring a little excitement to my Discussion?

Like a verbal discussion, you can make your Discussion quite animated - you can allow yourself to use stronger language and make stronger assertions than you might do in other parts of the paper. You are basically trying to 'sell' your data, but at the same time considering both sides of the issue.

A colleague of mine who is frequently asked to referee papers in his field recommends:

> Be upfront about your findings and achievements. In my work as a referee I often have difficulty in understanding how significant the authors feel their work is, and why their findings add value. This is because authors are not explicit enough – they don't signal to me (and the reader) that they are about to say, or are now saying, something important. The result is that their achievement may be hidden in the middle of a nondescript sentence in a nondescript paragraph … and no one will notice it.

By *upfront*, he means do not be too modest about your findings, and by *nondescript* he means phrases that do not stand out from the rest of the text. If you really want your contribution to be seen and appreciated, then you cannot use the normal flat phrases (Sect. 8.9) that you might use, for example, when describing your materials or methods.

One way to add some passion to your writing, is the very occasional (Sects. 9.2 and 9.4) use of emotive adjectives (Sect. 8.7) and nouns. The adjectives can be qualitative (e.g. *convincing, exciting, indisputable, undeniable*) or quantitative (*huge, massive*). Typical powerful nouns that suggest a major step forward are: *breakthrough, advance, leap*. These adjectives and nouns can also be used in combination (e.g. *a substantial insight, a massive advance*).

Here are some real examples:

S1. These observations provide *compelling evidence* that a *massive* black hole exists at the centre of NGC4258.

S2. It can be stated that these experiments have provided *undeniable evidence* of an autonomic link-up of the limbic area.

S3. The latter finding is *particularly important* in the sense that it cannot readily be explained socioculturally, thus presenting a *new and convincing argument* for brain-based etiology of this disorder.

S4. Major changes in the business processes and the organizational models are, *of course*, *indisputable reasons* for *drastic* decisions regarding the information systems used by the organization.

S5. *To date no work has been published* on the role of circulating miRNAs in breast cancer—an area where, if feasible, their use as *novel* minimally invasive biomarkers would be an *incredible breakthrough* in our management of this disease.

S6. The possibility of contributing to change the way we communicate with machines is a *very exciting proposition*.

My comments below imagine that the authors are describing their own findings or are discussing their own reasoning. However, this does not necessarily reflect how these sentences were in fact used by the authors.

The claim made in S1 is very strong and will certainly attract attention. It could be made softer (weaker) by preceding it with a preliminary statement, as in S2 (*It can be stated that*).

In S3 the authors back up their claim regarding the finding being *particularly important*, by illustrating its importance. There is no point in saying that something is important, without telling your readers why it is important.

S4 adds emphasis to the adjective *indisputable*, by preceding it with *of course*. This makes the claim appear as if it has already been accepted by the community. The adjective *drastic* adds extra power to the sentence.

S5 would work well as a final sentence in the Discussion, or in the Conclusions. Basically, it serves to show how the authors' work in one field could be extended to another field where, to date, it has never been used before.

S6 would be a great final sentence to a paper. It leaves readers feeling upbeat, i.e. optimistic and encouraged. It also leaves referees with a positive final impression of your paper, which may even affect their willingness or not to recommend the acceptance of your paper.

It is best to use this kind of emotive language wisely, and very infrequently (otherwise it loses its effect). Also, such language may not be considered appropriate in your discipline or in your chosen journal – so check with other papers in your journal.

To learn more on highlighting your contribution, and softening strong claims, see Chaps. 8 and 9, respectively.

17.10 How can I use *seems* and *appears* to admit that I have not investigated all possible cases?

It is crucial to be totally honest and non-misleading as to the status of results.

Let's take the example of a mathematical proof. There may be some cases that you have not checked, i.e. you are making an intuitive claim or guess based on what you have checked so far.

In such cases you can use *it appear*s to be or *it seems*. Such phrases say exactly the truth, i.e. that something is true for the cases you have checked. You are telling the reader that you intuitively suspect or expect that it could be always true, but you don't claim it. That is what 'appears' means. You make no assertion as to the probability because you have not computed or assessed a probability.

> *It appears that* stochastic processes for which x = y can produce finite dimension values.
>
> This completes the proof of Theorem 1. Note how this enables us to determine all the Xs and Ys at the same time. Thus *it seems that* some natural hypotheses can be formulated as ..

However, you must make it 100% clear to the reader that, for example, you have not checked all cases, that your sample size was small, and that some external factors may have influenced you results.

17.11 How can I show the pitfalls of other works in the literature?

There are three areas to call into question regarding the work of other authors.

- Hypotheses that have never really been tested. You want to test them.
- Other studies have only been conducted very generally or in one specific field. You want to apply this research to a new area.
- Other studies have limitations. You are trying to overcome these limitations.

The important thing when criticizing other's work is not to undermine their credibility (Sects. 9.11 and 9.12). The idea is that if you treat others with respect, they will treat you with respect.

17.12 How should I discuss the limitations of my research?

It is essential that you inform readers of any limitations to your research or any failures or contradicting data (Sects. 9.9 and 9.10). There is no need to consider these aspects of your research to be totally negative. Your readers will appreciate

learning about what went wrong, as this may help them with their own research.

However, when you discuss any limitations and failures, try to do so in a positive way – not like in S1 below:

S1. *The limitation of this paper is that the two surveys were not conducted in the same period. This will affect our results in terms of ...

