

Putting results in context

- Discussions have two audiences: people new to the field and experts
- Help those new to the field understand the results
 - State the conclusion
 - At the beginning of the discussion
 - In a single, direct sentence
 - Speculate on how they advance the field
 - One step beyond results
 - Don't suggest experiments you don't want to do
 - Compare them to related findings
- Answer experts' criticisms—include any that apply
 - Address inconsistencies within the paper and with others' results
 - Explain why limitations of methods don't disqualify conclusions
 - Defend your interpretation/ explain why others aren't as likely
- Indicate how you organized your material

Previous lessons have focused on issues of organization, emphasis and focus, and coherence specific to writing certain sections of papers and proposals. This lesson differs somewhat, as it covers mostly what content to include, but nonetheless matches the theme of the course—helping the reader. Key to understanding the results in a paper is knowing their context, and many discussions include little material that explains how they relate to other findings or to larger problems or questions, which leaves non-experts lost. This omission also makes the task of expert readers challenging, as it leaves unclear whether the authors know the context well enough to recognize the inconsistencies and limitations that the experts do.

State the conclusion

The first step to increasing the helpfulness of a discussion to non-experts is to consider what you look for when reading papers outside your field, or what you used to look for when you were new to it. Most people seem to try to find the overall conclusion, evidence for why the results matter, and an explanation of how they compare with related work. The overall conclusion is the most important statement in the whole paper—this is the one message the reader will likely remember. As mentioned in the “Explaining rationale” lesson, this conclusion should be the most exciting, interesting thing you can say with **certainty** based on your results, and that you couldn't have said before you got your results. Since this statement is so important, it should be emphasized as much as possible; placing it at the beginning of the section (and possibly again at the end, especially if it's a long discussion) will help readers identify it. Beginning your discussion with the conclusion tells readers that that's what the section is about, so they'll try to remember it as context for the rest of the section. Further, even if they don't read the whole section, they will likely read the first one or two sentences, so they will still get the point of your paper.

→ *State the conclusion at the very beginning of the discussion*

To further emphasize your conclusion, state it in a memorable way; if you don't, your reader may not get a clear idea of what the paper is about. This means you should make the statement as simple as possible: direct and brief—it's easier to remember something like "Light exacerbates migraine headache by activation of ipRGCs that project onto dura-sensitive neurons in the posterior thalamus" than "Our findings reveal a mechanism for the exacerbation of migraine headache by light, whereby the neuronal activity of a nociceptive pathway that underlies migraine pain is modulated at the level of the thalamus by retinal photoactivation. We propose that this photomodulation is exerted by axonal projections of RGCs that converge on dura-sensitive neurons in a discrete area in the posterior thalamus. To a large extent, the retinal projections to the posterior region of the thalamus consisted of axons of ipRGCs" (From Nosedá R et al., *Nat Neurosci* Jan 2010). See lesson 15 ("Conveying action") for a method to make your sentences more direct.

→ *Summarize your findings in a single sentence*

Other content for novices

The remaining pieces of content that help non-experts are rather more flexible than the overall conclusion; they may include different types of evidence and arguments depending on your results and your field. The explanation of why your results matter might involve how they affect understanding or treatment of a disease, or if your results are more distantly related to clinical problems, how they advance the field—what the results might mean about how similar proteins or cells work, or whether integrating them with previous findings leads to a model for a biological process. Both of these explanations require speculation, which you should do with caution, as going too far beyond your results will seem unjustified to reviewers, and may lead them to question how well your results support your conclusions. A good rule to limit your speculation is to make sure that it's only one logical step from your conclusions. Another reason speculation requires caution is that it may suggest to reviewers that completing the paper's story requires testing the ideas you propose; limit speculation to those ideas you're already testing or those that obviously require more than six months' work or resources you lack.

