Essentials of Scientific Writing

*Clear writing is writing that is incapable of being misunderstood* – Quintilian (100 AD)

The essential feature of scientific writing is clarity. Your job is to convey information so that the reader will understand information without being bogged down in detail and unnecessary language. Science is based on data, but scientific writing is what you do with the data, the interpretations, the story you want to tell. Sometimes the story overwhelms the data and the meaning is lost on the reader.

This handout is designed to give you a brief guide to what we (the psychology department) expect from the papers or lab reports that you submit for classes in psychology. This is a shortened version of information provided in APA’s “Publication Manual” (sixth edition). This summary includes a number of important points that are presented by Zeiger in *Essentials of Writing Biomedical Research Papers*, 2nd edition (2000).

**Nuts and Bolts (aka The Rules)**

This section is about how the information of your paper should be presented rather than what is to be presented. There are rules that you need to follow that are derived from the American Psychological Association (APA). You can find more information than is presented here in APA’s Publication Manual. The book is always available in the psychology department as well as in the library.

**General Document Guidelines**

The following is a brief table with all of the relevant details on format:

<table>
<thead>
<tr>
<th><strong>Margins:</strong></th>
<th>One inch on all sides (top, bottom, left, right). Please note that the default in MS Word is 1.25 inches and needs to be changed.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Typeface and size:</strong></td>
<td>Times New Roman, 12pt font (Arial or Courier are also acceptable).</td>
</tr>
<tr>
<td><strong>Line spacing:</strong></td>
<td>Unless otherwise specified, use double-spacing throughout the paper, without any extra spaces between sections. Please note that the default on MS Word is an extra 6pt before or after paragraphs that needs to be changed to 0pt.</td>
</tr>
<tr>
<td><strong>Alignment:</strong></td>
<td>Left justified (except centered titles)</td>
</tr>
<tr>
<td><strong>Page numbers:</strong></td>
<td>Please include page numbers in the top right of each page. Start numbering on title page (or first page of document).</td>
</tr>
<tr>
<td><strong>Length</strong></td>
<td>Length of paper given by professor does not include the title page and reference page (i.e. a 5-page paper is 5 pages of content).</td>
</tr>
</tbody>
</table>
Levels of heading. Use the following rules for how to format the header title for each of the following levels. See example manuscript for visual version of headers. (See p. 62 in APA Publication Manual for more information.)

Level 1: Centered, Boldface, Uppercase and Lowercase Heading on Own Line
Level 2: Flush left, Boldface, Uppercase and Lowercase Heading on Own Line
Level 3: Indented, boldface, lowercase heading, ending with period.
Level 4: Indented, boldface, italicized, lowercase heading ending with period.
Level 5: Indented, italicized, lowercase heading ending with period.

Level 1 examples: Abstract, Title name for introduction section, Method, etc.
Level 2 examples: Sub-sections in Method (Participants, Procedure, etc.)
Level 3 examples: Sub-sub sections such as various surveys in Materials sub-section

Structure of a Scientific Paper

Most scientific papers follow the IMRaD format (Introduction, Methods, Results, and Discussion), but not all. For example case studies, review articles, and critical thinking papers will include a different set of sections depending on what information needs to be communicated. However, since the majority of you will be writing empirical papers, we will start by focusing on this structure.

Introduction (Use Title of Your Paper – not word “Introduction”)

The easiest structure to use in an introduction is the funnel. As with a funnel, you want to start with a statement at the beginning to place your research and your message in a broader context and then work towards your question. Thus, you typically start with what is known in the area (broad), followed by what is unknown (narrower), and finally, the topic of your research (very narrow). Many introductions include the purpose of the study and the important hypotheses. You may want to also include in the introduction the methods used to answer the question.

