Research Paper Guide

As you write your paper, please remember that you are the world's expert in what you did. Your task is to communicate and teach. This is research, not advertising. You are not trying to sell something -- do not try to persuade the reader and do not include a lot of fluff that merely adds pages and vague opinions. If it helps, imagine that you are writing for a 10th grader. The 10th grader should understand what you did, why you did it, and be able to judge for him- or herself whether your experiment and results match your hypotheses and interpretations. I strongly suggest that you ask someone to read your paper before you turn it in. Often times, when people write, they do not notice how much information they have actually left out. Having someone else read your paper will help in this respect.

Here are the mandatory sections of your paper. The parenthetical items provide a general guide as to why each section is included in a paper.

Title Page (a traditional formalism)
Abstract (a service to potential readers)
Introduction (situate your work)
- Why are you doing this?
- What is your research question?

General Description of Experiment
- Overview of the manipulation and the measures
- Possible outcomes and relevance to learning.

Methods (replicability)
- Subjects
- Materials
- Design and Measures
- Procedure
- Coding

Results
- Overview of results.
- Details and graphs.

Discussion (writing to teach, not to persuade)
- Review of results.
- Interpretation of results with respect to issues.
- Alternative interpretations

General Discussion
- Restatement of issue.
- How the results bear on this issue.
- What next?
  - How could the study be improved?
  - Is it worth the effort to improve the study?
- The possible implications of the current results for theory or practice.

References
Appendix of Materials
DETAILS ABOUT WRITING A RESEARCH PAPER

0) General formatting concerns.

A typed paper is necessary. Thirty pages double-spaced is too long, eight pages double-spaced is too short. Graphs and tables should be labeled and precise. Do not paste in a printout from a statistical package. Figures and tables should be referenced in the body of the text. For example, "Figure 1 shows the percentage correct...." Accordingly, Figures and Tables should have numbers so I can identify which is which. Double spacing is not necessary. Put headings for the different parts of the text (e.g., Methods, Results, Discussion, General Discussion). This makes it much easier to move back and forth through the paper.

1) Title page.

It should include the title, your name, and some way to contact the author (in case I have some specific questions).

2) Abstract.

An abstract is a service to potential readers. It allows them to decide whether your work fits within their interests. It should include an overview of what issues you addressed, how you addressed them, and your results. In other words, it should be a brief version of your general hypothesis, your specific experimental test of that hypothesis (so you might mention what materials and dependent measures you used), and whether your results suggest confirmation, rejection or revision of your hypothesis. It should be 100-200 words long. As you may find, reducing your thoughts into a small, informative paragraph is an interesting exercise. To get a better handle on Abstracts, you might look at the abstracts from a few of journal articles.

3) Introduction.

The introduction to a research paper serves two primary purposes. The first is to situate your research in a broader context. This broader context may be theoretical (e.g., falsifying a general theory), practical (e.g., addressing a common class of issues facing people), educational (e.g., developing better ways to teach), prior research (e.g., a literature review), and so forth. Situating your work within a larger context is important because it helps people understand what you are about. Many experiments seem meaningless until someone draws out the larger issues that they address. The introduction is the place to pull out the larger issues. In addition to letting people make sense of your work, a larger framing allows people to think of other ways to test your ideas. One way to think about this piece of the paper comes from an example. The other day a student said that she wanted to demonstrate that people will run a (possibly stuck) red light sooner, if they see someone else run the red light. Let's say that the student successfully conducted this study and wrote it up. Imagine some guy reads the study and decides to run his own similar study. Unfortunately, he does not have anyway to set up a study involving drivers and red lights. A good introduction would help this person think of another way to test the issue at hand. In this case, the larger question is whether people follow models of local behavior instead of more global prescriptions of correct behavior (i.e., laws). So, given this larger question, it is possible to think of alternative experiments. For example, one might see if people follow the immediate opinion of their peers even though they know, at some level, that those opinions are wrong (e.g., rating racist passages after talking with a racist friend). Your introduction should situate your work in a larger context so that people can think of other

examples of the issues at hand.