→ *Limit your speculation: one step, no experiments you don't want to do*

Nearly or equally as important to making sense of the results is where they fit into the field as it stands now: are they on the leading edge of innovation, are they squarely within the current dogma, or are they on one side or another of a controversy? You don't have to contextualize each and every result, as there's probably not enough space, but including this information and interpretation for those that are essential to your conclusions would most help the reader evaluate how the whole paper compares to the field. As with speculation, there are consequences to consider in this type of discussion. Claims of novelty must be indirect to protect against the possibility that the result exists in literature you haven't read, and controversy must be handled carefully to avoid angering a reviewer whose work falls on the other side. This isn't to say that you should avoid all mention of controversy, because that would imply that the results will be easily

accepted, thus giving an erroneous impression to those who aren't familiar with the field.

→ *Explain how important results relate to the field in general*

Address experts' criticisms

Those who are familiar with the field are an equally important audience (or maybe more important, since they include reviewers) to consider when planning a discussion. This is also the audience for a proposal, so some of the following areas of discussion are also relevant to the preliminary data and research plan sections of proposals. Discussion forms a small proportion of these sections (usually at the end of a subsection describing a result or explaining a proposed experiment), but is important to convey to reviewers that you understand that results can't be predicted or interpreted with absolute certainty.

The overall idea of generating content for expert readers is to imagine how someone might disagree with your interpretations and to argue against those criticisms. If another conclusion from your results is possible, explain why yours is more likely (this sort of defense would strengthen a preliminary data section). If others' observations contrast with yours, convince a reviewer why your observation is valid (or why is theirs invalid or not similar enough for the contrast to matter). If your methods limit the conclusiveness of your results, explain why you didn't use another method and why your results are still useful (this argument would strengthen a research plan section, though ideally you would use additional methods to confirm the results from the limited one).

→ *Identify possible criticisms and explain why your conclusions still stand*

Organizing a discussion

The need to address two distinct audiences poses several challenges, which make composing discussions especially challenging. First, coming up with material and deciding what is important enough to include is made difficult by the fact that you are not a member of both audiences. One way to address this is to talk to a variety of colleagues, including those who are more advanced in your field than you and those who work in other areas of biology or medicine, to identify what questions your results lead them to ask. You could also put yourself in those positions—try to remember what you knew as a non-expert and imagine what your committee members or other mentors would ask. Those questions that come up most often must be addressed in the paper.

→ *Generate content by talking to people*

The result of these conversations and imaginings is probably a list of explanations and arguments, which may not immediately suggest a logical organization, other than by the order the results appeared in the paper. However, this organization is the trickiest, as it may make it hard to avoid describing the results again at the beginning of each paragraph, which makes it hard for the reader to identify the ideas that weren't in the results section. You could also organize by topic: importance of the results, how they

compare to others' and fit in the field, limitations of methods, etc. There are likely many other organization schemes, but the key is to indicate how you decided what material belonged in which paragraph, as this helps the reader see what connects all the sentences in it. It also helps to address a final problem of the variety of material necessary to cover different readers' needs—coherence. These indications of topics can be modified to explain how they relate to the previous topic or the overall conclusions. Alternatively, you could avoid the problem altogether by breaking the discussion into subsections with headings that state the main idea of each.

→ *Avoid repeating too much of the results*

→ *Indicate how you organized to help the reader follow*

Let's consider a well-written example, again from Feinstein JS et al. *PNAS* April 2010, to see to what extent it follows these guidelines.

