A **Routledge** and **Guilford Press** FreeBook

RESEARCH METHODS

Guilford Press

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INTRODUCTION

RESEARCH METHODS

This FreeBook is a thoughtfully curated selection of chapters from books published by Guilford Press and Routledge about research methods. *Research methods* are the processes by which we plan a study, collect and analyze data to deepen our understanding of a subject. There are many different approaches to research, including quantitative, qualitative, and mixed methods. The chapters in this FreeBook are relevant to researchers, professors, students, and anyone seeking to improve their knowledge about the art and science of research.

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CHAPTER 1: READING AND WRITING ABOUT THEORIES

In *Theory Construction and Model-Building Skills, Second Edition: A Practical Guide for Social Scientists* James Jaccard and Jacob Jacoby prepare graduate students, new researchers, and even seasoned investigators to develop their own theories or build on existing ones. In this chapter, entitled "Reading and Writing about Theories," the authors discuss practical issues to consider when you read about or present theories in articles, technical reports, and presentations.

CHAPTER 2: THINKING CRITICALLY ABOUT THEORY

In *Thinking Critically About Research*, Jane Ogden is helping the reader discern between fact and fiction. What is real and what is fake? What should we believe and what should we reject? In an environment of information overload, a distrust of experts, the circulation of misinformation and false facts, and public debates based upon poor evidence, *Thinking Critically About Research* comes at a vital juncture. The book is designed to help readers develop a critical understanding of evidence and the ways in which evidence is presented, and to challenge the information they receive in both academic and non-academic sources. The chapter "Thinking Critically About Theory" explores how to think critically about theory in terms of two problems of meaningfulness and differences and two key tensions between the obvious and absurd and between specificity and inclusivity.

INTRODUCTION

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CHAPTER 3: OPEN SCIENCE

In *Becoming a Behavioral Science Researcher, Second Edition: A Guide to Producing Research That Matters*, author Rex Kline helps novice behavioral scientists hit the ground running as producers of meaningful research. In this chapter, entitled "Open Science," Dr. Kline explains the open science movement, which emphasizes greater accessibility and transparency in sharing data and analysis materials. The chapter includes tips on open source tools as well as strategies for enhancing open access, transparency, and accountability.

CHAPTER 4: OPEN SCIENCE AND PLANNING RESEARCH

Introduction to the New Statistics is the first introductory statistics text to use an estimation approach from the start to help readers understand effect sizes, confidence intervals (CIs), and meta-analysis ('the new statistics'). It is also the first text to explain the new and exciting Open Science practices, which encourage replication and enhance the trustworthiness of research. In addition, the book explains NHST fully so readers can understand published research. The excerpt from the chapter "Open Science and Planning Research" discuses what's called the replicability crisis, then focuses on Open Science because that needs attention from the very start of planning.

As you read through this FreeBook you will notice that some excerpts reference previous or further chapters. Please note that these are references to the original text and not the FreeBook.

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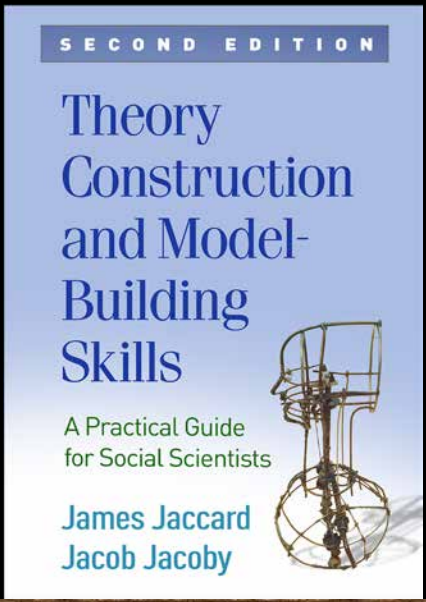

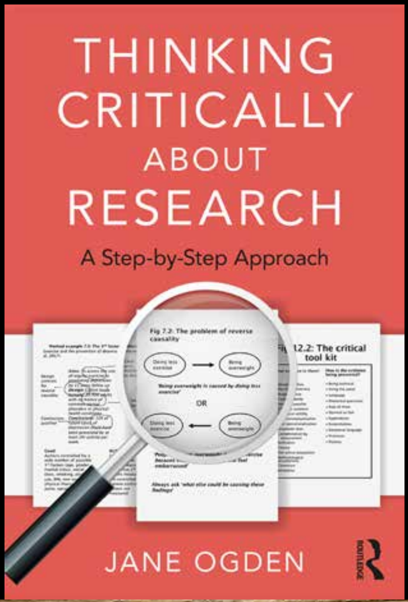

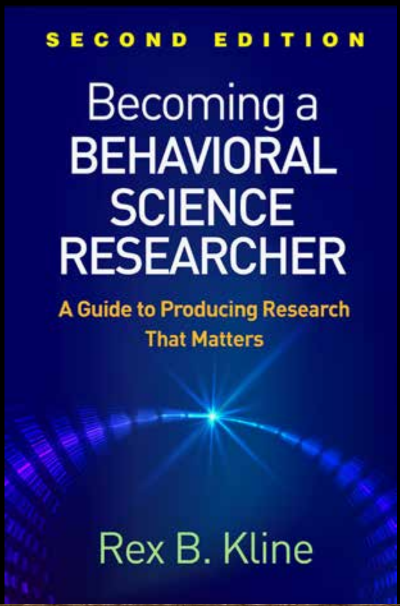

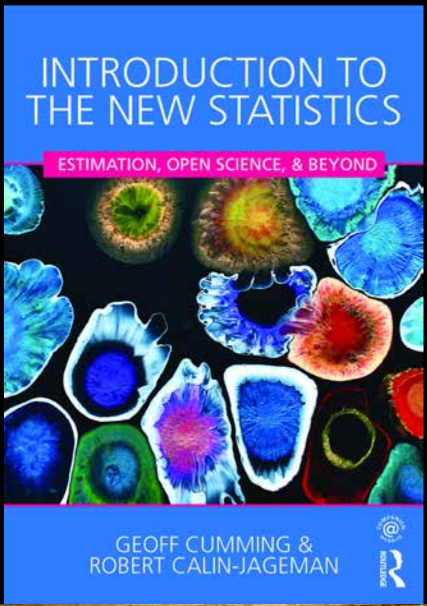

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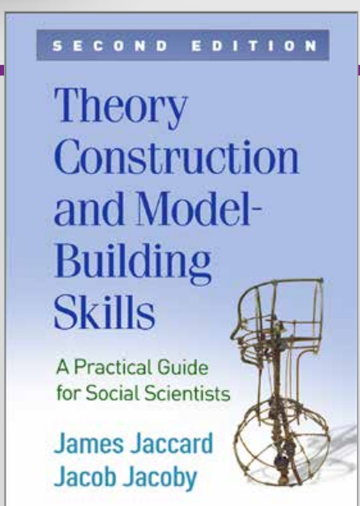
READING AND WRITING ABOUT THEORIES



This chapter is excerpted from

Theory Construction Model Building Skills, Second Edition

By James Jaccard and Jacob Jacoby

READING AND WRITING ABOUT THEORIES

James Jaccard and Jacob Jacoby

Excerpted from *Theory Construction Model Building Skills, Second Edition*

In *Theory Construction and Model-Building Skills, Second Edition: A Practical Guide for Social Scientists* James Jaccard and Jacob Jacoby prepare graduate students, new researchers, and even seasoned investigators to develop their own theories or build on existing ones. In this chapter, entitled "Reading and Writing about Theories," the authors discuss practical issues to consider when you read about or present theories in articles, technical reports, and presentations.

> The ability to express an idea is well nigh as important as the idea itself.
>
> —Bernard Baruch (1942)

Throughout your career as a scientist, you will read research reports that describe theories. Many of you will write articles that summarize or describe your own theories or the theories of others. In this chapter, we discuss practical issues to consider when you read and write about theories. We focus first on reading theories and then on writing about theories.

The way in which theories are written in professional reports differs by discipline. In disciplines that emphasize experimentation and empirical efforts to test theories, the theories appear as central elements of the empirical tests, but they are accompanied by information about the tests of the theory per se. In disciplines that emphasize emergent/ grounded theories, the theories usually are written in narrative form in a context that does not have the "tone" of a theory test. To be sure, the emergent theory is consistent with the collected data because, after all, the theory was derived from that data. In our discussion of reading about theories, we separate the two approaches, first describing how you will typically see theories presented in outlets emphasizing formal theory tests and then considering how theories are written about in outlets emphasizing grounded and emergent theorizing. We encourage readers to work through both sections no matter what your orientations are toward theory construction.

READING ABOUT THEORIES

READING ABOUT THEORIES IN OUTLETS EMPHASIZING THEORY TESTS

Journal articles are probably the most common source of information about theories. These articles typically contain four major sections: introduction, methods, results, and discussion. In this chapter, we consider each section and how to read and extract from all of them information about a theory. We do not consider methodological matters, such as research design and evaluating the quality of empirical tests of theories. That is a matter for methodological texts. We focus instead on how to identify and clarify the theory being tested. It may seem unusual to consider methods for extracting theories from research reports because one would think that articles would be clear about the theories being considered. Unfortunately, this is not always the case. We adopt a variable-centered and causal thinking approach in this section because these are dominant.

The Introduction Section

The *Introduction section* describes the general problem, reviews the relevant literature on the problem, develops the theory to be tested, and presents the hypotheses to be tested. Statements also are made about how the research will advance knowledge not only about the problem area but also about the theory. The essence of theories in most reports of this type is their variables and the posited relationships between them. A useful strategy for mapping out the theory being tested is to first make a list of all the major variables the author mentions in the measurement section of the Methods section. These are almost always the core variables that are addressed in the theory test. To be sure, the Introduction may discuss other variables to provide context and, if they seem relevant, add them to your list. After doing so, write out the formal conceptual definition of each variable/concept. Sometimes the author will provide an explicit conceptual definition, but other times, the conceptual definition is assumed to be known because the concept is used so often in the scientific literature that there is widespread consensus about its definition. In such cases, you might still write out the conceptual definition so you can be explicit about the theory, but that is a matter of choice. If the author does not provide a conceptual definition and you are not aware of a consensual definition, then generate your own "working definition" based on your reading of the article and your past knowledge of the problem area.

Once the concepts/variables and definitions are in place, on a separate sheet of paper draw an influence diagram of the causal relationships between the variables based on the information in the introduction. Use the methods for diagramming described in Chapter 7 that make use of influence diagrams. The influence diagram might include direct causal relationships, indirect causal relationships (with either partial or complete mediation), moderated causal relationships, reciprocal causation, spurious relationships, and/or unanalyzed relationships. As you draw the diagram, you may be surprised to find that the theorist does not specify causal links that you think should be addressed. Or you may find that the theorist is vague about certain relationships. As we discuss later, you may still be able to "complete the theory" based on material in other sections of the report. The idea is to draw the influence diagram as best you can based on the presented material.

Usually, a conceptual logic model will accompany each link in a theory. You also should write out the conceptual logic model and evaluate it using the approaches discussed in Chapter 4. Our companion website (www.theory-construction.com) provides multiple examples of extracting influence diagrams from articles and evaluating their conceptual logic models.

The Method Section

In the *Method section*, the researcher describes methodological features of the empirical study that was conducted to test the theory. This typically includes subsections that describe the research participants, the measures used in the study, how the data were collected, and any other procedural facet that is scientifically relevant. The subsection on the characteristics of the study participants is important theoretically because it suggests the population to which the theory is applicable. To be sure, the author may envision the theory as applying to populations broader than the one reflected by the particular sample studied, but at the very least, the sampled population provides some sense of whom the theory applies to.

As noted, the section on measures also is of interest. It is here that the researcher provides concrete instantiations of the constructs being studied. If the researcher was vague about a conceptual definition in the introduction section, here you can examine the measure for the concept and formulate a conceptual definition based on that measure because the measures usually are specific and concrete. For example, a researcher might theorize about the construct of intelligence in the introduction section, but never define it. In the method section, you discover that the researcher measured intelligence using the Peabody Picture Vocabulary Test (PPVT). As it turns out, the PPVT emphasizes the verbal aspects of intelligence and focuses on the breadth of vocabulary and facility with words. Use of this measure implies a certain conceptual commitment to the meaning of intelligence, and, in this case, the conceptual definition might be construed as one that reflects verbal intelligence.

Sometimes you will be surprised at the way a construct is discussed in the introduction section compared to the instantiation of it that appears in the method section. The measure may reflect a narrower conceptualization than you think is appropriate, or it may reflect a broader conceptualization than what you expected. For example, when discussing the concept of intelligence in the introduction, the researcher might use it in a context that reflects more than verbal intelligence, but when examining the measure, you discover that the PPVT was used.

Next to each variable you listed in the introduction section, modify any conceptual definitions you initially wrote after examining the measure for it. Then write a brief description of the measure that was used for each construct (or the strategy that was used to manipulate it) next to the conceptual definition. Revisit the concept as it was presented in the introduction, the conceptual definition written next to it, and the measure that was used to assess it. Based on these, you should be able to derive a reasonably clear sense of the variables involved, their conceptual meanings, and how reasonably the measures reflect or represent those meanings.

The Results Section

The *Results section* typically reports how the collected data were analyzed and the ensuing results. In most cases for these types of articles, results sections describe the application of statistical techniques. If a researcher was vague or fuzzy about relationships between variables in the introduction section, it is here that he or she must be more explicit. Almost all major statistical methods focus on characterizing relationships between variables. Just as measures are more specific instantiations of variables, statistical tests are more specific instantiations of presumed relationships between variables. Appendix 16.1 describes how different statistical tests map onto different causal models and how they can be used to infer the causal models addressed.

The Discussion Section

The *Discussion section* addresses, among other things, whether the empirical tests were consistent with the theory. If the theory was not supported, then revisions to the theory might be suggested. If the theory was supported, then the researcher often highlights the implications of the results and what future research is needed. Typically, the researcher will encourage the future study of new direct causes, mediators, moderators, extensions to new outcomes, or application of the theory to other contexts and populations to establish generalizability. The researcher often builds a case for the importance and implications of the research. Evaluate the quality of his or her arguments.

