Writing a Scientific Paper

Part 1: First Draft, Methods and Results

I know from experience that beginning to write is actually hard for most people. Especially if it's the first paper. And I don't think there is really one good method to overcome the procrastination and get you to write. The only really good advice is to **simply start writing**.

PREPARATION

Gather everything you already did

Most students will have already presented the work to a committee or in the lab meeting or in the department seminar. Or you have already presented a poster about your topic. This means that you have actually already thought through the "narrative" of your study in different ways. You should also already have some figures that you made - even if only preliminary ones to discuss your results with your adviser. These are actually the core of your paper. Have them in front of you!

Study the Author Guidelines

Before you write the whole paper, you should know which journal you are going to send it to. The guidelines will help you structure your paper right from the beginning. Some scientists find this restrictive, but I think it is very helpful. Structure and restrictions give you a clear goal of what the paper should look like to be accepted in the journal you are targeting.

Knowing the journal in advance also helps you with the framing. Should you emphasize technical excellence? The big picture? It really depends on who the journal thinks their audience is.

Also, some journals will send the manuscript back without looking at the content, if it is not in the correct format. Safe everybody (especially the unpaid(!) editors' and reviewers') time by preparing a manuscript according to the guidelines.

Pick a Similar Article in the Same Journal as Template

You probably chose a journal that publishes similar studies on a regular basis. Pick one of those and use it as a template for your own writing. Don't plagiarize, of course, but use it as an example of how other authors adopted the author guidelines.

WHERE TO START?! THE METHODS!

Sometimes you already have whole phrases, sentences and storylines for the introduction or discussion in your mind. If so, just go write that down, now!

If not, just start with the methods! You already know exactly what you have done, and you probably have been thinking about them a lot, even from the beginning of the study design process.

The method writing is also rather rigid. The method is the method, there is no interpretation necessary. You really just write down what you did.

The methods need to be detailed enough, so that readers can assess the limitations of your approach, and - if they so desire - replicate your work. Make sure to double check the author guideline!

If you did experiments involving animal or human subjects, you need to declare which laws and regulations applied and state hat your study didn't violate the standards of responsible research, regulations, or break any laws.

Then, for each experiment, you describe your subject groups. In my case it would be the species and strain, the amount of animals, and their age and sex. Check the author guidelines and ask your adviser which information you need to provide for your particular type of study.

Next would be the description of the study design, and finally, the details of the used methods. You finalize the methods by adding technical details, for example which hardware and software you used and the settings and functions you applied.

Style in the Methods

The current trend is to use active voice as much as possible. However, I think especially in the methods section there are good reasons to stick to passive voice. Mostly, it's because the actor

is always the same: you. And there are only so many ways to say "I did this", "I did that," and "then I did the other thing".

Here an example from one of my own papers:

Active voice:

> *We amplified the received signal, and filtered it with a band pass filter. We then digitized and stored it. Finally, **we** separated the activity of single neurons within a recording offline. For this **we** used the spike sorting function provided by Spike 2.*

Active voice puts an excessive emphasis on "we". This happens through the repetition, and because it necessarily shows up in emphasis granting parts of the sentences.

But who did the actions is not the focus. We already know you did it. So, using active voice moves attention away from the important information and towards redundant and irrelevant information.

Now in passive voice:

> ***The received signal** was amplified and band pass filtered before it was digitized and stored. **The activity of single neurons** within a recording was separated offline using the spike sorting function provided by Spike 2.*

I think this is more to the point and really emphasizes the important parts. And since we are talking about the first draft of your paper, I'd recommend to just go with it, for now. There is more to be said about how to manipulate emphasis in a sentence, and how to get creative with language. But that's not very important in the method section and I will talk about it in a later video.

NOW WRITE THE RESULTS SECTION

With the methods fresh in mind, you should start writing the results section. Remember why you did which experiment and find a good sequence for them to describe in the section. What is the best lead to convince your readers of your interpretations, and ultimately, your conclusions?

I have a suggestion for a sequence:

1. Proof of Concept and/or the Preliminary Results

Before you make the big claim of your paper you might want to convince the reader that the main premise of the crucial experiment is sound. This can be a replication of another finding that you are basing your own study design on. It serves as confirmation of the earlier study (especially if it was done by another group), as proof that the methods work as intended in your hands, and as control / baseline measurement before you show the effects of the particular manipulation you want to report.

2. Your Main Result

Now that you convinced your readers of the technical quality of your approach, you present them with your main point.

3. The Control Experiments

And finally you show the reader that your conclusions are sound by ruling out alternative interpretations of your main result.

Constructing a Paragraph in the Results Section

The structure of a paragraph as I recommend it looks like this:
1. **Statement of Interpretation of the figure** (this can also be a sub-header!)
2. **Motivation for the experiment**
3. **A description of the data, including descriptive statistics like means and standard deviations, and the results of statistical tests, such as p values, etc.**

And the easiest way to begin writing up the results of each experiment, is to describe the figures that you probably already have made in order to look at the data. So choose the figures that make your point most clearly. Put them in the sequence that we just talked about. And then describe each figure in one paragraph.

After you described a figure, go back to the beginning of the paragraph and write down what the purpose of this experiment was. And finally, go to the beginning of the paragraph, again, and formulate the main take-away from this paragraph.

Example:

1. Statement of Interpretation:
   IOS reveal odor-activated glomeruli at the dorsal surface of the main olfactory bulbs

2. Motivation of this experiment:
   To illustrate the signals we acquired, ...

3. Description of the figure:
   we show examples of IOS imaging data in Figure 1. Figure 1A is an average video frame. The red and blue circles indicate where we found activated glomeruli in the activation patterns elicited by two different odors. The red and blue arrows were introduced as landmarks that reappear in figure 1B. Each panel in figure 1B shows the activation pattern by one odor on the left main olfactory bulb. The glomeruli are visible as round black spots. [...]