Example:

\[ \begin{array}{ll}
A & \text{Known} \\
B & \text{Unknown} \\
C & \text{Question} \\
D & \text{Experimental approach} \\
\end{array} \]

It is not uncommon for excessive alcohol consumption to be an expectation among first-year students arriving on campus (Phillips, 2001; Smith, Brown, Clark, & Jones, 1976).\(^A\) However, the origins of these expectations remain unclear.\(^B\) The current study aims at exploring how peer networks influence the development of these expectations.\(^C\) Using a series of online surveys, we developed a comprehensive system anagram of peer relations in a mid-sized high school.\(^D\)

It is important that your question flow naturally from the material that is presented in the introduction. Leaps in logic and inconsistencies will confuse the reader. The question also needs to be stated clearly since the rest of the paper depends on it. The Method section will be used to describe the procedure, the Results tell about the data you collected, and the Discussion explains the conclusions that can be drawn regarding the question.
Method

The Method section presents in detail how the study was conducted. This helps the reader understand what you actually did and whether this was an appropriate approach to answer the question. It should also be clear enough that others could replicate your methods if needed. Three components need to be clear in the methods:

- The independent variable (the variable that was manipulated)
- The dependent variable (the variable you measured)
- All controls to eliminate other possible causes for your results

The structure of this section follows a relatively straightforward approach. It is customary to include headings for each of the subsections. According to the APA, you should provide the following information in the following order:

Participants (or Subjects)

This subsection is a description of the sample used to generate the data. You need to provide the information about the sample that is necessary to understand the findings. You will provide frequency or descriptive information. It is common to provide information about the procedure for selecting participants.

Example: The study included 60 volunteers who were recruited from an ad in the campus newspaper. The sample included 45 women and 15 men with an average age of 20.1 years (SD = 2.3). The participants were mostly Caucasian (84%) and African-American (12%).

Materials (or Measures)

This subsection provides a description of the measures used in the study. For a paper that examines a survey, a list of all the questionnaires/instruments that were used is provided. This section is usually where the dependent and independent variables are described in detail. You want to be as precise as possible since this will be important for the readers to determine if they agree with your approach and whether they could replicate the study. You would be disappointed to find that someone measures how long it took for someone to run a sprint using a calendar, or by some method you have never heard of before.

Example: Attitudes towards drinking scale. Subjects were asked to complete the Attitudes Towards Drinking Scale (ATDS). This measure includes 34 sentences and the respondent is asked to indicate the degree to which this sentence reflects their beliefs about drinking on a scale from 0 (Not at all) to 10 (Very much).

Apparatus

This subsection provides a description of the mechanical materials used to collect data. Often this includes information about the model and manufacturer.

Procedure
This subsection summarizes the procedures used in collecting the data. It includes any procedures that were used to randomly assign participants to a condition, the instructions that were given to participants, the sequence of events in the study, and if the participants were debriefed when the experiment was complete. This section needs to clearly demonstrate the relationship between the independent, dependent, and controls in the study. The reader should be able to replicate your study based on information provided in this section.

**Example:** Participants were randomly assigned to one of the experimental conditions (Group A, Group B, or Group C). Those assigned to Group A were presented with scenarios that reflected peer attitudes that were positive towards college drinking. Those assigned to Group B were presented with scenarios that reflected peer attitudes that were negative towards college drinking. Those assigned to Group C were presented with scenarios that reflected peer attitudes towards an unrelated topic (owning a car on campus). After reading the scenarios, participants were asked to complete a series of measures that assessed their attitudes towards drinking at college, and how many of their friends hold similar attitudes to those presented in the scenarios. All participants were debriefed after the study about the purpose of the study and all concerns were discussed.

**Results**

The results section presents a summary of the data collected and the statistical procedures used in the analyses. You need to report the data in sufficient detail to justify the conclusions you present in the discussion. You rarely present the raw data, unless it is a case study or a small number of data points were collected. In terms of structure, you always want to start with some kind of basic description of the important variables in the study. This means you typically provide means and standard deviations for the variables. You also can present data in a Table or Figure, but if you have just a few data points, you may want to simply include them in the text.

**Example:** The rate of alcohol consumption was compared in a 3 (Group) x 2 (Age) ANOVA (see Figure 1). A significant main effect of group was found, $F(2, 46) = 12.41, p = .021$. Participants assigned to the group that were presented with positive attitudes towards college drinking reported significantly more alcohol consumption ($M = 18.9, SE = 2.5$) than those presented with a negative attitude ($M = 7.5, SE = 1.8$), $t(44) = 5.67, p = .017$. Neither the main effect of age nor the interaction of group and age were found to be significant, $F(1, 46) = 2.11, p = .54$, $F(2, 46) = 0.32, p = .78$, respectively.