READING AND WRITING ABOUT THEORIES

James Jaccard and Jacob Jacoby

Excerpted from *Theory Construction Model Building Skills, Second Edition*

READING ABOUT THEORIES IN OUTLETS EMPHASIZING GROUNDED/EMERGENT APPROACHES

Articles that publish reports of grounded or emergent theories have a somewhat different format than articles based on confirmatory approaches that report theory tests. Although some grounded/emergent theory articles represent a blending of qualitative and quantitative approaches, our discussion here elaborates traditional grounded/emergent theory styles of presentation that emphasize qualitative data.

Articles using grounded/emergent theory typically begin with a statement of the problem, brief background material to provide a context, and a characterization of the relevant past literature. Prior to describing the method and results, many writers provide an overview of the major conclusions that were reached in the study, so the reader can keep the "big picture" in mind as the particulars are developed. It represents a glimpse of the theory that evolved. This is followed by a method section that describes how the data were collected, who the data were collected on, the strategy used for writing field notes, and how the data were analyzed. It is here that authors build a case that they involved themselves adequately for purposes of conducting an informed grounded/ emergent analysis. The results are then presented in which the different theoretical assertions are provided, coupled with exemplars that justify the conceptual logic model underlying them. The examples are representative and often vivid and image provoking. The article typically ends with a section that places the emergent theory in context relative to other theories and that draws out its theoretical/practical implications.

As with any scientific report, one expects the emergent theory to be clearly developed and articulated. In cases where the emergent theory is variable-centered, one can use the same principles described earlier to clarify the constructs and their interrelationships. For process-oriented theories, one can consider creating a process map, as discussed in Chapter 10. As with the variable-centered approach, it often is useful to write out the key concepts and propositions in the theory. The method section of articles often provides details that might clarify definitions that are vague. We find it useful to make a list of each major theoretical proposition and the key arguments in favor of and against it.

EVALUATING THE QUALITY OF THE THEORY YOU ARE READING

When you read about theory, you want to critically evaluate its quality and assess the extent to which the theory being addressed makes a contribution. The material we covered in Chapter 3 is key to this process. Chapter 3 articulated 16 ways in which researchers can seek to make a theoretical contribution. As you read an article, determine which of those approaches the article is pursuing. To reiterate from Chapter 3, the strategies include (1) clarifying, refining, or challenging the conceptualization of a variable/concept; (2) creating a new variable or constellation of variables that are of theoretical interest; (3) identifying one or more explanatory variables that have not been considered in prior work; (4) identifying the mechanisms or intervening processes responsible for an effect of one variable on another; (5) identifying the boundary conditions of an effect of one variable on another; (6) identifying variables that moderate the effect of one variable on another; (7) extending an existing theory or idea to a new context; (8) identifying nuanced functional forms of relationships; (9) identifying unenunciated/unanticipated consequences of an event; (10) enriching and deepening the understanding of established quantitative associations; (11) developing typologies/taxonomies; (12) importing or applying grand theories and frameworks from other disciplines; (13) synthesizing multiple theories into a unified framework; (14) developing theories of measurement; (15) pitting opposing theoretical explanations against one another; and/or (16) proposing alternative explanations to established phenomena, among others (see Chapter 3 for an elaboration of each strategy). Does the theory in the target article successfully accomplish any of these?

Chapter 3 also described the qualities of a good theory, including the extent to which it is logically consistent, in agreement with prior data, testable, appropriately parsimonious, broad in scope, novel/original, useful, and likely to stimulate research by others. Does the theory you are reading meet these criteria? Chapter 3 also described three criteria that editors and reviewers often use to judge the theoretical contribution of an article: (1) novelty or originality, (2) practical utility, and (3) scope. How does the theory you read about fare on these particular dimensions?

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POWERPOINT PRESENTATIONS OF THEORIES

PowerPoint presentations are commonplace, and you often will present a theory using this form of media. Here is a list of 40 things to consider as you prepare a PowerPoint presentation:

1. Make your first or second slides an outline of your presentation.
2. Follow the order of your outline for the rest of the presentation.
3. Use one or two slides per minute of your presentation.
4. Write in point form, not complete sentences.
5. Include no more than four or five points per slide.
6. Avoid wordiness: Use key words and phrases only.
7. If possible, show one point at a time by adding points dynamically to the same slide:
    - This helps the audience concentrate on what you are saying.
    - This prevents the audience from reading ahead.
8. Do not use distracting animation.
9. Use at least an 18-point font.
10. Use different-sized fonts for main points and secondary points.
11. Use a standard font such as Times New Roman or Arial.
12. Place words in all capitals only when necessary—it is difficult to read.
13. Use a color of font that contrasts sharply with the background.
14. Use color to reinforce the logic of your structure (e.g., light blue title and dark blue text).
15. Use color to emphasize a point, but only occasionally.
16. Using color for decoration is distracting.
17. Use backgrounds that are attractive but simple.
18. Use backgrounds that are light.
19. Use the same background consistently throughout your presentation.
20. Data in graphs are easier to comprehend and retain than are raw data.
21. Always title your graphs.
22. Minor gridlines on graphs usually are unnecessary.
23. Proof your slides for spelling mistakes, the use of repeated words, and grammatical errors.
24. If your presentation is not in your first language, have a native speaker check it.
25. Use a strong closing and summarize the main points of your presentation.
26. Consider ending your presentation with a "question slide" that invites your audience to ask questions or that provides a visual aid during the ques-tion period.
27. Show up early for your talk. Check whether your equipment works prop-erly.
28. Check whether the projector's resolution is the same as your laptop's. If it isn't, then your slides may be cropped, may jump, or may lose scan lines.

29. Don't leave Standby Power Management on your laptop on; make sure that your laptop does not turn off if you're inactive for a while during your talk.
30. Don't leave your screen saver on.
31. Don't use the mouse as a pointer. Moving a mouse on a slide show may cause a pointer to appear that is suboptimal in terms of performance.
32. Don't use the edges of the slide. Some projectors crop slides.
33. Do not assume your presentation will work on another person's laptop. Disk failures, software version mismatches, lack of disk space, low memory, and many other factors can prevent this. Check these out before your presentation.
34. Practice moving forward and backward within your presentation. Audi-ences often ask to see the previous screen again.
35. If possible, preview your slides on the screen you'll be using for your pre-sentation. Make sure that they are readable from the back-row seats.
36. Have a Plan B in the event of technical difficulties (e.g., transparencies and handouts).
37. Practice with someone who has never seen your presentation. Ask him or her for honest feedback about colors, content, and any effects or graphics you've included.
38. Do not read from your slides.
39. Do not speak to your slides. Face the audience, not the slides.
40. When possible, run your presentation from a hard disk rather than a floppy disk or a flash drive. Using a floppy disk or flash drive may slow your presentation.

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When evaluating a theory, one should ask if each of the core constructs in the theory is clearly defined. Are the constructs "fuzzy" or ambiguous? As discussed in Chapters 4 and 10, theoretical propositions should have strong conceptual logic models based in either deductive reasoning, inductive reasoning, analogic reasoning, abduction, or some other viable logic system. Is this the case for the theory you are reading? Chapter 6 on thought experiments stressed the importance of theories being clear about the nature of the relationships between concepts or variables. Is this the case for the theory you are reading?

WRITING ABOUT THEORIES

In this section, we identify points to consider when presenting your theory, focusing on general points relevant to all reports. Later, we discuss issues specific to certain outlets.

HOW YOU SAY IT CAN BE AS IMPORTANT AS WHAT YOU SAY

Over the course of our careers, we have seen articles by colleagues with very good ideas be rejected for publication, and we have seen articles with what we thought were weak ideas published in highly competitive journals. Although there are many reasons for this variability, one particularly important reason is how the theory is "packaged" in the written product—that is, how the theory is presented. A description of a theory is not unlike the telling of a story, with some people being better storytellers than others. We wish the world was such that it was purely the quality of the idea that mattered. But it is not. If you can't communicate your ideas well, and if you can't get people excited about your ideas, then you are going to have a difficult time publishing your work. You need to be both clear and engaging when presenting ideas.

In graduate school, one of the authors (Jaccard) was taken aside by a senior graduate student who, somewhat tongue in cheek, decided to tell the struggling first-year student the secret to writing scientifically. "Try to think of the most boring and dryest way you can say something in the fewest words possible, and you will be a successful scientific writer." In essence, the message was to get to the point and to be concise in getting there. I (Jaccard) was taught as a graduate student by my mentors to avoid "cute titles" for articles and instead to include the main variables in the title so that the title would be informative. I also was taught to avoid journalistic tricks, such as starting an article with a gripping, real-life event of an individual who had experienced

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the phenomenon I was studying (or something related to it), and then using this as a lead-in to the presentation of the science. The strategy of giving phenomena memorable labels (e.g., "fundamental attribution error") also was viewed pejoratively as "marketing." Despite the more conservative training I received, there are those who believe otherwise. Sternberg (2003) and Peter and Olson (1983), for example, suggest a mindset for scientific writing that is similar to that of an advertiser: "Keep in mind that you have something to sell, namely your ideas, and sell it" (Sternberg, 2003, p. 22). Scientists are only human, the logic goes, and if they have to listen to someone tell a story, they would rather hear it from a good storyteller than a bad one. There are reasonable arguments on both sides of this issue.

BRIEFER IS BETTER, BUT DON'T BE TOO BRIEF

Readers appreciate papers that are concise and to the point. A lengthy theoretical description is often greeted with dread and sometimes hostility. Yet, you need to make your case and provide background to your theory. Don't be afraid to use the space you need; just make sure you need it. For a variety of reasons, most journals have strict limits on the number of manuscript pages that can be published. You typically will find your hands tied because of this restriction. Sometimes you may elect to publish in an outlet not only because the outlet reaches your intended audience, but also because it does not have strict limits on the number of pages. The journal may be less prestigious, but at least you can say what needs to be said and build your case effectively. The bottom line is that you need to be scholarly and thorough while at the same time being as brief and concise as possible.

PREPARE AN OUTLINE

Many people benefit by preparing an outline of the section of the manuscript where the theory is presented (and for that matter, the entire article) prior to actually writing about it. An outline helps you keep the logical sequence of your presentation in mind as you write. It also makes it easier to recognize if you have omitted something crucial. Writing from an outline can help prevent the inclusion of irrelevant thoughts. Some people like to write brief outlines consisting of only key terms or phrases; others prefer to write complete-sentence outlines.

PROVIDE A ROADMAP

It often is useful to provide readers at the outset with a "roadmap" of where you are headed in the narrative. This usually consists of a short paragraph, strategically placed after some introductory orientation, such as: "In this article, we first discuss the prevalence of adolescent drug use. Next, we consider . . . ". In other words, provide an overview of the structure of the theoretical presentation. It also helps readers if you make liberal use of headings and make the headings reasonably descriptive.

PROVIDE A SUCCINCT REVIEW OF CURRENT KNOWLEDGE

It goes without saying that you need to review past research and summarize current knowledge about the topic area you are addressing. The omission of a key article or result from prior work in your characterization of the literature will be problematic. For journal articles, you usually will not have the luxury of writing about all relevant past research in depth. You might do so in a dissertation but not in a journal article. If a large body of literature already exists on your topic, try to cite and incorporate published literature reviews. The primary objective of your literature review is to provide a good sense of what is already known about the topic you are addressing so as to set the stage for describing how your theory will make a contribution relative to this body of work.

DISCUSS THE IMPLICATIONS AND IMPORTANCE OF YOUR THEORY

The importance and implications of your theory may be clear to you, but this does not mean that your readers will automatically recognize them. It helps to be explicit about what new insights and perspectives your theory has to offer. Directly answer the question "What is new here?" and envision a reader who is constantly saying "So, who cares, anyway?" Consider adding a section in the introduction at a strategic location (e.g., at the end of the introduction), titled "Summary, Innovations, and Implications."

Earlier, we presented a listing from Chapter 3 of the strategies researchers use to make theoretical contributions. Consider telling the reader the strategy or strategies you are using (in the introduction) or used (in the discussion) and make a case for why the strategies you chose are important. Chapter 3 also emphasized the importance of the originality, scope, and utility of a theory to reviewers and readers. Humbly build a case for these criteria in your presentation of the theory in the introduction section and reiterate it in the discussion section. Good theories generate future research, so it is important to include a description of the future research implications of the work in the discussion section.

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KEEP YOUR AUDIENCE IN MIND

Before writing a paper, it helps to have made a decision, at least tentatively, about the journal to which you plan to submit the paper for possible publication. This defines your "audience." Various criteria can be used as the basis for selecting a journal. A common strategy used by those who are at an early point in their careers is the quantitative impact factor of the journal. This index reflects how often articles published in the journal typically are cited by other researchers and are frequently thought to be indicative of the "prestige" of the journal. There are many limitations to such indices, and we tend not to rely on them when we are making placement decisions. To be sure, we seek to publish in journals that are rigorous and reputable in our discipline, but we form such judgments based on our own readings of the journals and in consultation with senior colleagues whose opinions we respect. When selecting a journal to submit an article to, we think more in terms of the audience we want to reach, that is, who the typical readers are of a particular journal and how large that audience will be. We also think about the likely backgrounds and orientations of the readers because these can affect how we ultimately structure and frame our theory to them. The type of scientist who reads a journal can best be determined by examining who publishes in the journal, the type of articles published in it, and who cites work published in that journal. A sense of the type of scientist who reads a journal and the types of articles published in it can be determined by examining recent issues of the journal. A sense of who cites the work can be garnered by choosing an article from the journals and then using Google Scholar to reveal other articles that have cited it.

Before a target audience will ever see a paper, however, it must first be accepted for publication. This means that you must also write with another audience in mind, namely, the likely reviewers of the article. If your theory is well articulated, clearly laid out, and makes a contribution, then these strengths will count a great deal toward your paper being accepted by a reviewer. With a complex theory and a complex study (or set of studies) surrounding a theory, it sometimes is difficult to anticipate all the reactions and issues that two or three diverse reviewers will have. Having a draft of a paper reviewed by your colleagues for purposes of feedback can help in this regard. A heuristic we often use is to assume we will be assigned an expert but hostile reviewer who seeks to find every fault he or she possibly can with our work and who is determined to reject our manuscript. Our task is to write the article in a way that addresses every concern the reviewer might have and to convert the reviewer to an advocate rather than a critic.