S1 is extremely honest, but could be expressed in a way that sounds less negative, as in S2:

S2. Although the two surveys were not conducted in the same period, this will only affect our results in terms of …

The negative impact of S1 is reduced in S2 by:

- removing the word *limitation* - this is not a bad word to use, but if you use it more than once or twice, the reader may go away thinking that your work has more negative aspects than positive ones. If you have to refer to several limitations, another solution to reduce the possible negative effect on the reader is to use synonyms: *shortfall, shortcoming, pitfall, drawback, disadvantage* etc.
- introducing *although* and *only* – these adverbs qualify what you are saying. In this particular case, *although* immediately tells your reader that you are going to say something negative, but that something positive will immediately follow. *Only* implies a limited number of cases, thus it lessens the level of seriousness of the shortcoming
- combining two sentences into one sentence - this gives the reader less time to ponder on the negative content

When you outline the limitations, you also need to be clear what these limitations are and what exactly the implications are. S3 and S4 fail to do this.

S3. *One limitation of our research was the sample size, which was too small.

S4. *The unfortunate contamination of a few of our samples may mean that some of our conclusions are somewhat misleading.

S3 and S4 are not very helpful and are not likely to please your referees. S3 does not explain why and in what way the sample size was too small, nor what the consequences of this were. S4 does not explain why or how the samples were contaminated, nor to what extent the conclusions are misleading.

S5 and S6 provide much more information, and do so in a more positive way that does not undermine your research too dramatically:

S5. One limitation of our research was the sample size. Clearly 200 Xs are not enough to make generalizations about Y. However, from the results of those limited number of Xs, a clear pattern emerged which …

S6. Two of our samples were contaminated. This occurred because … We thus plan to repeat our experiments in future work. However, our analysis of the uncontaminated samples (24 in total) supported our initial hypothesis that …

The important thing is to be (i) honest, (ii) clear, and, if appropriate, (iii) discuss possible remedies.

17.13 What other ways are there to lessen the negative impact of the limitations of my study?

Another way to lessen the impact of the limitations of your findings is to say that other authors have experienced similar problems, as illustrated in the extract below:

> Analytic expressions for the density (1) were not derived, (2) because their interaction depends on the relative orientation of the spheres, (3) thus making integration considerably more complex. (4) Similar complications in the analytical determination of the density, using the same approach that we used, were experienced by Burgess [2011].

The strategy used in the above extract is:

(1) explain the pitfall (i.e. the limitation in your work)

(2) give reason for the pitfall

(3) outline consequence of the pitfall

(4) refer to a similar pitfall experienced by another author

You can also attribute your limitations to the fact that current knowledge (theories, models, technologies etc.) is unable to resolve the problems you have encountered.

> (1) A full treatment of our problem using Gabbertas's theory (GT) is complicated to handle in our case, (2) *given* the complex geometry. (3) *In fact*, the expressions derived by GT are only available for a few simple geometries [Refs]. (4) *Moreover*, GT is not well suited to describing the upper regions. (5) *An additional problem* is that a theoretical description of X is still the target of active experimental and theoretical research. (6) There is little experimental or theoretical information available for the properties of X [Refs]. (7) *At the same time*, the properties of Y can be described by Burgess's model, (8) *however* its ability to well describe X is still under investigation.

The strategy adopted in the above case is:

(1) say that current theories (models etc.) cannot deal with your problem

(2) give an explanation for (1)

(3 + 4) give support for (1)

Note how (5–8) follow the same pattern as (1–4). The author uses link words (highlighted in italics) to give emphasis and logic to her argumentation and she provides variety by using different link words. Note however that excessive use of link words can be very tedious for readers (Sect. 5.6).

Finally, when discussing your limitations, be consistent. Say either *this worked in 75% of cases* (affirmative approach) or *this did not work in 25%* (negative approach), then stick with just one of the two approaches. Otherwise you are in danger of confusing the reader.

17.14 Summary: How can I assess the quality of my Discussion?

When you have finished writing your Discussion, it is a good idea to make sure you can honestly answer 'yes' to all the questions below. This will enable your peers to make a critical assessment with regard to the strengths and weaknesses of (a) how you carried out your research (b) and how you analyzed your findings. The result will be that you will be seen as a credible researcher.

- Is my contribution to the knowledge gap clear? Have I underlined the significance of my findings?
- Have I explained what I believe to be new and important very clearly but without exaggerating? Have I ensured that I have not over-interpreted my results (i.e. attributed interpretations to them that cannot actually be supported)?
- Have I truly interpreted my results, rather than just reiterating them? Have I shown the relationship (confirmation or rejection) between my results and my original hypothesis? Have I generated new theory rather than simply giving descriptions?
- Is there a good balance, rather than being a one-sided version? Have I really offered alternative explanations?
- Have I clearly distinguished fact from speculation? Will the reader easily be able to understand when I am merely suggesting a possible interpretation rather than providing conclusive evidence for something?
- Have I ensured that there is no bias in my research? (i.e. I have not hidden any of my data or any unexpected results, simply because they do not confirm what I was hoping to find)
- Have I included those works in the literature that do not corroborate my findings? Likewise, have I avoided distorting the magnitude or direction of the data of the literature that I have selected? (i.e. I have made sure that I have not committed publication bias)
- Have I discussed my findings in the context of what I said in the Introduction? Have I exploited my Review of the Literature?
- Have I integrated my results with previous research (including my own) in order to explain what I observed or found?
- Have my criticisms of the literature been justified and constructive?
- Have I ensured that I have not introduced any new findings (i.e. findings not mentioned in the Results)?
- Are all the statements I have made in the text supported by the data contained in my figures and tables?
- Have I removed any trivial information? Have I been as concise as possible?

In addition, remember to make a clear distinction between your work and others but appropriate use of

- *we/our, they/their*
- references in parentheses to the literature
- minimal use of passive form

You can massively improve the structure and the language you use in your Discussion by analyzing how other authors in your field write their Discussion sections. If possible, try to adopt the same approach to analyzing texts as I have used in this chapter.