**Discussion**

The discussion section does not have a specifically followed structure. There are some general guidelines. The most important guideline is to re-state the purpose of the study and hypotheses at the beginning of the discussion section. Often the first result discussed is the most important finding of the study, and you want to draw attention by placing it in the most prominent position. After stating your most important finding, provide supporting evidence for it. Organize the remaining paragraphs of the discussion according to the logic of the study or in order from most to least important finding. Indicate the organization by providing topic sentences or use sub-headers so that the reader can follow the organization of the story of the
discussion. The discussion usually provides the limitations (what could be done differently) and future directions. Finally, you need to provide closure to the story. It is recommended to write a summary paragraph at the end of the discussion that allows you to give an overview of what was done, what was found and a general concluding statement about the current study.

Example: The results of the current study show that alcohol consumption in college is related to the kind of environment that the student is exposed to in high school. … In summary, the study shows that paying attention to the high school environment is important in describing and potentially controlling under-age drinking.

References

After the discussion, you will provide the list of the sources you used in your study. Later in this document there is an entire and exhaustive section on how to cite these sources within the text of your paper as well as in the reference section.

Writing Style

Focus on the reader. Imagine you are studying for an exam. Your professor has assigned a lot of material to cover (we always do!). How do you want this information to be presented? Do you want the information to be presented with a lot of detail and complicated language, so that it’s hard to tell what is important? Or do you want short, clear and meaty? If you answered that the second alternative is better, then you need to learn how to write short, clear, and meaty papers. If this is what you expect from papers, then you need to produce this type of paper. Who knows, your work may be someone’s assigned reading one day!

One question that always arises is to whom am I writing? You should ask the professor of the course who the audience is for each assignment. But, we generally want you to learn how to write for a more general audience (rather than write a paper for the professor). The main reason for broadening the audience is that you may be more likely to cut corners in presenting information if it is written for the professor, since you will assume that we know what you are talking about and can fill in pieces you omitted. This is a bad habit and I want you to learn to write in a manner that will be easily understood by people who are not in this class. This means that you should be able to write your paper so that others in this class will understand, but also your roommate, grandmother, and of course those future students who will be assigned your paper to read. Sometimes your professor will ask you to write for an audience with more expertise knowledge. You also have to take into consideration the state of the person who is reading the paper. Many of you are only half-awake when you read papers, with other things on your mind and many other distractions. So, your job is to write in such a way that it is as easy as possible to understand. The job of the reader is to follow the author’s writing then to agree or disagree with the information presented. How frustrated do you get when you have to read, re-read and then ask others for their interpretation of a scientific paper? Thus, if you want others to get your message, you need to make it abundantly clear from the start.

There is an added benefit to writing clearly: it makes your thinking about a topic a lot clearer. Many authors think all they have to do is get their thinking on paper and all will be clear. But this is rarely the case. You may find that as you write your paper, the answers you thought were so clear when you started writing appear a bit confused now that you re-read your
masterpiece. The thoughts are still genius material, but how do you make sure others recognize your innate talents? Many times, our thoughts are jumbled in our heads. Having to write them down provides structure and focus. As we work through our thoughts, the answer we started with might change and evolve into a different answer. Sometimes lapses in logic, holes in background materials, or inconsistencies are discovered and corrected. This development while we write is natural and a great asset if recognized and used effectively. Make sure to keep reworking the writing so that the entire document flows together like any good story.

In summary, there are two important reasons to write clearly: first, it makes it easier to get your message across to others, and second, it makes sure that you yourself know what you mean and want to say.

Word choice. Psychology has a long history of using labels and acronyms when describing the individuals we study and treat. In a particular context, these labels serve as diagnostic labels with a specific meaning. However, over time, the labels are adopted by the general public, lose their original meaning, and often become pejorative. While we cannot control how these terms move into the vernacular of our culture, we can control how we use them, especially in our writing. I have provided some guidelines on how I want you to use language in your writings for this class.