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USING FIGURES

Because journal space is limited, editors typically discourage the use of many diagrams or figures. Articles generally contain only two or three figures, if any. For variable- centered frameworks that rely on causality, an influence diagram can speak a thousand words, theoretically. Some theorists provide the influence diagram early in the introduction section and then use it to organize an ensuing narrative that considers each path or a cluster of paths in the diagram. The relevant literature is reviewed for each path to provide a sense of current knowledge about it, and then the contributions of the study to be reported are developed relative to this literature. Other theorists present a narrative organized in this way but reserve the presentation of the formal diagram until the end of the narrative, as a multivariate summary of the prior discussion.

Some theorists list theoretical propositions and label them with phrases like "Proposition 1." Such propositions formalize a theory and highlight its most important points. One can translate an influence diagram into propositions and present the logic verbally rather than using a figure. For example, in the case of mediated relationships, consider the assertion that the impact that watching violence on television has on aggression is mediated by the perceived legitimacy of acting aggressively. The mediational chain can be stated verbally as:

> Proposition 1: The more televised violence that people view, the more legitimate they perceive it is to act aggressively.
>
> Proposition 2: The more legitimate viewers perceive aggression to be, the more aggressively they behave.
>
> Proposition 3: The more televised violence that people watch, the more they will behave aggressively.

Some scientists prefer presenting theoretical propositions in this format, whereas others prefer influence diagrams with supplementary narratives.

CITE SOURCES FOR YOUR IDEAS, TEXT, AND RELATED ITEMS

Section 3.1.3 of the Council of Science Editors' (2012) White Paper on Promoting Integrity in Scientific Journal Publications defines plagiarism as "the use of text or other items (figures, images, tables) without permission or acknowledgment of the source of these materials" (p. 39). All of us are familiar with plagiarism. Many are not as familiar with "piracy," however, which the White Paper defines as "the appropriation of ideas, data, or methods from others without adequate permission or acknowledgment. The intent is the untruthful portrayal of the ideas or methods as one's own" (p. 39). In other words, not only is it unethical to use the exact words of another author without permission, it also is unethical to use ideas originated by others without adequate permission or acknowledgment.

Both authors, as well as a number of our colleagues, have been subject to blatant idea theft and, in some instances, plagiarism as well, and it is frustrating. Although many scientific societies and professional organizations have codes of ethics prohibiting plagiarism, a lesser number have corrective mechanisms for handling the problem. All too often, there is not much one can do about plagiarism or piracy.

That said, sometimes it is hard to remember the sources of your ideas. Moreover, there are instances (as with introductory texts, including this one) where providing citation after citation would burden readers. Furthermore, some journals place limits on the number of citations one can use, so that authors submitting work to such journals sometimes are left in a quandary as to which prior works to cite and which to ignore. So, piracy is not always a cut-and-dry matter. However, you should always approach your writings in the spirit of giving credit where credit is due.

DO NOT ENGAGE IN HARKING

Norbert Kerr (1998) coined the term *HARKing* (*H*ypothesizing *A*fter the *R*esults are *K*nown) to refer to scientists who write up a study as if the significant results were anticipated and hypothesized prior to data analysis when, in fact, the "hypotheses" were derived only after analyzing the data. HARKing can have the unfortunate effect of causing readers to presume higher levels of initial confidence in a proposition prior to conduct of the study, which, if one adopts Bayesian perspectives, can be detrimental to theory evaluation (see Chapter 15 as well as the broader discussion of HARKing by Rubin [2017]). It also is intellectually dishonest. We do not encourage the practice.

SPELLING, GRAMMAR, TYPOS, AND PUNCTUATION

If your manuscript has spelling errors, poor grammar, and/or "typos," then some readers will conclude that you are "sloppy" and don't care enough about your science. Scientists are noted for being careful and methodical thinkers, and these attributes should generalize to other areas of the scientific process, even to the level of spelling, grammar, typos, and punctuation. It is best to be compulsive in this regard.

READING AND WRITING ABOUT THEORIES

James Jaccard and Jacob Jacoby

Excerpted from *Theory Construction Model Building Skills, Second Edition*

In sum, when presenting your theory, good communication is the key. How you say something can be just as important as what you say. Being brief and to the point is preferred, but not at the expense of being scholarly. Many theorists benefit by creating outlines prior to writing. If you are developing many ideas, be sure to provide an overview of what you will be covering and make liberal use of headings. State the general problem and then do a succinct review of current knowledge. In addition to presenting the theory, be sure to discuss its implications and importance. As you do so, keep your target audience and reviewers in mind, give credit where credit is due, and correct those typos! In the final analysis, the best way to get a sense of writing styles is to read first-hand articles in the outlets where you will be publishing your work. It is through such readings that you will get a sense of the organizational structures and writing styles that typify successful writing in the areas of study you pursue.

THE ROLE OF THE ABSTRACT

The abstract of an article allows for only a few sentences about your theory. However, it is critical in that it usually is the first exposure readers and reviewers will have to your theory, and it can shape their impressions accordingly. An abstract that leads to the reader's reaction that your work is mundane is not a good starting point. This means you need to think carefully about how to summarize the essence or "big picture" view of your theory in a few sentences. Don't trivialize the role of the abstract. Decisions about whether an article is worth reading often are at stake.

GRANT PROPOSALS, TECHNICAL REPORTS, AND PRESENTATIONS

Social scientists write for different outlets, although by far the most common one is the scientific journal. All the principles discussed in this chapter will usually serve you well independent of the outlet for which you are writing. Technical reports usually include an "executive summary" that is intended to capture the essence and main conclusions of the larger project in one to three pages. The idea is that a top-level executive usually is too busy to read about the details: He or she just wants to get to the bottom line quickly and efficiently—but have the entire report available should he or she desire to read in greater detail.

It is common for researchers to seek funding for their research efforts. Grants can be pursued either from federal or state governments or from private, not-for-profit organizations. Typically, the social scientist writes a formal grant proposal and submits it for review by the agency that ultimately decides to fund (or not fund) the research. The level of detail and the description of the underlying theories guiding the research vary considerably, depending on the funding source and the goals. Many agencies focus on applied problems and are most interested in addressing those problems rather than advancing science or helping to accumulate knowledge about a problem area. In short, their focus is on solutions. Other agencies understand the importance of building a strong knowledge base through both theory and research and demand that strong theories guide the efforts of the research they fund. If you pursue funding for your research, look carefully at the proposal guidelines developed by the funding agency, determine the focus and goals of the agency, and try to find examples of successful proposals in your field to see how theory was presented in those proposals.

In terms of oral presentations, you typically will give presentations that are either 15 minutes long (e.g., at a scientific convention) or 45–50 minutes long (e.g., at a job talk or a colloquium). Usually, only a small portion of this time is used to describe your theory—perhaps one-fourth or one-third of the allocated time. In oral presentations, you might spend a few minutes on a literature review that summarizes current knowledge, a few minutes laying out the theory itself, a few minutes describing what is new and innovative about the theory you propose, and a few minutes on its implications. The book by Alley (2003) in the Suggested Readings section provides numerous useful strategies for structuring presentations. Our companion website (www.theory-construction.com) has links to videos about preparing presentations and posters at conferences.

SUMMARY AND CONCLUDING COMMENTS

When reading theories in scientific reports, we want to capture the essence of the theory being addressed. For variable-centered theories, a useful strategy is to make a list of the variables in the theory, write out their conceptual definitions, and then draw a path diagram to reflect the presumed causal relationships that operate between the variables. A well-specified theory will clearly articulate the concepts on which it focuses, the nature of those concepts, and the relationships between variables. If the theorist is vague or unclear about these matters, you often will find clarity as the researcher instantiates his or her theory in the methods and results sections. For process-oriented theories, you should list the relevant processes and try to characterize each, perhaps using the process map described in Chapter 10.

READING AND WRITING ABOUT THEORIES

James Jaccard and Jacob Jacoby

Excerpted from *Theory Construction Model Building Skills, Second Edition*

When writing about your theory, you need to follow several key imperatives, notably: (1) attend not only to what you say but also to how you say it, (2) be brief and to the point, but not at the expense of good scholarship, (3) work from outlines, (4) provide readers with an overview of the organization of the paper, (5) make liberal use of headings, (6) provide a succinct review of the literature and characterize the current state of knowledge about the phenomena you are studying, (7) discuss the implications and importance of your theory, (8) always keep in mind the target audience and reviewers, (9) give credit for ideas where credit is due, and (10) do not HARK. The best way to get a sense of good scientific writing is to read articles in journals where you intend to publish and take note of the styles used.

SUGGESTED READINGS

Alley, M. (2003). *The craft of scientific presentations*. New York: Springer.

—A host of strategies for making effective scientific presentations, based on the techniques of scientists who are effective presenters.

Becker, H., & Richards, P. (2007). *Writing for social scientists: How to start and finish your thesis, book, or article*. Chicago: University of Chicago Press.

—A well-written book about practical writing strategies for social scientists. One of the better resources on the topic.

Council of Science Editors. (2012). White paper on promoting integrity in scientific journal publications. Retrieved from www.councilscienceeditors.org/wp-content/uploads/entire_whitepaper.pdf.

—An excellent source of information on the roles and responsibilities of authors, editors, reviewers, sponsoring societies, and media in regard to publishing scientific papers.

Friedland, A., & Felt, C. (2000). *Writing successful science proposals*. New Haven, CT: Yale University Press.

—Strategies for writing grant proposals.

Locke, L., Silverman, S., & Spirduso, W. (2010). *Reading and understanding research, 3rd ed*. Thousand Oaks, CA: SAGE.

—A very clear exposition of strategies and principles for reading research articles.

Peter, J. P., & Olson, J. (1983). Is science marketing? *Journal of Marketing, 47*, 111–125.

—A discussion of the importance of selling readers on your ideas.

Silva, P. (2015). *Write it up: Practical strategies for writing and publishing journal articles*. Washington, DC: American Psychological Association.

—A "how to" for writing articles and working through the publication process.

Sternberg, R. (2003). *The psychologists' companion: A guide to scientific writing for students and researchers* (4th ed.). New York: Cambridge University Press.

—A book filled with ideas for more effective writing by social scientists.

KEY TERMS

Introduction section (p. 462)

Methods section (p. 463)

Results section (p. 464)

Discussion section (p. 464)

EXERCISES

Exercises to Reinforce Concepts

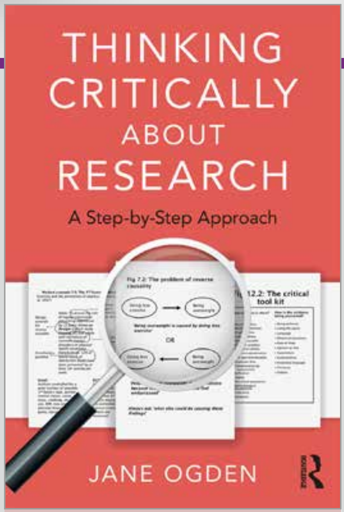
1) Describe the strategy you would use to discern a theory from the introduction section of a journal article.
2) In what ways can you use the method section to help give clarity to a theory?
3) Describe what you think are the most important points to keep in mind when writing about a theory.

Exercises to Apply Concepts

1) Choose an article that empirically tests a theory and write a short summary of that theory. Identify points in the theory that need clarification or elaboration.
2) Write a report that presents either a theory of your own or an existing theory from the literature using all the principles discussed in this chapter.
3) Prepare a PowerPoint presentation of a theory and present it to someone.

2

THINKING CRITICALLY ABOUT THEORY



This chapter is excerpted from
Thinking Critically about Research, First Edition
By Jane Ogden

THINKING CRITICALLY ABOUT THEORY

Jane Ogden

Excerpted from *Thinking Critically about Research, First Edition*

In *Thinking Critically About Research*, Jane Ogden is helping the reader discern between fact and fiction. What is real and what is fake? What should we believe and what should we reject? In an environment of information overload, a distrust of experts, the circulation of misinformation and false facts, and public debates based upon poor evidence, *Thinking Critically About Research* comes at a vital juncture. The book is designed to help readers develop a critical understanding of evidence and the ways in which evidence is presented, and to challenge the information they receive in both academic and non-academic sources. The chapter "Thinking Critically About Theory" explores how to think critically about theory in terms of two problems of meaningfulness and differences and two key tensions between the obvious and absurd and between specificity and inclusivity.

OVERVIEW

The final area for thinking critically about research is theory. Although theory often frames research and can be considered part of the basic structure to any research study, thinking critically about theory is more conceptually complex which is why I have left it to last in this section. This chapter will therefore explore how to think critically about theory in terms of two problems of meaningfulness and differences and two key tensions between the obvious and absurd and between specificity and inclusivity. This completes step 2 of thinking critically about research and the first question 'what evidence is there'?

TWO PROBLEMS

Thinking critically about theory involves being aware of two problems: the problem of meaningfulness and the problem of difference.

THE PROBLEM OF MEANINGFULNESS

When listening to a lecture, reading a research paper, or watching coverage of research in the media it is easy to sit back and accept it all as true because it is being presented by an 'expert' or published in print in an outlet that must be 'respectable'. But sometimes we get the sneaking feeling that 'this doesn't make sense' or might be 'just nonsense'. The first stage of thinking critically about theory involves trusting this feeling rather than pushing it away, thinking 'who am I' or 'I'm just being stupid' then working out exactly what the theory is saying and whether it is meaningful. It also helps to put the theory into simple terms and relate it to your own experience to

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see if it makes sense. This is illustrated by both past and current theories.