The second purpose of the introduction is to explain how your specific experiment is a fair examination of the larger issue. For example, if your hypothesis is that people tend to forget things that conflict with their opinions, an experiment testing how fast people can recognize colors would hardly fit. In the introduction, you want to make clear how your experiment bears on the larger issue at hand. The best way to do this is by operationalizing your hypothesis. Operationalizing a hypothesis means turning a more expansive view of human cognition into a falsifiable, measurable claim. For example, if your hypothesis is that people tend to forget things that conflict with their opinions, how would you operationalize the claim? Well, you might ask people to rate a number of opinions as to whether they conflict with their own. Afterwards, you would ask them to recall all the claims that they rated. If they forget the opinions that conflict with their own (as shown by their ratings), then you have support for your claim. On the other hand, if they remember all the opinions, or worse, only the opinions they disagree with, then your general claim will be falsified in this experiment. To help in the exposition of the particular operationalization, it often helps to include a piece of your experimental materials. For example, if you were measuring responses to different photographs, you might say, "Consider Figure 1 showing a picture of a well-dressed man. What sort of person do you think this is -- dangerous, kind, smart? Now imagine this man dressed in jeans and a t-shirt. I propose that people would be very influenced by this superficial change in the man's appearance. People tend to judge on the basis of very limited, and often unreliable surface features. In this case, I am examining this hypothesis in the context of clothing."

4) General Description of the Experiment

In this section you provide detail about your study. It may be somewhat redundant with the prior discussions. However, it should explain things in more detail. In particular, it should describe what your independent variables are and what your dependent measures are. Your independent variables are the ones that differ between the different conditions in your experiment. For example, if group A reads a biology text in silence, group B reads the same text with their favorite music, and group C reads the text with their least favorite music, then your independent variable might be called, Audio Accompaniment. It has three **levels** -- no music, favored music, disfavored music. It is possible to have multiple independent variables, which are also called **factors (*Note: For this class, there's no need to have more than one independent variable/factor.)**. A common example of multiple factors occurs in a crossed-factor design. For example, you might have two levels of a Text factor -- biology and physics passages. If you crossed the Audio Accompaniment with the Text factor, you would have six **conditions** within your design. A condition is simply a combination of one level of a factor and one level of another factor. In a between subjects design, a different person would be in each condition. In a within-subject design, the same person would go through all six conditions. In a mixed-design, the same person would go through some of the conditions but not all of the conditions. For example, a subject might read the physics and biology text in the no music condition, another subject might read the physics and biology text in the favored music condition, and so forth. There are lots of ways to mix things up.

Your dependent measures are what you are going to count or evaluate. In this case, you might use free recall as a dependent measure. So, you would count up number of correctly recalled ideas from the passages. You might also use a comprehension measure by asking subjects to solve some biology or physics problems discussed by the text. So, in this case, you might count up percent correct responses. It is possible to have more than one dependent

measure (e.g., both recall and comprehension). In many studies with multiple dependent measures, the dependent measures can be thought of as factors. For example, we might have a Report factor that has the levels of free recall and comprehension. You might hypothesize that disfavored music depresses recall and increases comprehension, whereas favored music increases recall and decreases comprehension.

As you describe your independent and dependent variables, make sure to explain why you use these variables in this experiment. You want to explain why they provide an appropriate test of your hypothesis. Don't just say, "I did this and that." Say, "I did this because..."

Before you move onto the Methods section, you want to indicate the space of possible outcomes. That is, you want to help the reader think about the different possible outcomes and their potential significance. So, you want to explain what results would confirm your hypothesis (e.g., favorite audio leads to better recall and comprehension). For example, "If subjects in the favorite audio condition recall and comprehend both the biology and physics passages better than the other conditions.…" You also want to spend a little time explaining what results would definitively falsify your hypothesis. For example, "If the subjects do the worst in the favorite audio condition, then...." Finally, you should consider the other reasonable possibilities and explain what they would mean. For example, you might write, "If, on the other hand, subjects in the no audio condition recall the most, then this would suggest that any form of audio interferes with reading a text, regardless of whether people like the audio or not."