Words in scientific papers should be: precise, simple, and necessary. The words you use should be as precise as the science you are reporting. Precise, definite, specific, concrete words evoke a mental image, which in turn makes it easier to read and understand. For example, stating that 85% of the sample responded to the stimulus when presented is better than saying that “most” or “several” subjects responded to the stimulus.

In terms of being simple, I am not saying that big, fancy, scientific sounding words are necessarily bad and that simple, little words are always better. Rather, because science often needs us to write with big, technical words, try to keep it light and simple elsewhere in the text. If you can, try to use words like “use” rather than “utilize”. In general, if an idea is simple, do not try to make it more complex. If an idea is complex, try to write as simply as possible.

Necessary means that you use as few words as possible. The more noise and distraction in the text, the harder it is to see the message. However, never sacrifice clarity for brevity. If it takes more words to be clear, then use more words.

A note about abbreviations: try to keep them to a minimum. I have seen papers where you get something that says that “scores on the MMPI, WAIS-III, and CWSCT all suggested that the individual was suffering from MDD, IDD, and NPD.” Some of you may understand this, but the majority of others will not. If you had to stop and really think what these mean, imagine someone who has little knowledge of the field. If you are going to use abbreviations, make sure to spell them out as soon as possible. For example, “scores on the Minnesota Multiphasic Personality Inventory (MMPI), Weschler Adult Intelligence Scales III (WAIS-III), and the Cowen Word and Sentence Completion Task (CWSCT) were administered to all subjects.”

Avoiding biased and pejorative language. In general, avoid anything that causes offense. The style manual makes the following suggestions:
DO NOT use | when you can use
---|---
ethnic labels (for example, Hispanic) | geographical labels (for example, Mexican Americans if from Mexico)
"men" (referring to all adults) | "men and women"
"homosexuals" | "gay men and lesbians"
"depressives" | "people with depression"

The term “gender” is cultural and should be used when referring to men and women as social groups. “Sex” is a biological concept, and should be used in specific contexts (i.e. sexual differences in hormone production). Note as well that the term “sex” is often confused with sexual behaviors such as sexual intercourse.

**Sensitivity to labels.** As I mentioned before, we need to be sensitive to labels. A person in a clinical study should be called a "patient," not a "case." Avoid equating people with their conditions, for example, do not say "schizophrenics," say "people diagnosed with schizophrenia." Use the term "sexual orientation," not "sexual preference." The phrase "gay men and lesbians" is currently preferred to the term "homosexuals." To refer to all people who are not heterosexual, the manual suggests "lesbians, gay men, and bisexual women and men".

In racial references, the manual simply recommends that we respect current usage. Currently both the terms "Black" and "African American" are widely accepted, while "Negro" and "Afro-American" are not. These things change, so use common sense.

Capitalize Black and White when the words are used as proper nouns to refer to social groups. Do not use color words for other ethnic groups. The manual specifies that hyphens should not be used in multiword names such as Asian American or African American.

Labels can be tricky, and the manual has a lot to say about them. For example, "American Indian" and "Native American" are both acceptable usages, but the manual notes that there are nearly 450 Native American groups, including Hawaiians and Samoans, so specific group names are far more informative.

The terms Hispanic, Latino, and Chicano are preferred by different groups. The safest procedure is to use geographical references. Just say "Cuban American" if referring to people from Cuba.

The term Asian American is preferable to Oriental, and again the manual recommends being specific about country of origin, when this is known (for example, Chinese or Vietnamese). People from northern Canada, Alaska, eastern Siberia, and Greenland often (but not always!) prefer Inuk (singular) and Inuit (plural) to "Eskimo." But some Alaska natives are non-Inuit people who prefer to be called Eskimo. This type of difficulty is avoided by using geographical references. For example, in place of "Eskimo" or "Inuit" one could use "people from northern Canada, Alaska, eastern Siberia, and Greenland."