Past theories: In the past, there have been many theories that were considered meaningful in their time but have now been rejected. For example, the study of phrenology argued that human characteristics such as aggression, perfectionism, intelligence, or musicality were located in very specific areas of the brain and that these areas grew bigger when people excelled in them. Scientists used to study the shape of people's heads to find out what kinds of people they were by feelings for lumps and bumps around each specific area and the Nazis used this method in WWII to identify people of Jewish heritage. A majority of people also used to believe that the Earth was flat and that if you travelled to the edge you would fall off. Similarly, humoral theory was endorsed up until the 19th century, which argued that the body was made up of phlegm, black bile, yellow bile, and blood. If in balance, the person was healthy. But if they had too much of one humour they became ill; excess phlegm made people 'phlegmatic' or apathetic; excess black bile made people 'melancholic' or depressed; excess yellow bile made people 'choleric' or angry; and excess blood made people 'sanguine' or hopeful. In retrospect, it easy to criticise these theories and see them as 'nonsense' but at the time if people had only critically questioned 'how come I am more musical than my friend but don't have a bigger bump where I should have one'?, 'when I walk to the horizon why does it change and not get any nearer'? and 'why have I never seen these humors'? then maybe they would have been seen as meaningless and not believed at the time.

Current theories: It is not just the past; however, that has meaningless theories. When AIDS started to emerge in the US a key theory was that it was the result of recreational drug use in homosexual men rather than a contagious virus. In fact, some conspiracy theorists still believe this. But a bit of critical thinking to ask 'why have some people with AIDS never taken recreational drugs'?; 'why is AIDS also apparent in heterosexual people who don't take recreational drugs and have had blood transfusions'; or 'why are children born HIV positive'? would make it clear that it is contagious. Even more recently, researchers in my field still argue 'Obesity is caused by genetics' and cite the statistic '80% of body weight is genetically determined'. I struggle with this as I know evidence shows that when people migrate to a new country their body weight increases to match that country (i.e. their genes remain constant but their environment and behaviour changes). I also know research indicates that body weight runs in friendship groups (who share environment and behaviour but not genes), and I also know that when I am ill and eat less I lose weight and when I go on holiday and eat more I gain weight.

It is therefore good to question whether theories are meaningful. Sometimes they are. But sometimes when you put them into simple terms and relate them to your own experience they just don't make sense. This is a good step towards thinking critically about theory.

THE PROBLEM OF DIFFERENCE

The world is a complex place and there are many variables to study and many ideas about how the world works. To make it clearer, researchers rely upon differences so they can classify this complex world into more manageable chunks. To do this they use conceptualisation and operationalisation to define and measure variables so that they are different than each other. These 'different' chunks underpin the many boxes we see in our theories that describe these 'different' chunks and then see how they fit together. The need for different chunks makes research easier and is an essential process of classification without which we would just have a blur or unclassified 'soup'. But this need for difference also raises the problem of difference and whether one box is really different than another. This can be seen for constructs, stages, statistics, and associations.

Different constructs: Theories are based upon constructs that form the core to any discipline. For example, sociology draws upon social class, gender, and culture; psychology emphasises mood, cognition, and behaviour; and medicine is based upon health, disease, and life expectancy. Critically thinking about theory involves questioning whether some of these constructs are as different to each other as often proposed. I have been a psychologist for 30 years, but I am still not convinced by the difference between a cognition and an emotion: Is the thought 'I am sad' an emotion or a cognition? Once any emotion has a label and can be thought about, does it become a cognition? Can we therefore ever describe an emotion? Some psychologists also differentiate between different types of personality such as 'empathising' (relating to emotions) and 'systematising' (making things ordered into lists). This is hypothesised to relate to autism and to be gender linked. But I am very emotion orientated (and very people friendly) but like to order things (including emotions: I am happy because of xxx; sad because of xxx; and frustrated because of xxx). I am both these personality types; are these two types of personality actually different? Constructs are put into boxes and treated as different to each other but does this difference makes sense? The difference between these constructs may be far more arbitrary and blurred than presented but research treats them as separate and discrete as this classification process makes research more straightforward. The problem of different constructs is illustrated in Worked Example 17.

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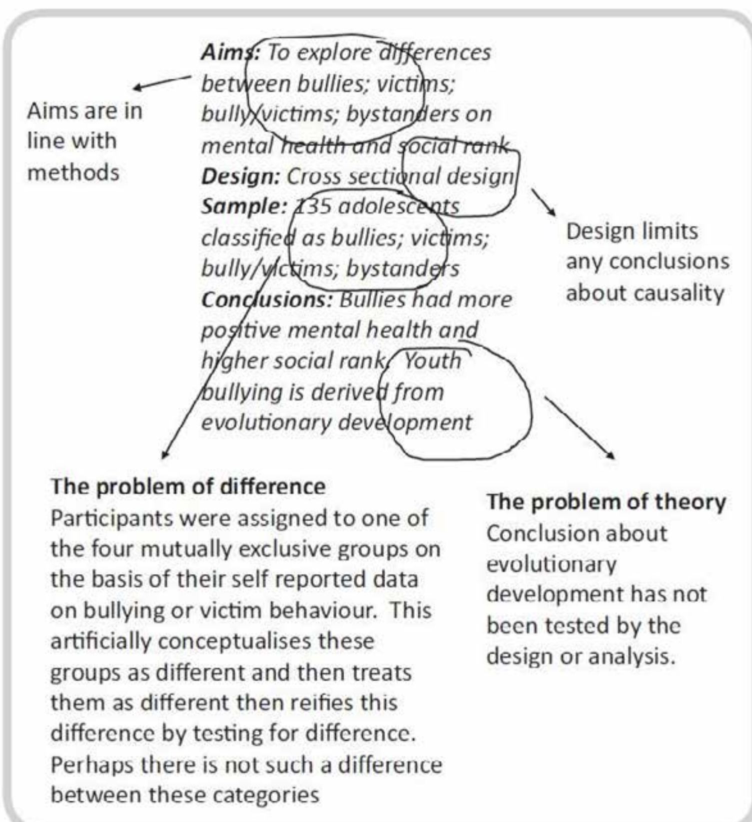
Different stages: Some theories also have stages whereby a temporal order is attached to the different constructs. For example, morality is seen to develop through six stages grouped into three levels: pre-conventional, conventional, and post-conventional morality. Similarly, the Stages of Change Theory describes how addictive behaviours involve six stages from precontemplation to relapse (DiClemente & Prochaska, 1985; see Task 7) and Theories of Grief highlight five stages of denial, anger, bargaining, depression, and acceptance (Kübler-Ross, 1969). Even the Sun is described as having a life cycle as it passes through different stages. These stage theories consider change to be discontinuous with each stage being qualitatively different to the previous one. But are they actually different? Or do they just merge seamlessly into each other, but we impose stages artificially for simplicity. And do they always occur in the specified order? And how would we be able to show whether they are different stages or not? Like with constructs, these stages may be more blurred and not as discrete as they are often presented. This relates to the next problem of difference: statistics.

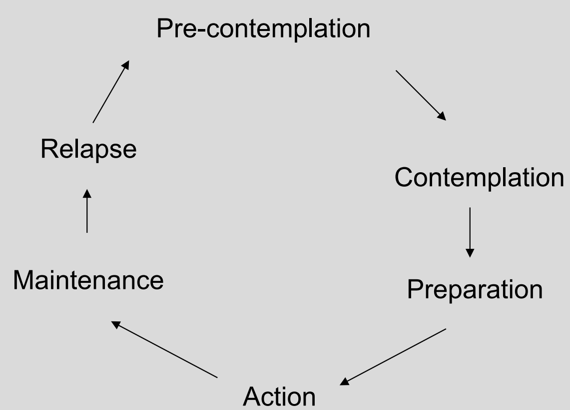


Evolutionary origins of bullying (Koh & Wong, 2015).

Difference statistics: Research questions involve exploring differences between constructs (mood vs. cognition) or stages (denial vs. anger). They also look for differences within these constructs whether by gender (male vs. female), age group (old vs. young), illness group (cancer vs. heart disease),

Look at the model below:

- Are the stages really different to each other?
- Are they just artificially imposed on a continuum?
- Are the stages always in the same order?
- Can the stages go backwards?
- How can we test that they are different?



Task 7 The problem of difference: different stages (Prochaska & DiClemente, 1982).

or ethnic group (White vs. Black vs. Asian). These research questions are then tested using statistics which explore differences between counts (men vs. women) or means (mood vs. cognition). The results then tell us whether there is a difference. There are two problems inherent in this process. First, it assumes the groups, constructs, or stages are different in the first place. This may not be the case and the boundaries between these groups, con- structs, or stages may have been artificially imposed. Second, by asking a differences question (men vs. women) and using a differences statistic (the mean for men vs. the mean for women) we inevitably find a difference (or don't) which **reifies** the notion that the different groups exist. For example, whether or not we find that men are stronger

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than women, by asking the question and testing the data with statistics the classification of gender into men and women has been reified. This **process of reification** can create **false dichotomies** whereby blurred variables become split into groups, constructs, or stages and through statistics, the different group (men vs. women), constructs (mood vs. cognition), or stages (anger vs. denial) start to seem real. The constructs therefore become different because we treat them as different.

This was a dyadic study exploring the disordered eating of mothers and daughters. If I asked 'Do mothers and daughters have different levels of disordered eating?' the answer was 'Yes. Daughters have higher levels of disordered eating than their mothers. BUT if I asked 'Are mothers and daughter levels of disordered eating related to each other?' the answer was 'Yes. The greater the mothers disordered eating then the greater the daughters eating. The choice of research question, determines the statistics used which determines the answer you get!

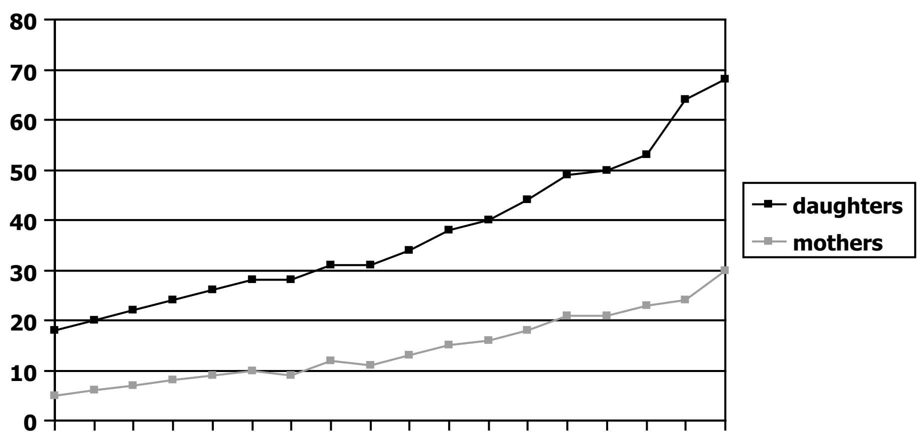

Figure 10 The problem of difference statistics.

USING STATISTICS: WHAT QUESTION YOU ASK DETERMINES THE ANSWER YOU GET.

We then test the difference between them using difference statistics. The problem of difference statistics is illustrated in Figure 10. The problem of association: When variables have been conceptualised and operationalised as being different to each other, theories then explore how they fit back together. For example, researchers might theorise that burnout at work is a product of coping, social support, and appraisal. These constructs are defined as discrete; the theory then hypothesises how they might be associated with each other. Likewise, researchers might argue that the recovery from a heart attack relates to the severity of the heart attack, changes in behaviour such as smoking and exercise, and a sense of control. These are defined as separate constructs that are then analysed to find associations between them. Sometimes the constructs are actually discrete from each other and it makes sense to see if they are related. This is known as 'truth by observation' or 'synthetic truth'. For example, the theory that 'smoking causes lung cancer' is true by observation and a synthetic truth because the definition and measurement of 'smoking' is different to the definition and measurement of 'cancer'. Many theories, however, involve 'truth by definition' and 'analytic truths' which are more problematic. This is because they are tautological and associating like with like. For example, 'heart disease is caused by hardening of the arteries' is tautological and an analytic truth because 'heart dis- ease' is defined as 'hardening of the arteries'. Likewise, 'depression' causes 'insomnia' is an analytic truth because the definition and measurement of depression includes a measure of insomnia. Similarly, the finding that 'how people make sense of their illness' is associated with 'coping' is problematic because the items used to measure both these constructs overlap. This problem of tautology is core to many theories and a product of imposing difference then looking for associations between these 'different' variables. It is not surprising that we find associations when we are simply comparing like with like. This problem of tautology is illustrated in Figure 11.

ARE THE CONSTRUCTS REALLY DIFFERENT?

Many theories create different constructs and then see if they relate to each. If they are conceptually different this is an example of synthetic truths. Often the constructs are actually the same. Associating 'like with like' in this way illustrates the problem of analytic truth and the issue of tautology. The TPB (Azjen, 1985) can be criticised for this (Ogden, 2003).

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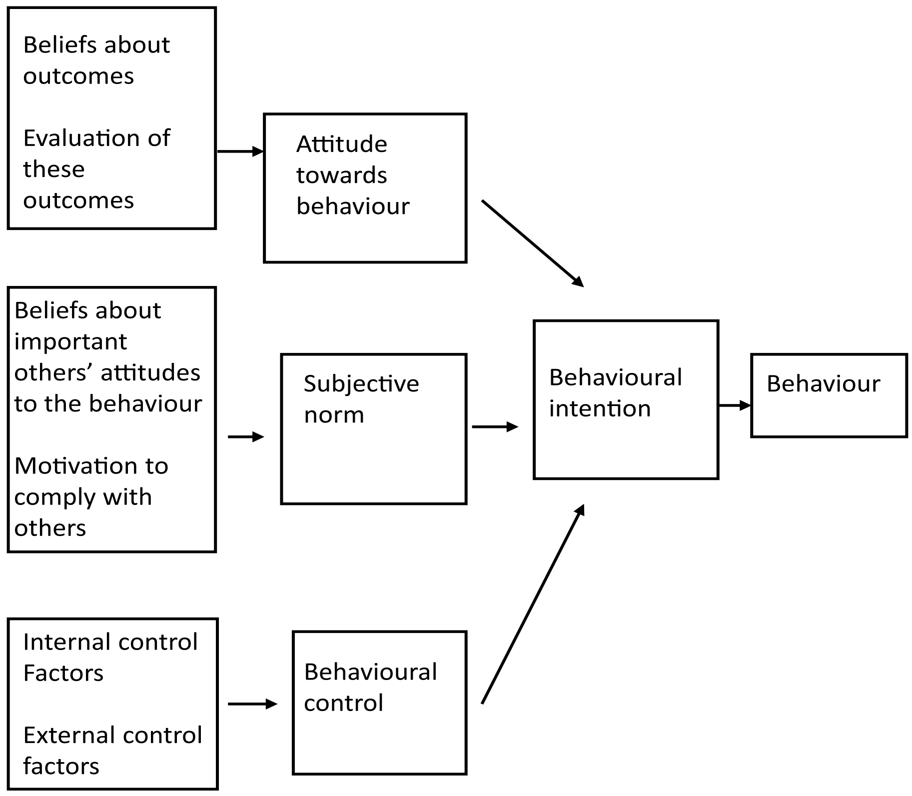

Figure 11 The problem of tautology.