5) Methods.

This section is primarily dedicated to describing your experiment in sufficient detail that a reasonably smart person could replicate your experiment precisely. Of course, they could never replicate your study exactly (e.g., they could never get the same subjects at the same point in time), but they could get pretty close. Use your common sense in what aspects of your study are replicable and should be explained. By this time, you may have already written in the previous sections much of what you should include in this section. Nonetheless, it is a convention to include a detailed description in the Methods section. This allows readers to know where to go to find the details of your study.

Participants.
Describe the number of subjects and their experimentally relevant characteristics (e.g., college students or babies, male or female). This way the reader knows what population your results should generalize to. Also describe how they were selected to participate (e.g., randomly, convenience)

Materials.
Assuming that your subjects do something, they must have some sort of materials to do something with. This could be different snippets of music, a text passage, pictures, video, a list of nonsense syllables, etc. In some studies, the materials are more important than in other studies. Often times, the materials are different for two conditions. For example, one condition may read physics passages while the other condition may read biology passages. You need to explain your materials in some detail and with some logic. However, you do not need to describe them in gory detail, just give enough that a smart person could come up with the same sorts of materials from your description. If your materials are fairly sensitive (i.e., they are very specific pictures), you might give one complete example of a material and then leave the rest for an appendix.

Design and Measures
This section describes the contrast you are setting up. For example, do you have a simple control versus experimental experiment? Are the same subjects in all conditions? Although it is not standard practice, I strongly suggest you make a table that indicates the design of your study. This will clarify your thinking and help with some of the difficulties you may find that you have due to a limited vocabulary for experimental research. Here is an example ala Lepper, Greene, & Nisbett, 1973:

	Interest in coloring with markers	
	High	Low
Reward	A	C
No reward	B	D

This is a between-subjects design: There are different subjects in each condition. A= one group of subjects, B = second group of subjects, etc. All groups take the same "test" of their interest after the experimental manipulation.

Here is an example with one within-subjects factor and one between-subjects factor:

	Male	Female
Easy Story	A	B
Difficult story	A	B

This study tests how male and female children respond affectively to a new reading curriculum. Students indicate their mood/affect after they learn easy and difficult stories using the curriculum. All students experience both easy and difficult stories, so story difficulty is a within-subjects factor. Gender is a between-subjects factor.

Do NOT call your conditions A, B, C, etc. Name them something that says what they are. For example, Easy Story or Difficult Story conditions.

A convenient word for this section is "counter-balanced." Did you counter-balance the order the subjects went through the conditions? Did you counter-balance the males and females in each condition? Etc.

In the design section you should also indicate your dependent measures. This can mean simply saying, "We recorded how long people took to finish the activity." Or it could be a description of test questions, etc. you used to measure your subjects' behaviors.

Procedure.
This should be the easiest section to write. Just say what you did. For example, "Subjects were run individually using a portable tape player with ear phones. In One-Minute condition, the subjects were told to identify the composer of the first piece of music, which lasted 1 minute. They were told that it was one of three composers. If they got the right answer they were praised

and if they got the wrong answer they were told the correct answer. They then heard the second piece with the same instructions to identify which of three composers wrote the music. This continued until they heard all nine pieces of music. In the Three-Minute condition, the procedure was the same except each subject heard the music for 3 minutes and only heard one selection from each composer. Subjects in the Three-Minute condition either heard all sonatas, all concertos, or all waltzes. After completing the training phase, the subjects in all conditions heard a new 1-minute piece of music by each of the three composers. They were told to identify which composer wrote the piece. However, unlike the training phase, they were told that the piece might not be written by any of the composers. This was done to make sure they would not be able to figure out the third composer by a process of elimination. They received no feedback during this testing phase. Afterwards, subjects were told the purpose of the experiment."