In general, call people what they want to be called, and do not contrast one group of people with another group called "normal" people. Write "we compared people with autism to people without autism", not "we contrasted autistics to normals." Do not use pejorative terms.
like "stroke victim" or "stroke sufferers." Use a more neutral terminology such as "people who have had a stroke." Avoid the terms "challenged" and "special" unless the population referred to prefers this terminology (for example, Special Olympics). As a rule, use the phrase "people with x" (for example, "people with AIDS," not "AIDS sufferers").

In referring to age, be specific about age ranges; avoid open-ended definitions like "under 16" or "over 65." Avoid the term “elderly”. “Older person” is preferred. Boy and Girl are acceptable referring to high school and younger. For persons 18 and older, use men and women.

**Quotations.** You are strongly discouraged from using any direct quotations in your papers. This is typically used in other fields to assigning specific language to individuals. In scientific writing, the ideas expressed by the language are often more important than the exact words used to convey the idea. The encouraged format would be to paraphrase (use different words without losing the original meaning of the phrase) and then cite the source of the material in the text.

*Example:* From the original study by Smith, Brown, and Carns (2006): “The results of the study showed that ...”
You would paraphrase: The dependent variable was significantly changed based on the independent variables (Smith, Brown, & Carns, 2006).

Use quotation marks only for an odd or ironic usage the first time but not thereafter, for example, "This is the "good-outcome" variable, but as it turns out, the good-outcome variable predicts trouble later on . . ."

**Citation of References**

One of the most important aspects of your paper is citing and referencing sources. The Wofford honor code makes it very clear that plagiarism is a significant offense with serious consequences. Studies have shown that many of the perpetrators of plagiarism do it out of neglect and ignorance rather than intent and malice. You should use a citation when your words are influenced by or learned from others ideas, theories, or research findings. You are implying that you have personally read the cited work when you reference it.

Below are some guidelines on how to correctly cite sources in your text and then reference them in the reference section (page) of your manuscript. These suggestions are guidelines and not meant to be exhaustive. You can consult the APA Style Guide for an exhaustive treatment of these issues.

**In-text citations.** If you use ideas that were first proposed by someone else, or use the work of others to bolster one of your points, you need to cite the source in the text. All sources cited in your text – and only those sources cited in your text - are referenced in the reference list. The underlying principle is that ideas, words, and work of others need to be formally acknowledged. The reader should then be able to obtain the details of where to find the source of the citation from the list of references.
When the names of the authors of a source are part of the formal structure of the sentence, the year of publication appears in parentheses following the identification of the authors.

Example: Smith and Brown (2006) found a reduction in the dependent variable over time in the treatment condition compared to the control condition.

When the authors of a source are not part of the formal structure of the sentence, both the authors and years of publication appear in parentheses, separated by semicolons, in alphabetical order by first author.

Example: With recognition of the limitations of medical and surgical treatment has come increased interest in self-management approaches to OA (Barlow, Williams, & Wright, 1999; Brandt, 2000; Buckwalter, Stanish, Schenck & Coutts, 2001; Creamer, 2000).

When a source that has one or two authors is cited, one or both authors are included every time the source is cited. When a source that has three, four, or five authors is cited, all authors are included the first time the source is cited. When that source is cited again, the first author's last name and “et al.” are used (if in parentheses at end of sentence – if used in sentence use “and colleagues”). When a source has six or more authors, the first author's last name and “colleagues” (if in sentence) or “et al.” (if in parentheses at end of sentence) are used the first time and every time the source is cited.

Example: Reviews of research on religion and health have concluded that at least some types of religious behaviors are related to higher levels of physical and mental health (Payne, Bergin, Bielema, & Jenkins, 1991).

Next time cited in the text: Payne and colleagues (1991) showed that…
Or: Religion behaviors are related to higher levels of health (Payne et al., 1991).

Every effort should be made to cite only sources that you have actually read. For example, in the introduction of another study or in a review article (Murzynski & Degelman, 1996), you come across the description of an interesting study conducted by Grayson (1956). When it is necessary to cite a source that you have not read (i.e. Grayson) that is cited in a source that you have read (i.e. Murzynski & Degelman, 1996) use the following format for the text citation and list only the source you have read in the references list:

Example: Grayson (as cited in Murzynski & Degelman, 1996) identified four components of body language that were related to judgments of vulnerability.