Thinking critically about theory requires understanding whether or not a theory is meaningful. It also involves addressing the problem of difference in terms of whether constructs and stages are as different as sometimes proposed and whether this difference is being reified through statistics. Further, once constructs have been defined as different, theories often show how they relate to each and this can involve analytic truths and the problem of tautology.

SOME KEY TENSIONS

Theories can also be critically analysed in terms of two key tensions: between the obvious and absurd and between specificity and inclusivity.

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BETWEEN THE OBVIOUS AND ABSURD

Theories should frame research, offer a new and interesting way of thinking, and be a product of creative thinking. But they also need to fall some- where between the extremes of the being blatantly obvious and absurd. I am a psychologist but have spent much of my career working with non-psychologists. When I explain my discipline to these GPs, surgeons, nurses, dieticians, or nutritionists I often see their eyebrows raise as I say 'yes people eat a healthy lunch because they intend to'; 'those who think fruit and vegetables are good for them are more likely to eat them'; 'those who feel capable of cooking, cook' or 'people are more likely to eat carrots if they can access them'. If we are not careful, research can very quickly descend into the science of the blatantly obvious as we test our common sense hypotheses only to discover what the rest of world knew already. Yet at the other extreme, theories should not be absurd either. 'I eat fruit and vegetables . . . because I think they are good' may be obvious but 'I eat them . . . because I like elephants' would be bizarre! So somewhere between the two is a good place to position ourselves. Although this place is hard to define, I think it has something to do with 'surprising', 'novel', or 'exciting'. From my own discipline, here are some examples: Peter Herman suggested that if you intend to eat less you eat more – that's surprising (Herman & Mack, 1975); Wegner argued that if you try to not think about something, you think about it more – that's exciting (Wegner, 1994), and Richard Totman suggested that a placebo works better if you invest in it as it creates cognitive dissonance which was novel (Totman, 1987). Thinking critically about theory involves recognising the tension between the blatantly obvious and the absurd and working out where any given theory lies. There is a good test for this. Put the theory into simple terms, do the 'friends test' and watch for one of these three reactions: (i) If your friends say 'is that it?!' you have reinvented the blatantly obvious; (ii) Watch their eye brows and if they go up (in a good way) you have invented something surprising; (iii) If they laugh out loud you have invented the absurd. Be careful though as some 'absurd' theories can turn out to make more sense than we might initially think. For centuries, stomach ulcers were believed to be caused by stress. When Marshall and Warren suggested that they might be caused by bacteria this was laughed at as 'absurd' as 'bacteria can't live in the highly acidic stomach'. They turned out to be correct (by drinking the bacteria then treating themselves with antibiotics) and identified *helicobacter pylori* which has given us one of the most effective treatments of the past few decades.

THINKING CRITICALLY ABOUT THEORY

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BETWEEN SPECIFICITY AND INCLUSIVITY

Thinking critically about research also involves an analysis of the tension between specificity and inclusivity. There are many different theories (laws, models, and frameworks) used in research which range from the specific and focused to the inclusive, generic, and broad. Those that are specific can be clearly operationalised but only work within very limited domains and can always be criticised for what they miss. For example, Nudge Theory suggests that behaviours can be best changed by making small alterations to the environment and influencing the 'choice architecture'. An example would be placing fruit next to the till in a supermarket rather than being tucked away (this is illustrated in Figure 12). Similarly, the COM-B (Michie, van Stralen, & West, 2011; Michie, Atkins, & West, 2014) argues that behaviour is driven by capability (I can cook), opportunity (I have a cooker), and motivation (I want to cook). These specific theories are in part true, but are met by the cry 'but it's not as simple as this'. In contrast, inclusive theories miss nothing but are difficult to test and are seen as 'kitchen sink theories', a 'theory of everything', or a 'theory of quite a lot of things'. For example, the Behaviour Change Wheel (Michie et al., 2011) recognises not only the role of individual level factors but also 'biological and external factors' and 'includes environmental planning, legislation, and fiscal measures'. (This is illustrated in Figure 13). Likewise, Engel's Biopsychosocial theory (Engel, 1977) is a useful framework but is so inclusive it is impossible to test. Similarly, the Foresight report on obesity was so complex it was hard to use (Butland, 2007; see Figure 14). There is therefore a tension. Be specific and testable but miss something and make things seem more simple than they are or be inclusive and miss nothing but be unwieldy with limited utility.

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The classic example of 'Nudge theory' are the plastic flies in urinals which 'improve aim'. This works for this very specific behaviour but is changing more complex behaviours such as diet, exercise, sleep, smoking etc as easy as this?

Figure 12 Being critical of theory.

The tension between specificity and inclusivity: being too specific.

Nudge: 'any aspect of the choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives' (Thaler & Sunstein, 2008).

There is tension between theories being too specific (when they miss out key variables) and too inclusive when they include everything. The Behaviour Change Wheel (Michie et al, 2011) can be criticised for being too inclusive (Ogden, 2016ab).

THINKING CRITICALLY ABOUT THEORY

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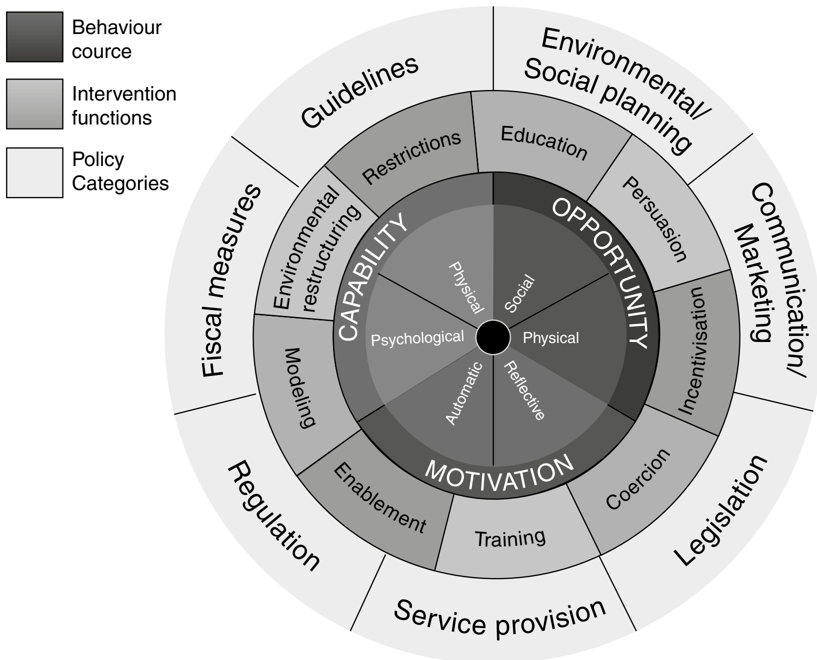

Figure 13 Being critical of theory.

The tension between specificity and inclusivity: being too inclusive (Michie et al., 2011). The behaviour change wheel (Michie et al., 2011).

The Foresight Report on the problem of obesity was published in 2007. It was extremely comprehensive and included every level of every possible factor. It was impossible to implement in any useful way.

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Excerpted from *Thinking Critically about Research, First Edition*

FULL GENERIC MAP

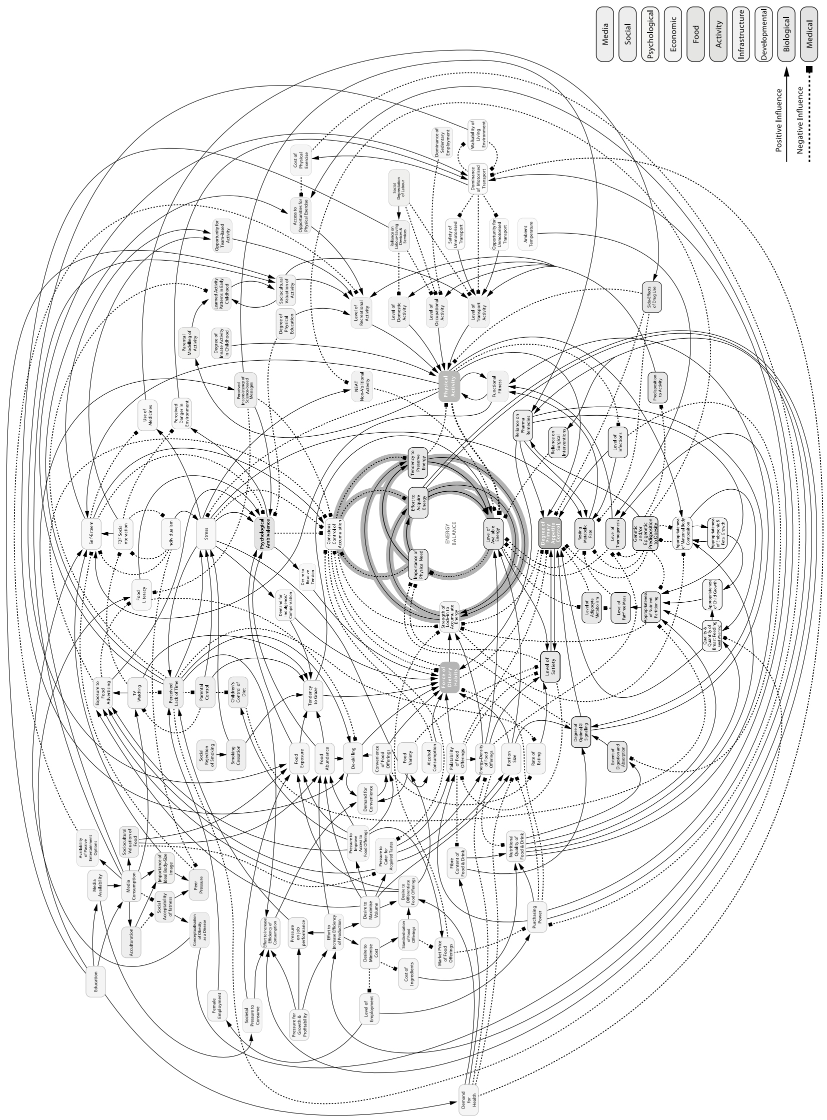

Figure 14 Being critical of theory.

The tension between specificity and inclusivity: being too inclusive (Foresight report on obesity, 2007).

THINKING CRITICALLY ABOUT THEORY

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Excerpted from *Thinking Critically about Research, First Edition*

IN SUMMARY

Thinking critically about research involves knowing how research is done and then being able to criticise each of the different components. This chapter has highlighted how to think critically about theory in terms of the problems of meaningful-ness and difference and the tensions between being obvious and ridiculous and between specificity and inclusivity.

WHAT EVIDENCE IS THERE?

Step 1 involved knowing methods and developing an understanding of the processes involved in doing research. Step 2 then described how to think critically about each of these processes from the basics, through design, measurement, data analysis, and theory. This highlighted a wide range of potential problems with research that all limit the conclusions that can be made and raise questions as to whether any conclusions are justified. The next step is to understand the ways in which evidence is presented and how this can persuade the reader to believe what they hear or read.

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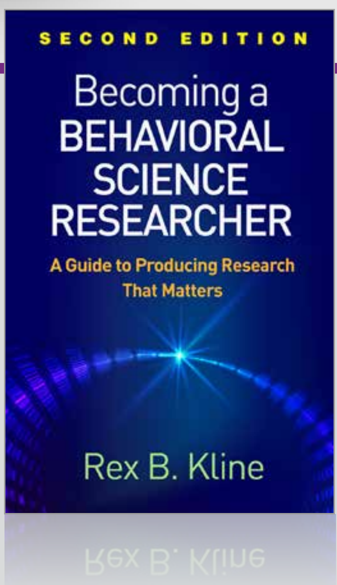
OPEN SCIENCE



This chapter is excerpted from

Becoming a Behavioral Science Researcher, Second Edition

By Rex B. Kline

OPEN SCIENCE

Rex B. Kline

Excerpted from *Becoming a Behavioral Science Researcher, Second Edition*

In *Becoming a Behavioral Science Researcher, Second Edition: A Guide to Producing Research That Matters*, author Rex Kline helps novice behavioral scientists hit the ground running as producers of meaningful research. In this chapter, entitled "Open Science," Dr. Kline explains the open science movement, which emphasizes greater accessibility and transparency in sharing data and analysis materials. The chapter includes tips on open source tools as well as strategies for enhancing open access, transparency, and accountability.

How many times have you had this experience? You are using Google or a different web search engine to find scientific articles related to your thesis. On the search results page, you read the description for a recent empirical study that looks especially relevant. You click on the link for the study. Next, you read the abstract on the website of the journal in which the study was published. With excitement you realize that this study seems perfect for your literature review. Next, you click on the link for article access. The only option that comes up is "Purchase PDF for $79.99." Congratulations, you just hit the paywall of a for-profit publisher. If there is no other way to access the article, then either you pay to play (buy the article in order to read it) or skip it. A tenet of the open-science movement is that price barriers should never come between students (or anyone) and the products of scientific research. The open-access principle also includes data, tools, lab notes, and peer reviews; that is, all these resources or materials should be freely available and thus transparent. Open access and other open-science principles are described in this chapter. The open-science movement is already changing how granting agencies, journals, and other repositories of scientific knowledge operate, so young scholars should know about it.

WHAT IS OPEN SCIENCE?