Example: starting with the conclusion; using results as evidence for new ideas

The results of this investigation reveal a striking dissociation between the sustained experience of emotion in the face of impaired declarative memory for that emotion's origin. Moreover, the dissociation was found for both happiness and sadness, supporting the conclusion that feelings of different valence can persist independent of explicit memory for the inducing event. It is important to emphasize that it would be difficult (if not impossible) to obtain a dissociation of this magnitude without the benefit of studying patients who have severe amnesia. For healthy individuals with normal memory, such a dissociation might even seem implausible, especially when considering situations that elicit intense states of emotion (such as traumatic events, the death of a loved one, being diagnosed with cancer, going through a divorce, the birth of a child, or winning a lottery). It is quite remarkable to imagine that someone can completely forget about the triggering event and still experience an intense state of emotion. Yet, the results of this study reveal that amnesic patients with damage circumscribed to their hippocampus are capable of experiencing emotions well after their memories for the emotion-inducing events have faded away. Patient Am1 provides a salient example of this phenomenon. While watching the sad film clips, she exhibited extreme facial displays of sadness, including tearful crying that lasted for several minutes. Shortly after the induction was over, Am1 was unable to recall even a single detail about the preceding film clips and her recognition performance was at chance level. Yet, her sadness lingered for over 30 minutes, lasting much longer than any other participant, including normal comparison participants with fully intact memory for the film clips. Thus, patient Am1 demonstrates a complete dissociation between emotion and memory and, even beyond that, a sustained feeling of sadness that persisted at an abnormally high level.

An intriguing question that arises from this work concerns the specific signal(s) that amnesic patients are using to determine their emotional state. There are many possibilities, ranging from emotional signals arising from the body, to nonverbal emotional images resonating in the mind, all of the way to emotion-congruent thoughts. Another possibility is that patients are using whatever remaining knowledge they have regarding the film clips to guide their emotion ratings. This latter possibility

might be plausible for some patients, such as patient Am5, who had somewhat higher levels of recall and recognition (albeit still well below normal). For other patients, however, it appears much less likely that any residual memory for the film clips is influencing their emotional state. The most compelling example is patient Am1, who appeared to have essentially no memory trace for the film clips to rely on when filling out the postmemory emotion measures. Other patients had slightly more memory. For example, patient Am3 remembered seeing a movie with “Meryl Streep”. Her normal comparison, on the other hand, remembered seeing the specific scene in *Sophie's Choice* where Meryl Streep's daughter is ripped away from her by a Nazi soldier and sent to die. Despite the profound differences between the recollections of these two individuals, both reported experiencing a similar magnitude of sadness. This argues against the likelihood that declarative memory is playing a prominent role in guiding the amnesic patients' subjective assessment of how they feel. It will be important for future work to try and decipher the precise mechanism by which amnesic patients are determining their emotional state.

Several of the amnesic patients, despite their impoverished memory for the film clips, showed a slow decay of sadness, sometimes even slower than the normal comparison participants. In fact, some of the patients were still experiencing high levels of sadness and negative affect during a time when all such emotion had dissipated in the comparisons. Such a finding was most evident in patients Am1 and Am2 ([Fig. 4](#)).

After the experiment was over, Am2 provided some insightful comments upon debriefing. She claimed that in everyday life, she frequently experiences different emotions and has no idea of what caused them. Without a clear understanding of the emotion's source, Am2 reports feeling compelled to search for a cause. Interestingly, she claims to only feel this urge while experiencing negative emotions, not positive ones. In her words, “It's not so much with the happy or the good feelings. You just kind of accept them. You don't worry about why. It's more for what I would call negative feelings... like when I'm feeling really sad, then I have to find out why. [Experimenter: “And do these sorts of feelings stay even though you don't know why?”] Yeah... and they don't go away.” Thus, one potential explanation for the sluggish decay of sadness evident in some of the amnesic patients is that without a clear understanding of why they are feeling sad, the emotion persists ([32](#)). On the other hand, the amnesics' experience of happiness appears to decay at a relatively normal rate ([Figs. 5 B and C](#)). Altogether, these findings suggest that remembering the origin of an emotional state may help expedite the recovery of negative emotions while having less of an effect on the recovery of positive emotions, an asymmetry that may have some adaptive value.

The results of this study have direct implications for how society treats individuals with memory disorders (such as patients with Alzheimer's disease), as events that have long been forgotten could continue to induce suffering or well-being. For example, a simple visit or telephone call from family members might have a lingering positive influence on a patient's affective state even though the patient may quickly forget the visit or phone call. Likewise, a funny joke might boost a patient's level of happiness long after the punch line is forgotten. On the other hand, routine neglect from staff at nursing homes may leave the patient feeling sad, frustrated, and lonely (even though

the patient can't remember why). As the number of individuals suffering from Alzheimer's disease and other forms of dementia reaches epidemic proportions, it will be imperative for society to follow a scientifically-informed standard of care for patients with memory impairments. Here we provide clear evidence showing that the reasons for treating amnesic patients with respect and dignity go beyond simple human morals.