To cite a personal communication (including lecture notes, class handouts, and e-mails), include initials, surname, and as exact a date as possible. Because a personal communication is not "recoverable" information, it is not included in the references section. Try to keep these to a minimum.

Example: (J. C. Lefebvre, class notes, January 1, 2007)
**Summary Table**

<table>
<thead>
<tr>
<th>Source</th>
<th>Citation</th>
<th>Source</th>
<th>Citation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 author</td>
<td>(Smith, 2006)</td>
<td>Multiple studies</td>
<td>(Balda, 1980; Kamil, 1988; Pepper &amp; Salt, 2000)</td>
</tr>
<tr>
<td>2 authors</td>
<td>(Smith &amp; Brown, 2006)</td>
<td>Parts of a source</td>
<td>(Head &amp; Shoulders, 1981, p. 322)</td>
</tr>
<tr>
<td></td>
<td>Next cite: Smith et al. (2006)</td>
<td>communication</td>
<td></td>
</tr>
<tr>
<td>6+ authors</td>
<td>(Smith et al., year)</td>
<td>In press</td>
<td>McDonald (in press)</td>
</tr>
<tr>
<td>Groups as authors</td>
<td>(National Institute of Mental Health [NIMH], 1999)</td>
<td>No date</td>
<td>(Smith, n.d.)</td>
</tr>
<tr>
<td></td>
<td>Next cite: (NIMH, 1999)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**References in reference section.** Below are the most common types of references you will use in papers. If you come across a format that is not listed, I suggest you consult the APA Manual; it demonstrates 95 examples of different reference types! For each we have provided the general format then an example. Note the hanging indent on references (select “paragraph” then select “hanging indent”).

**Periodical (journals, magazines, scholarly newsletter)**


**Non-periodicals (books, reports, brochures, manuals, movies and other AV materials)**


**Part of a non-periodical (book chapter, section of an edited book)**

Author, A.A., Author, B.B., & Author, C.C. (year). Title of the chapter. In A. Editor, B. Editor, & C. Editor (Eds.), *Title of the book* (pp. xxx-xxx). Location: Publisher.

**Online periodical or document** (online journal abstracts, web sites or web pages, newsgroups, web or email based discussion groups, web or email based newsletters)

Note: You should use the following format if you use materials that were obtained from sources that you can only get online. If you use articles derived from our online databases, and you can see the entire article, then you use the periodical format for the reference. If you use an abstract you saw on Medline and you did not see the entire article, then you should use the online periodical format.

**General form for online periodical:**


**General form for online document:**

Author, A.A. (year). *Title of the work*. Retrieved day month day, year, from source.


**Guide for Tables and Figures**

Number all tables and figures in order that they are first mentioned or noted in the text, regardless of whether a more detailed discussion of the table or figure occurs later in the paper. Tables and figures each get numbered separately.

**Table layout.** Tables only use horizontal lines (no vertical lines). The font should be the same (e.g. Times New Roman, 12pt) as the rest of the paper. The header is above the table. The first line should say “Table X” (without italics or bolding). The next line should be a title for the table that is not indented, italicized, with capitals and lower case (e.g. “Numbers of Children With and Without Proof of Parental Citizenship”). If necessary, a “note” section can appear under the table that provides definitions of abbreviations. Specific notes can appear on separate
lines. This information starts with the word “Note” left justified, in italics (e.g. Note. The probability of ...). Many examples are provided in the Publication Manual (p. 128-150).

**Figure layout.** Figures can be graphs, charts, schematics, drawings, or photographs. They should be easy to read with all elements labeled. The font used should be the same as the rest of the paper (e.g. Times New Roman, 12pt). The caption appears below the figure. It should read “Figure X.” (in italics, left justified), then on the same line the caption about the figure, which is a concise explanation of the figure and serves as the title. It should be a brief, descriptive phrase. For example (from APA Publication Manual, p 156), “Figure 1. Accuracy in Experiment 1 for each type of feedback and for each test. Error bars represent standard errors.” See Publication Manual for additional information and examples (p. 150-167).