Open science has two basic principles: accessibility and transparency. This means that (1) research should be conducted in open, replicable ways where (2) all components of research, including data, methods, peer review, and publications, are freely available (Hanwell, 2015). The goal is to make it easier to publish and distribute research results to any interested party, whether fellow researchers or members of the general public. Pay-to-play access to articles or research tools, such as specialized computer software, closed peer review, no access to data, and dissemination of research findings to narrow, elite audiences are all antitheses of open science. The open-science movement is confined mainly to publicly funded research, for which its advocates insist that those who fund research should be accorded unrestricted access to it.

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Pontika, Knoth, Cancellieri, and Pearce (2015) described a taxonomy of components and ideas behind the open-science movement. Outlined in their categorization are associations between the four core principles of open science and more specific practices, workflows, policies, or techniques in particular situations. Listed next are the core principles. Each corresponds to an open movement with roots in publishing, government, engineering, computer science, or social advocacy, among other areas. Their convergence in open science calls for profound changes in practices that concern the whole research life cycle:

1. **Open access** means that peer-reviewed scholarly research is freely available online to any interested party. There are now many open-access journals in both the natural and social sciences, but some levy an article processing charge when an article is accepted for publication. These charges take the place of subscriptions as revenue for the journal. Some journals distributed by for-profit publishers offer the option for open-access publication, if the researcher elects to pay the charge.
2. **Open data** refers to research data that can be freely accessed or used by anyone. Some journals now offer the option for researchers to post their data files (after measures are taken to preserve confidentiality), along with other supplemental materials that can be freely retrieved by readers, who can verify results of the original analyses or conduct new analyses not pursued by the original researchers.
3. **Open source** stems from computer science, and it means that software can be accessed online with a license that permits the free use of the software or even alteration of its source code, which is editable by users (i.e., it is not proprietary).
4. **Open reproducible research** is the practice of open science in ways that support the independent replication of original empirical results. Reporting standards aimed at enhancing replication is part of this movement. Another is open-notebook science where research notes, records, diaries, and lab procedures are made freely available online with terms for their reuse and distribution (Pontika et al., 2015).

Described next are additional concepts of open science. Some are more specific aspects of the four core principles just considered or have relatively shorter histories (Pontika et al., 2015):

1. **Open-science evaluation** consists of two subtopics. One is open peer review, which means that the whole scientific review process is public. This reform includes disclosing the names of peer reviewers to authors and making all

reviewer commentary and author responses accessible to readers after an article is published. That is, the entire prepublication history of a paper is transparent. The other subtopic is **open metrics and impact**, which includes the public reporting of article and journal metrics of impact, or statistics that summarize the citation frequency of published works, such as impact factors or the number of citations.

2. **Open-science tools** refer to computer tools, equipment, or services that support the practice of open science. Examples include freely available software for managing research project workflow, web platforms for training in open science, and repositories for open archiving of the scientific literature and related content.
3. **Open-science policies** concern guidelines or incentives by institutions such as granting agencies or governmental bodies that encourage the practice of open science. One example is the effort to reorganize science publishing around open-access principles. Another is the awarding of open-science badges by journals to researchers who share data and materials or who preregister studies.

Some essential characteristics of open science are considered in more detail next.

OPEN ACCESS

Suber (2012, p. 4) defined **open-access literature** as "digital, online, free of charge, and free of most copyright and licensing restrictions." Although free for readers, researchers may be required to pay article processing charges that cover publishing costs in open-access journals. These charges vary greatly, depending on the journal. Most open-access journals—roughly 70%—require no fee; others assess nominal charges of, say, $1–50, but still others, such as open-access journals in medicine or those with higher impact factors, can levy processing charges of Ð$5,000. A rough average amount would be about $1,500 among open-access journals with higher profiles that charge processing fees (Markin, 2017). Such charges are typically paid through grant funds instead of the researchers' own pockets, but the costs can be rather substantial.

Article processing charges are a possible hindrance to thesis students, either undergraduate or graduate, who do not typically have direct access to grant funds (and have relatively little disposable income, too). Unless their supervisors pay for such charges out of grant funds, thesis students may be prevented from submitting manuscripts to open-access journals with charges. It helps that many open-access journals do not levy processing charges, but only if such journals are appropriate outlets for the research of a particular thesis student.

Traditional copyrights on published works, intended to protect the intellectual property rights and financial interests of both publishers and authors, can be another kind of access barrier. Such copyrights basically transfer **exploitation rights** from author to publisher. This means that permission to reproduce, reuse, translate, or modify the content of a copyright-protected work must be sought from the publisher. This requirement holds even for authors of the original material. Although there may be no permission fee to reproduce or adapt small portions of a copyrighted work, fees for larger requests can run into hundreds or even thousands of dollars. The permission-seeking-with-fees model of traditional copyright serves the interests of authors looking to make money on their published works, but not all science writers are so motivated. That is, some researchers may simply want to share their work as widely as possible (Suber, 2012), but traditional copyright restricts this intention.

In open-access publishing, there are basically three alternative models for traditional copyright regarding author rights (Hoorn & van der Graff, 2006):

1. **Retain it**, which means that authors keep the copyright, and that copyright allows for free classroom use of the material, but other uses require author permission. Also, the author is free to publish the same work elsewhere, but only with proper reference to the original (first) publication. This model spares authors the necessity to ask permission to share their own work. It also relieves journal editors or publishers from dealing with permission requests.
2. **Share it**, which nowadays refers to a Creative Commons license that is shared with authors. Creative Commons is a nonprofit organization that licenses the sharing and reuse of original material.[1] These licenses reserve the right for authors to be properly cited for their work but with fairly generous allowances for others to use or reuse the material, even for commercial purposes. Suber (2012, chap. 3) has described other variations on Creative Commons licenses.
3. **Partly transfer it**, which is a copyright model adopted by some journals that switched from for-profit publication to open-access publication. Licenses in this model assign copyright to the author, but the publisher retains all commercial exploitation rights. This means that authors are free to share their work in any way except for commercial republishing or redistribution, for which the original publisher holds the rights.

Removal of copyright price barriers only is called **gratis open access**, whereas removing at least some permission barriers is known as libre open access. In the United States, even traditional copyright allows for fair use, which permits use of a

[1] https://creativecommons.org/

work for purposes such as teaching, scholarship, criticism, or research without the need to seek publisher permission. But what actually constitutes "fair use" can be ambiguous, and the specific definition of fair use changes over countries. With these limitations in mind, gratis open access removes price barriers, but users must still seek permission to exceed fair use. In **libre open access**, users can exceed the bounds of **fair use** in certain ways, such as when the publisher retains commercial rights but allows noncommercial uses of a work (Suber, 2012).

The distinction between gratis and libre open access concerns the rights of users, but the difference between gold versus green open access concerns how content is delivered, or the venue (Suber, 2012). In gold open access, open access is delivered by the journal itself. It usually means that

(1) free public access is available for an article as soon as it is published;

(2) the article processing fee, if any, is paid by authors, or on their behalf by an institution or funding agency; and

(3) authors may be offered a choice between a commercial or noncommercial user agreement[2].

Green open access involves an **open repository**, which is an electronic archive or database that hosts scientific documents with free public access to those materials. After a submission is reviewed and accepted for publication in an open-access journal, it is the researcher who **self-archives** a version of the article in an online open repository. Public access will not be immediate if there is an **embargo period**, or a length of time specified by the publisher before which access to the work is free and unfettered. Embargo periods vary by journal, but they generally range from 6 to 24 months. There may be no article processing charge for green open access. Suber (2012) noted that green open access can be either gratis or libre, but it is usually gratis open access (no price barrier only). In contrast, gold open access is more likely to be libre open access (no price or permission barrier).

There are thousands of open repositories, some sponsored by institutions, such as universities, and others devoted to particular subjects or research areas. It would not be feasible for a researcher to search them all one by one. Fortunately, there are some free open-science tools or services for searching many open repositories at a time. An example is OpenDOAR (Directory of Open Access Repositories), a freely available online search engine that covers thousands of institutional- or subject-based open repositories[3]. A second example is the Clearinghouse for the Open Research of the United States (CHORUS), which is a partnership between the federal

[2] Other color words that describe open-access status include bronze, platinum, titanium, white, and copper, but they are not yet used consistently in the literature.

[3] http://v2.sherpa.ac.uk/opendoar/

government and open-access publishers. It consists of development tools for publishers, institutions, and researchers for increasing public access to peer-reviewed publications reporting on federally funded research[4].

Suber (2012) argued that (1) open peer review complements open-access publishing by making transparent all intermediate steps in the process, from the submission of an original manuscript through initial peer review and, for manuscripts not rejected outright, subsequent revisions and new rounds of peer review. Also, (2) open peer review requires open access, but not the other way around. That is, not all open-access journals have open peer-review policies.

Increasing proportions of research articles are published in open-access journals. For example, Piwowar and colleagues (2018) selected three random samples of 100,000 articles, each from an online database about open-access scholarly articles. About 28% of the articles sampled were published as open-access works. In the most recent year surveyed (2015), about 45% of the articles were open access. About half of all publications in biomedical research and mathematics were freely available, while less than 20% of articles in chemistry and physics were open access. In psychology, about 30% of all articles were open access. Open-access articles received about 18% more citations than average after controlling for discipline and length of time since publication. In contrast, works protected by a paywall were cited 10% below average.

OPEN DATA

The practice of open science—transparent, accountable, and verifiable—requires open access to research data. Free access to data promotes the following goals and activities:

1. Original results can be verified.
2. New hypotheses can be tested by other researchers who conduct analyses not performed in the original study.
3. Data from one or more original studies can be combined with new data, which means that new work can readily be built on previous findings.
4. Research synthesis including meta-analysis is easier to carry out when complete data are available from primary studies.
5. The occurrence of research fraud, an infrequent but ugly reality in science, is easier to detect when original data are accessible.

[4] https://www.chorusaccess.org/

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Other motivations for open-science data include ethical standards of professional associations and granting agency requirements. For example, the code of ethics for the APA states that

> after research results are published, psychologists do not withhold the data on which their conclusions are based from other competent professionals who seek to verify the substantive claims through reanalysis and who intend to use such data only for that purpose, provided that the confidentiality of the participants can be protected and unless legal rights concerning proprietary data preclude their release. (2017, Section 8.14)

Major granting agencies, such as the National Science Foundation and the National Institutes of Health (NIH) in the United States, have increasingly mandated data access and sharing. For example, the NIH enforces the following requirement on data sharing: "The NIH expects and supports the timely release and sharing of final research data from NIH-supported studies for use by other researchers" (2003, para. 2).

There is an unfortunate history of secrecy with regard to data from scientific studies. In the past, data were treated as proprietary, and access to original data by other researchers was often blocked. For example, Wicherts, Borsboom, Kats, and Molenaar (2006) requested that data sets analyzed in 141 empirical articles published in APA journals be sent to study authors via e-mail. Their purpose was to reanalyze the data in order to assess the robustness of the results to outliers. Six months later, after sending over 400 e-mail messages, Wicherts and colleagues (2006) received only 38 positive responses and the data from just 26% of the original analyses. The authors concluded that "a nonresponse rate of 73% signals a very serious problem even on its most favorable interpretation" (p. 727). An obvious difficulty here is the apparent violation of APA ethical guidelines on data sharing.

Reasons for not sharing data include the fear of being scooped, or having other researchers publish something before the researcher who originally collected the data, and the legitimate sense that researchers who collect data should benefit from their investment of time and effort (NIH, 2003). Other reasons to oppose data sharing include the sometimes appreciable costs to prepare very large data sets for open access and concern about possible misuse of the data. A darker reason to not share data is to cover up evidence of fraud, an idea elaborated next.

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Simonsohn (2013) described two cases where apparently fabricated data, some of which were reported in studies that were subsequently retracted after publication (Sanna, Chang, Miceli, & Lundberg, 2013; Smeesters & Liu, 2013), were detected through the use of a statistical procedure that looks for results that are "too good to be true," or they follow patterns that are extremely unlikely in actual data sets. These anomalous results were detected because Simonsohn (2013) had access to the original raw data or analyzed summary statistics reported in original articles. Simonsohn (2013) mentioned a third case with comparably suspect results, but the first author of that work in question claimed to have lost the original raw data, and the coauthors did not wish to be involved. Whether fraud was committed in this third case is unknown, but the excuse of lost data has been used in other cases where intentional fraud seems to have been committed (Gill, 2014). Loss of original data due to computer hard drive failures, stolen laptop computers, corrupted data files, or just plain disorganization is actually fairly common, and these kinds of things can happen even with no intention to deceive. Routine posting of data from published empirical studies would both protect against accidental loss and make the detection of fraud more likely.

There are now many online data repositories in which data are made available for reuse by authors of original empirical studies in both the natural and social sciences. For example, the Inter-university Consortium for Political and Social Research (ICPSR), an association of more than 750 academic or research institutions, maintains a freely accessible repository with over 250,000 data sets from empirical studies in education, psychology, criminal justice, substance abuse, and other fields[5].

There are also many **data repositories** for research in particular areas, such as the Pediatric Trials Network[6] for pharmacological clinical trials with children. There are now so many data archives that it would be extraordinarily difficult to search each one individually. Fortunately, there are better options. Many university libraries maintain lists of searchable data repositories or offer online searches over multiple archives; so do some commercial publishers.

A resource with an open data policy is the Psychological Science Accelerator (PSA), which is a distributed network of international psychological research laboratories that coordinates data collection for studies selected by a review board[7]. Applications are accepted by researchers whether or not they are members of the PSA, and the review process takes about 8 months. Translation services are available for international studies. All projects on PSA must be preregistered, including analysis

[5] https://www.icpsr.umich.edu/

[6] https://www.pediatrictrials.org/

[7] https://psysciacc.org/

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plans, and there should be explicit statements about when analyses are exploratory, and data must be archived[8]. The number of studies supported by the PSA is not yet large, but the fact that hundreds of laboratories are members is promising.

Thesis students often do not have complete control over their data sets, which are usually collected as part of research groups under the direction of their supervisors. Thus, thesis students may not be in a position to decide how open they can be with their data. In research groups that follow open-science practices, data would routinely be made available. But not all researchers willingly share data, and some researchers may actively resist doing so. In such cases, there is little that a thesis student can do despite his or her commitment to open data. But paranoia about sharing data should fade over time as expectations about open data access continue to rise and eventually become the norm.