Finally, the findings in our amnesic patients could be taken to suggest that the brain is organized in such a way that the feeling of emotion can persist without any explicit memory for its cause (33–35). Such a conclusion runs counter to the popular notion that by simply erasing our painful memories we can also erase the psychological suffering; a concept vividly illustrated in the movie *Eternal Sunshine of a Spotless Mind*. As scientific advances take us ever closer to the possibility of selectively removing painful memories, we must tread cautiously. To be certain, there are a host of contentious legal and ethical issues surrounding the debate on selective memory erasure, especially with regard to treating victims of trauma (36). The results of our study further complicate the debate by highlighting the possibility that erasing negative memories may have the paradoxical effect of actually prolonging (rather than alleviating) feelings of distress. Indeed, it appears that the experience of emotion can operate largely independently from memory, even though the two processes are often perceived as being fused together within our stream of consciousness.

Analysis of example

This discussion starts with the conclusions and moves forward into what they mean, which is the point of a discussion but is still worth noting since so many discussions dwell on results or begin with a second introduction. It does describe individual observations at some length in three of the five paragraphs, but these descriptions are either in greater detail than those in the results section or are not in the results at all, and each is used as evidence to support an idea not proposed earlier in the paper.

→ Describe only results (or aspects of results) that don't appear earlier

The opening paragraph states the conclusion, which helps emphasize the overall idea, suggests how it relates to current understanding of emotion and memory, and defends the authors' interpretation. However, the statement of the overall message is not the simplest, most memorable way to say it; "our results show that the experience of both positive and negative emotion persists despite impaired declarative memory for the inducing events" is a more direct alternative. The beginning of the first paragraph continues to focus on the big picture by saying something about the conclusions—that they probably couldn't be discovered in any other way, and that they're surprising. This helps emphasize how novel and exciting they are (without saying "novel") and puts them in context; even someone outside the field can tell that this paper is an advance in the understanding of emotional memory. (The latter half of the paragraph is about a specific result and should probably be a separate paragraph.)

→ Write the first paragraph about what the conclusions mean

This discussion is somewhat unusual in the distribution of its content, and barely mentions or omits some topics that are standard in discussions. The first paragraph is the only one that even somewhat compares the results to others', which leaves the reader to wonder whether the individual results, such as those on recollection in amnesic patients or induction of emotions by film clips, agree with those of other investigators. The discussion does not address the limitations of the study, but the reason for the major limitation, a small sample size, (not that many amnesic patients exist) is so obvious that explaining it would not add anything to the paper.

→ *Failing to address potential reviewer concerns raises doubts*

The other unusual feature about the content is that so much space is devoted to speculation (two out of five paragraphs). This helps the discussion engage the reader's attention, since speculation is generally more interesting than comparing results to others' in great detail. However, some of the speculation is rather open-ended—the second paragraph eliminates only one of four possible mechanisms the authors suggest. This doesn't help the reader form an opinion about which is most likely, and seems almost inappropriate for a paper since the possibilities are given without reason for why they're being suggested. Nonetheless, this and the other speculative part are appropriately limited, taking observations as the condition for each possibility (not a possibility as the condition). The other paragraph that proposes a new idea provides an explanation for the unexpected finding that sadness persists longer than happiness, which may have aroused reviewer concern that there was some inconsistency in their method between the two conditions.

Finally, the discussion makes clear the importance of the findings by explaining their relevance to the real world—treatment of Alzheimer's patients and future possible memory erasure. The second reason, with its mention of a popular movie, may go further than necessary to establish importance since memory erasure is not currently a common occurrence.

→ *Explain relevance beyond the field*