Coding

This may be the most difficult or easiest section depending on your experiment. In some experiments, you start out knowing that you will be measuring percent correct or reaction time. In this case, coding is straightforward. For other experiments, you may need to figure out how to count up how much was recalled in a free recall paradigm. This can be difficult because people remember true things, partially true things, and false things. They also tend to remember in half sentences. For yet other experiments, all your work shows up in the coding scheme. For example, you may be coding creativity and you need to come up with a fair and replicable way of coding the results. In general, your goal should be to explain how you managed to convert your data into numbers. What were your rules for coding the data? Explain what you did in sufficient detail that other people could replicate your coding. Sometimes, it helps to include examples. For example, "Subjects received half credit for a sentence like, 'The dog, uhm, bit the cat,' because they correctly remembered the dog biting something but mis-recalled what the dog bit." Or, "Figure 3 provides an example of a picture that received a zero on a creativity scale. You may notice that the subject used each of the features provided in the example and thus was not creative enough to generate his/her own."

6) Results.

The results section is simply a description of what you found. It should have minimal interpretation. Begin with a general overview of your results. For example, "The results supported the hypothesis in that subjects in the Generate condition recalled more facts than subjects in the Copy condition. These results, however, are somewhat muddy in that several subjects did not follow the ideally confirmatory pattern of results." Afterwards, you want to dive into your results in detail. Think carefully about the best way to present your results. They will most likely be fairly complicated. You want to organize your presentation so that people can make sense of this complexity. I find that making my graphs first helps focus my writing around the graphs. You must include graphs or tables -- this provides the most compelling and succinct summary of your results. The graphs/tables should not be overwhelming in complexity. While you have been steeped in your data and design, your reader will be struggling to remember the details, and throwing a graph with 18 bars on it will not help (unless the bars make some sort of pattern). In general, you should begin with the main pattern for one variable and then describe the smaller details. Then you should move to the next main pattern of results.

For your studies, because you used small sample sizes, it may be necessary to look at the results of individual subjects as well as the average performances. Be smart about this. A good results section does not blindly describe what each individual subject did. This leaves the reader

all the work of figuring out whether your hypothesis was supported or not. Highlight individual performances to make a point.

7) Discussion.

Summarize your results in succinct fashion. As you do so, explain how your predictions fared in the face of these results. In a sense, this section picks up right where section 4 (General Experimental Description) left off. Afterwards, you may begin your more detailed interpretation of what happened. This would include the finer details of what you found and what you think it means. After this, you should consider alternative possible interpretations of your results. For example, "An alternative interpretation of the results is that people remembered the words to the songs better because they already knew the song." Most likely there are multiple alternative interpretations. If you are feeling ambitious, you should explain what sort of experiment could help determine which alternative is correct.

8) General Discussion

Restate your main concern and claim and how the results bear on them. Then you should talk about how the study could be improved (always explain why your modifications or new ideas would improve the study). You should also spend some time considering whether it is worth fixing up the study or whether you were simply wrong. (Don't bother saying you need a bigger sample size – for most of your studies, this will be completely obvious to a reader.)

Finally, in the last paragraphs of the paper, you may begin to speculate on the implications of the study with respect to theory or practice. It is a funny thing, but it has become a convention. At the end of a research article you may loosen up a bit and throw around unsubstantiated claims and possibilities. Although this seems unscientific, it may provide the most food for thought for other researchers who become interested in following your line of research. So, you might be creative and describe how your results could be used to enhance education, advertising, memory, etc.

9) References.

If you cited any articles, include them here. This should be on a separate page.

10) Appendices.

This is where you stick all the details that would be of interest to the most dedicated reader. This may include screen shots of your program, your experimental materials, extra graphs of your data, or fuller examples of your method of coding data or subject productions. Each entry in an appendix should be labeled or explained. Don't just stick things in the appendix hoping that the reader can figure out what they are.