OPEN SOURCE AND TOOLS

The **open-source software movement** began in computer science. It emphasizes (1) decentralization of the software development process by (2) making source code available so that (3) peers, or individual users, can modify the software. These activities are covered under (4) an **open-source license** that may permit individual users to download, modify, redistribute, or publish their version back to the community.

The open-source model is the antithesis of a commercial software model that features proprietary code, top-down and centralized development, and licenses that permit use of a computer tool, but nothing more. The open-source movement itself is an offshoot of **the free software movement**, which has more of a social agenda where users' freedom to run, study, change, or redistribute code is unfettered, but the two movements, open source and free, correspond to the same general software category (Stallman, 2016).

Unless researchers are computer scientists or have especially strong programming skills, they are unlikely to alter program source code. Instead, such researchers may benefit from freely available science computer tools, of which there are a growing number. Perhaps the most familiar example to behavioral science researchers is the R programming language and environment for statistical analysis and data visualization, which is free software that is described in more detail in Chapter 9 along with other free computer tools for analyzing data.

[8] https://osf.io/93qpg/

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The Center for Open Science (COS) is a nonprofit organization that supports open reproducible science[9]. One of its cofounders, Brian Nosek, led the psychology reproducibility project described in Chapter 3, where 100 empirical studies published in three different journals were replicated (Open Science Collaboration, 2015). The COS sponsors the Open Science Framework (OSF), which is an open-source software project that facilitates open collaboration in research[10]. After registration, users can access online computer tools for research project management, including the open archiving of data, file sharing, version control (used to document revisions and recover earlier drafts), workflow and task assignments, and they can view project analytics such as tracking the number of visitors to project websites for public research projects.

Pontika and colleagues (2015) described the Facilitate Open Science Training for European Research (FOSTER) project, which is an online portal and resource center for learning about open science and related areas[11]. Part of the efforts in the area of open-science educational resources, in which online courses or materials that support science learning are made available free of cost (Scanlon, 2012), the FOSTER portal offers resources for researchers, research support staff, and librarians. Although funded by the European Union and related organizations, courses and materials available through FOSTER are relevant for scientists outside of Europe who seek to implement principles of open science. Course topics include open peer review, data sharing and management, open licensing, and data mining.

Many collaborative groups or associations sponsor websites with links to open-source or free scientific computer tools, such as OpenScience Project[12] and SourceForge for scientific and engineering software,[13] or they feature capabilities for keeping archival records about open research projects. An example relevant for psychology research is PsychDisclosure. org (LeBel et al., 2013), which supports a website where authors of recently published studies can publicly disclose additional information beyond that called for by reporting standards and that is essential for understanding the results or replicating the study.[14] The rationale for the site builds on the 21-word disclosure statement by Simmons and colleagues (2012) that all details about sample size, data exclusions, conditions or manipulations, and measures be fully disclosed (the original statement is quoted in Chapter 3 of this book). Authors of published studies can provide additional details in any of the four areas listed on the PsychDisclosure.org site. A similar four-item disclosure statement appears on the submission portal for the journal Psychological Science (Eich, 2014).

[9] https://cos.io/

[10] https://osf.io/

[11] https://www.fosteropenscience.eu/

[12] http://openscience.org/

[13] https://sourceforge.net/directory scienceengineering/scientific/

[14] https://psychdisclosure.org/

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TRANSPARENCY GUIDELINES AND OPEN-SCIENCE BADGES

Nosek and colleagues (2015) developed the transparency and openness promotion (TOP) guidelines as shared standards for open practices across journals. It consists of eight modular standards that can be applied in whole or in part[15]. Each standard is listed next with a brief description:

1. **Citation**, or whether journals require that data, analytic methods (computer code), and research materials are all properly cited.

2–4. **Data, code, and materials transparency**, or whether authors are required to make any of these resources available to other researchers for the purposes of replicating the procedures or results.

5. **Design and analysis transparency**, or whether journals require the identification of the specific reporting standards followed when the article was written.

6. **Study preregistration**, or whether it is required that studies are pre- registered in an independent, public registry. Study preregistration facilitates the discovery of research, including unpublished studies (Nosek et al., 2015).

7. **Analysis plan preregistration**, or whether authors are required to preregister analysis plans, which makes apparent the difference between exploratory and confirmatory analyses.

8. **Replication**, or whether the submission of replication studies is officially encouraged by the journal, and if so, whether replications are reviewed in two steps following the registered report format (see Chapter 3).

Because not all eight of the TOPS standards are applicable in all research journals, Nosek and colleagues (2015) defined levels for each standard. The levels indicate the degree to which openness in a particular area is represented in journal article submission policy. Level 1 corresponds to a minimum requirement that may be relatively easy to implement while still encouraging openness. Level 2 refers to stronger expectations for openness, while avoiding the need to commit major resources to adopting the standard. Level 3 is the strongest policy that may need support resources, such as when authors are required to submit data files so that reviewers or editors can reproduce the analyses (Nosek et al., 2015). Some journals now award open-science badges to authors who follow open practices. For example, authors who submit manuscripts for empirical studies to Psychological Science are eligible to earn badges in up to three categories—open data, open materials, and study preregistration— for, respectively, sharing the data, making publicly available the materials or procedures, and preregistering the design and analysis plan. If a

[15] https://cos.io/top

manuscript is accepted for publication, authors complete an open-practices disclosure plan that specifies the implementation details. Each badge has a specific graphical design by the Center for Open Science[16].

There is evidence that awarding badges actually works. For example, Kidwell and colleagues (2016) found that rates of reported open data in *Psychological Science* articles increased from about 2.5% before badges to nearly 23% after badges, or about a 10-fold increase. There were no appreciable increases in rates of data sharing among articles from control journals over the same time period (about 3%). Rates of reported open materials in Psychological Science articles increased from about 13% before badges to around 30% after badges, while rates of similar reporting in control journals remained at about 20% during the same time. There were also increases in the rates of Psychological Science authors who used independent repositories for data or materials from before the awarding of badges to after.

That a badge has been awarded for open data or materials reporting does not guarantee that those data or materials are actually accessible, correct, usable, or complete. For instance, Kidwell and colleagues (2016) found that most, but not all, data sets were actually available for *Psychological Science* articles awarded open data badges. Specifically, among the articles in which data were reported as available at a website or repository, about 94% were actually available, 86% had correct data, and 70% had either usable data or complete data. These rates are not perfect, but they were much higher than comparable rates among the relatively few authors of works in control journals who reported open data. For example, only about 16% of open data sets described in such works were complete. So it seems that the awarding of badges facilitates the sharing of data and materials, which are steps toward the practice of open science and also good news in psychology.

RAYS OF HOPE WITH MORE TO DO

The reputation of psychology research has suffered greatly under the weight of multiple crises, most of which are self-inflicted. But some of us are hopeful (Nosek, 2016), myself included. Perhaps the combination of revised or new journal article reporting standards and the influence of the open-science movement will alone revitalize psychology research, but I think more is needed. That is, the two changes just mentioned, though welcome, are insufficient to cure what ails us.

This is because if we continue to rely on analysis results, or p values in significance testing, that we do not understand and may also be wrong in most studies for

[16] https://cos.io/our-services/open-science-badges/

reasons explained in the next chapter, then we may not get very far even if we adopt better practices about access, reporting, and transparency. Disciplines where significance testing is not so strongly entrenched as in psychology will not have the same problem, and in this way they enjoy an advantage. So efforts to restore credibility to psychology research are ongoing, with no quick fixes in sight. It took decades for us to become complacent and distracted, and it will take some time to recover, but there is progress and, for now, that is enough.

SUMMARY

Research in the behavioral sciences will increasingly follow an open-science model with (1) greater sharing of data, methods, and materials and also (2) more emphasis on transparency, accountability, and proper reporting practices. These changes are long overdue and perhaps an encouraging sign that the behavioral sciences are finally ready to mature. Thesis students should expect that how they practice science in the future will differ from the ways to which their mentors have been accustomed. This change includes dealing with a wider range of choices about venues for articles or other scholarly works (for-profit vs. various types of open-access publications), collaborating and sharing with wider ranges of like-minded researchers and, yes, being more careful and responsible about data, study preregistration, and replication. Indeed, thesis students, who are not quite as set in their ways as some of their mentors, will probably thrive in this changing environment. The future of the behavioral sciences will be fine in their hands.

RECOMMENDED READINGS

Suber's (2012) book about the nuances of open-access publishing is fittingly itself an open-access work[17]. So is the report by the Royal Society on the full range of developments and issues in open science, in which many examples of large open-science projects are described.

Royal Society Science Policy Centre. (2012). Science as an open enterprise. Retrieved from https://royalsociety.org/topics-policy/projects/science-public-enterprise/report.

Suber, P. (2012). Open access. Cambridge, MA: MIT Press.

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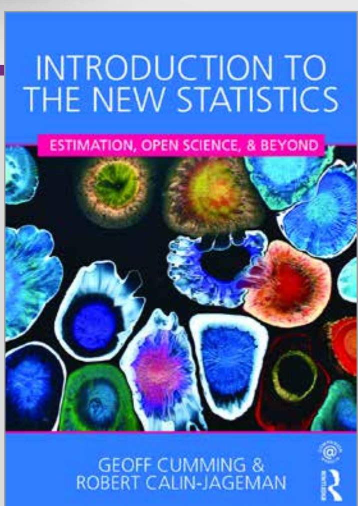
OPEN SCIENCE AND PLANNING RESEARCH



This chapter is excerpted from

Introduction to the New Statistics

By Geoff Cumming, Robert Calin-Jageman

OPEN SCIENCE AND PLANNING RESEARCH

Geoff Cumming, Robert Calin-Jageman

Excerpted from *Introduction to the New Statistics*

Introduction to the New Statistics is the first introductory statistics text to use an estimation approach from the start to help readers understand effect sizes, confidence intervals (CIs), and meta-analysis ('the new statistics'). It is also the first text to explain the new and exciting Open Science practices, which encourage replication and enhance the trustworthiness of research. In addition, the book explains NHST fully so readers can understand published research. The excerpt from the chapter "Open Science and Planning Research" discuses what's called the replicability crisis, then focuses on Open Science because that needs attention from the very start of planning.

Our topic is the planning of research. I'll discuss what's called the replicability crisis, then focus on Open Science because that needs attention from the very start of planning. I'll move on to discuss pilot testing, and the formulation of sampling and analysis plans. Much of the rest of the chapter is about the vital issue of choosing N: Of course, we'd like big N, but there are costs as well as benefits, and sometimes big N is impossible. I'll take two approaches to choosing N. First, using estimation, we take the precision for planning approach by asking "How large an N do we need to estimate the effect we are studying with a certain precision, say within ±0.2 units of d?", where Cohen's d is the effect size measure we're using. Second, using NHST, we can take the statistical power approach by asking "How large an N do we need to have an 80% chance of achieving statistical significance at the .05 level when we test the null hypothesis of Ð = 0 in the population, if the population effect size is really, say, Ð = 0.4?"

HERE'S THE AGENDA:

- The replicability crisis: Why many published results may be false, and what to do about it
- Open Science, and how to adopt Open Science practices
- Pilot testing, preregistration of plans, and open materials and data
- Precision for planning for the independent groups design
- Precision with assurance: Finding N so we can be reasonably certain our CI won't be longer than the target length we've chosen
- Precision for planning for the paired design
- Statistical power and how it can guide choice of N when planning research

OPEN SCIENCE AND PLANNING RESEARCH

Geoff Cumming, Robert Calin-Jageman

Excerpted from *Introduction to the New Statistics*

THE REPLICABILITY CRISIS: WHY MANY PUBLISHED RESULTS MAY BE FALSE

In Chapter 1, I outlined a striking example of results that failed to replicate (Gorn, 1982). Here's a second example: Caruso et al. (2013) reported five studies showing "currency priming", meaning that a subtle reminder of the concept of money increases people's endorsement of free- market systems and social inequality. This was a substantial and perhaps surprising result, which was picked up by media outlets. However, Klein et al. (2014a, 2014b) published extensive replication results, which found $d = -0.02$ [–0.07, 0.03], which is a precisely estimated zero or trivially small effect.

Science progresses by identifying and correcting error. However, when few replications are carried out and probably incorrect conclusions are influential for decades (Gorn, 1982), we have a problem. An excellent explanation of the main causes of the replicability crisis was given by Ioannidis (2005) in a famous article with the stunning title "Why most published research findings are false". He identified three problems:

- Selective publication. Studies that do not achieve statistical significance are less likely to be published— the file drawer effect.
- The .05 imperative. Researchers feel enormous pressure to achieve $p \leftarrow .05$ so their results have a chance of publication in a good journal, which is the key to obtaining a faculty job, tenure, and funding.
- Lack of replication. Once a result has reached statistical significance and been published, it is regarded as established. There is little incentive to conduct replications, and replication studies are difficult to get published. Therefore, they are rarely conducted.

In Chapter 9 I discussed the first problem, selective publication, and explained the Open Science requirement that, to avoid the problem, all research conducted to a reasonable standard must be made publicly available, whatever the results. Now let's consider the second and third problems.

THE .05 IMPERATIVE: QUESTIONABLE RESEARCH PRACTICES AND P-HACKING

In Chapter 2 we discussed the problem of cherry picking, of merely seeing a face in the clouds. I explained that specifying a single effect in advance can give us a conclusion that deserves our confidence, whereas if we inspect the data before choosing a result of interest, we are much more likely to be capitalizing on chance, of merely seeing a lump in the randomness. In other words, we should use planned analysis, and distinguish that carefully from exploratory analysis. Recently, however, researchers have started to appreciate that usually there are many more choices to make than merely choosing which result to highlight. Suppose we're comparing two independent groups. As we run and analyze the study we might make many choices, including some of these:

- If our first attempt doesn't seem to work, we make the participant's task easier and start again.
- We run 20 participants in each group, look at the data, then run 10 more. (A "run- and- check" approach: We stop the study when we like the results.)
- We note a few outliers, and exclude those aberrant results.
- The SDs differ considerably, so we use the Welch– Satterthwaite method rather than assume homogeneity of variance.
- We had used three measures of performance, but one is easier to measure and seems to give more consistent results so we drop the other two.

On any of those issues we could easily have made a different decision.

There's a vast number of possibilities, any of which we might report as our study. Simmons, Nelson, and Simonsohn (2011) demonstrated that there are typically so many combinations that it's possible to start with random numbers, make a few judicious choices, and probably find some analysis for which $p \leftarrow .05$. As they summarize in the title of their article, "Undisclosed flexibility in data collection and analysis allows presenting anything as significant". The various choices made after seeing at least some of the data, as in my five bullet points, are questionable research practices. Cherry picking a single result to report is just one of many possible questionable research practices. Indulging in any of them is p- hacking, defined as trying multiple things until you get the desired result. Specifically, p- hacking is finding a way to achieve $p \leftarrow .05$.

Questionable research practices arise often, and can be subtle. Any time you analyze data, you must be alert. Choose the median rather than the mean? Choose to use percentages, not the original scores? Choose to transform to Cohen's d? Any such decisions are questionable if made after seeing the data, because they might be influenced, perhaps unconsciously, by a desire to achieve $p \leftarrow .05$ and a publishable result. To avoid such p- hacking, we not only need to distinguish carefully between planned and exploratory analysis but should also, wherever possible, preregister a detailed research plan, including a full data analysis plan. More on that shortly.

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LACK OF REPLICATION

Now for the third problem identified by Ioannidis (2005). In many disciplines, almost all journal articles report statistically significant results, p ← .05. Ioannidis explained how the combination of selective publication and p-hacking might lead to many, perhaps even the majority, of those results being false. To complete this sad picture, he argued that researchers tend to have so much faith in statistical significance indicating truth that, once a result achieves p ← .05 and is published, it is rarely questioned, and so replication may not seem to be necessary. In addition, journals wish to publish exciting new findings, not me- too replications, so researchers have little incentive to conduct replication studies. Therefore, few replications are conducted and published false findings simply persist.

In summary, Ioannidis (2005) identified over- reliance on p ← .05 as an underlying factor in all three problems he discussed. Using estimation and meta- analysis rather than p values should help substantially, but cannot pro-vide the full solution. It can be just as misleading to use questionable research practices when using estimation. It's just as important to distinguish planned and exploratory analysis, and to preregister. Also, replication remains essential. Therefore, adopting estimation is a big step forward, but to overcome the three problems, we also need Open Science.

OPEN SCIENCE

The Center for Open Science (cos.io) was created in 2013 "to foster the open-ness, integrity, and reproducibility of scientific research". That's a pithy summary of the aims of Open Science. The Center's first major project is the Open Science Framework (osf.io), which is an ever-growing online environment that provides numerous facilities to help researchers use Open Science practices.

10.1 What's the list of Open Science requirements that we've built up in previous chapters? What's the slogan?

10.2 a. Visit osf.io and click Support at the top. Click on Frequently Asked Questions (also available via FAQ if you scroll to the bottom). Click to read any of interest. Read about registration. Note that, when any document is registered, it is date-stamped. What would be most useful to register on OSF in advance of running your study?

b. At osf.io, again click Support at the top. Click on Guides to see the simple introductory resources that are available. Try one or two, to get a general idea of the OSF. You could take the plunge and sign up. It's easy and free.

10.3 a. At cos.io read the brief summaries of what the Center does. From the top menus, go to Services/ Statistical Consulting and read what COS offers.

b. Find one or two services that might be helpful to you. Find one or two that you might like, but that the Center doesn't offer.

Open Science is our best prospect for escaping the replicability crisis and solving the three Ioannidis problems. It's a momentous development that requires major changes in what researchers do— especially by preregistering studies. To succeed it requires journals to revise their policies so researchers are encouraged, or even required, to adopt Open Science practices.

This is now happening. For example, Psychological Science has requirements for full reporting of the studies it publishes to ensure that readers are given important parts of the full story. It also "recommends the use of the 'new statistics'— effect sizes, confidence intervals, and meta- analysis— to avoid problems associated with null hypothesis significance testing (NHST)" (tiny.cc/ PSsubmissionnew). There's more on that in the Preface to this book.

OPEN SCIENCE BADGES

In addition, Psychological Science was one of the first eight journals to offer three badges created by the Center for Open Science to acknowledge articles that use particular open practices. Here are the badges with brief descriptions. Each comes in a labeled and a simplified version:

The Open Data badge is earned for making the full data publicly available.

The Open Materials badge is earned by making publicly available sufficient information to enable replication, including details of the procedure, materials, participants, and data analysis.

The Preregistered badge is earned for having preregistered the design and data analysis plan for the reported research and for conducting and reporting the research according to that plan.

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Not every study can be preregistered or earn badges. For example, researchers are often quick to respond to catastrophic events, such as Hurricane Katrina, not only to offer immediate assistance, but also to study people's reactions and to investigate how psychological therapies should be tailored for disaster situations. Such studies are developed on the spot and may change day by day. They can be highly valuable, despite preregistration not being possible. As another example, in some cases data cannot be made publicly available for commercial or privacy reasons.

10.4 From the home page cos.io go to Communities, read the note about Badges to Acknowledge Open Practices, then click on Learn more. State briefly in your own words why the badges were created.

Now I'll turn to four important aspect of planning: pilot testing, preregistration, open materials and data, and finally the big one— choice of N. These are four of the main things we need to work on to be using Open Science, and perhaps even submitting our study to Psychological Science.

PILOT TESTING

When you watch a good movie, it's easy to get caught up in the action and not appreciate what it took to produce the film. However, any "making of" documentary shows us that there's a tremendous amount of groundwork that takes place before filming even begins: scripts are edited and re-edited, shooting locations are scouted, lines are painstakingly rehearsed, and so much more. Then there are numerous decisions: which camera angles are best, what lighting is most effective, which scenes to cut… the list goes on. We don't see all this initial work and decision making in the final film, but it was essential to making a quality movie.

Strange to say, but research is rather like film production: In most cases, the exciting new article we read required a tremendous amount of initial planning, rehearsal, and decision making. Consider the pen–laptop article (Mueller & Oppenheimer, 2014). The authors had to decide how many students to test, what topics to have them learn about, how to measure their learning, and many other aspects of the study. To help make these decisions wisely, the researchers needed pilot testing. Like rehearsals prior to shooting a film, a small-scale pilot study tests part or all of the study being planned. Pilot studies allowed Mueller and Oppenheimer to refine all aspects of their studies before data collection commenced. This careful preliminary work led to a research plan for the final studies that so effectively addressed their research questions.

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Sometimes previous research gives strong guidance for pilot testing, but often pilot explorations can be exciting, as you follow your hunches and, perhaps, make new discoveries. There are no restrictions— you can adjust and restart and run further participants and analyze as you wish, but the results are hardly ever for reporting, because you've been exploring. Be prepared to spend considerable time and effort on piloting, as you aim for a study you can conduct within all the practical constraints. Think hard, discuss with others, and enjoy the excitement of being creative. Pay careful attention to what your pilot participants tell you. After conducting any study you debrief your participants, meaning you describe the aims and how their participation is a valuable contribution. You answer their questions and ask for their perspective. Listen carefully and try to see the study through their eyes— then improve it. Finally, you decide that you're ready to formulate your research plan. If possible, pre-register that plan, then run your study, with good reason to hope it will answer your research questions.

Piloting is required even for a replication study. For a close replication, the goal is to mimic the original study as closely as possible, and for this you need piloting. You need to practice to make sure the protocol is being administered correctly, and that your participants experience the stimuli the same way as the participants in the original study. It's important, if possible, to contact the original researchers. With their cooperation, you can obtain the original materials and discuss any points of confusion that arise as you pilot. Let's go behind the scenes of a close replication.

BEHIND THE SCENES: LUCKY GOLF BALL REPLICATIONS

In Chapters 7 and 9 we met the close replication that Calin-Jageman and Caldwell (2014) conducted of Damisch 1, the lucky golf ball study. Here's some of what took place behind the scenes.

We contacted Lysann Damisch, who provided us with tremendous assistance— information on the exact putter used, where to place the golf tee, and what feedback to provide after each shot. To be really sure we were administering the study correctly, we made a videotape of our pilot procedure and sent it to her for review. This turned out to be really important— she reported that our lab assistant was too jovial when saying that the ball was lucky, which a participant could have interpreted as a lack of conviction. With this feedback, we retrained the lab assistants to match the demeanor in the original study. Protocol videos are becoming another important Open Science practice for increasing replicability— after all, if a picture is worth a

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thousand words, just imagine how useful a video is for conveying what, exactly, was done in the original study.

PREREGISTRATION

You wouldn't want to board an aircraft if the pilot didn't have a clear plan for getting to the destination. Open Science tells us the plan should, where possible, be preregistered before takeoff. Think of your research plan as a statement of your research questions, then the Method section of your final report, plus much of the Results section although without any data. You therefore need to consider:

Research questions— Express these in estimation terms ("To what extent?").

Participants— Who do you wish to participate and how will you recruit them? The big question is N— how many— which we'll discuss at length below.

Materials— Instructions to participants. Stimuli to be presented. Tasks to be completed. Measures.

Procedure— A time line of events during a testing session: instruction, prac-tice, testing, debriefing.

Data preparation— Data coding and checking.

Exclusion rules— Should we really exclude any data as problematic? Unfortunately, participants may not follow instructions, may exhibit careless responding (such as filling in the same answer over and over), or may fail to complete the study. You don't want to include junk data— responses that probably lead to longer CIs, the opposite of what we want. It's reasonable to have exclusion rules, provided that (i) they are stated in advance, and (ii) you report fully about any exclusions you make. For example, in the pen–laptop study the researchers could have decided to exclude any participant who scored 0% for conceptual knowledge, taking that score as evidence of a participant who didn't take the study seriously. Looking carefully at your pilot data often helps with formulating the rules, because it can reveal participant misunderstandings and the range of responses to expect. Also think carefully about any data point that's excluded: Is it offering an unexpected message you need to hear?

Data analysis— Effect sizes to be calculated and details of all analyses to be run, to provide answers to your research questions.

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Studies vary enormously— tasks in the lab, a questionnaire in the shopping mall, systematic observations at the zoo, a survey posted on social media— so the above list is only a general guide. Adjust it to suit your study.

Preregistration may sound daunting, but the process is actually easy thanks to the Open Science Framework, which provides free online accounts that enable researchers to upload their materials and research plan in advance of data collection. When you are ready, a simple click of the button creates a citeable, permanent, unalterable preregistration of all your plans.

We always need to bring critical thinking to bear on any new study, but seeing a preregistration badge helps us feel confident the study was thought through in advance, rather than shaped in consultation with the data.

You might be wondering why, when I'm saying it's so important, you don't see many preregistration badges in journals. That's an excellent question. It's partly because preregistration is not always possible, but mainly because, although preregistration has long been practiced in some medical research fields, appreciation of its importance has only recently been spreading in other disciplines. I hope and expect it will become common.

One of the benefits of the Open Science push for preregistration is that it's now possible for anyone, including students, to browse the preregistered plans for completed studies and for those currently in progress. Reading these plans can be incredibly helpful, giving you a better sense of what goes into planning a study and what fascinating questions researchers are currently investigating. Here are some of my current favorites:

- *Collaborative Replications and Education Project (CREP)* osf.io/wfc6u: This is an exciting project that encourages groups of undergraduate students, supported by their professors, to replicate published studies they choose from a list, probably as part of their statistics or methods course. Start by reading the wiki.
- *Investigating Variation in Replicability: A "Many Labs" Replication Project* osf.io/wx7ck: This was a landmark collaborative effort by numerous different labs from around the world to replicate 13 famous psychology studies. It's a treasure trove of materials, data, and ideas. Check out the videos used to ensure the replications were as similar as possible to the original studies. Click on "final manuscript" and examine Figure 1, which compares the replication and original results for all 13 effects. Caruso et al. (2013), the currency priming result I mentioned at the start of this chapter, is bottom in the figure, and shows a large discrepancy between the original result (indicated by a cross) and all the replication results (dots).

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- *RRR – Strack – Chasten* osf.io/4rh87: This is a project page made by undergraduate psychology major Kelsie Chasten. For her Honors project, Kelsie applied to be part of a large, registered replication of the facial feedback hypothesis, organized by Beek, Dijkhoff, Wagenmakers, and Simons (2014, see osf.io/ pkd65). Kelsie's application was accepted, so she ran participants at her own university using the exact protocol and materials developed for the overall project. She uploaded her final data to the project page.

10.5 At osf.io, use the search function (magnifying glass, top right) to find studies you may be interested in. Often there are many files listed, but a .pdf or .docx file is most likely to be a plan or report that's interesting to read. Or click to open the project's wiki, which usually starts with an overview. Or sign up, log in, and go to Browse/New Projects at top right. Use the links at left to see popular projects and popular registrations.

OPEN MATERIALS AND DATA

To have the full story we need access to the materials and data of any study we care about. The Open Materials and Open Data badges indicate that a published study provides that information. Mueller and Oppenheimer (2014), for example, earned those two badges, and the article includes a link (osf.io/ crsiz) to where anyone can access their materials and data. Calin-Jageman and Caldwell (2014), the two replications of the Damisch study, earned those two badges and, in addition, the preregistration badge (osf.io/fsadm).

Open sharing in this way has many benefits: It makes meta-analysis easier, allows anyone to check for errors of analysis and interpretation, and makes it much easier for others to replicate your work. In addition, researchers can analyze your data in different ways, perhaps to address different research questions. Of course, you must not post sensitive or identifying information about your participants, and you need to be sure your participants have consented to anonymous data sharing. When at the outset of your study you seek ethical approval, you should describe how you plan to remove identifying information and then place the materials and data on open access.

You might feel that, having made the enormous effort to collect your precious data, you want to be able to use it as part of future research, rather than release it immediately to other researchers. When there are good reasons, it can be acceptable to delay release of full data while you work further with it, but usually 12 months should be the maximum delay before it is made openly available.

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What about your final full report? You'll probably want to seek journal publication, but another option is simply to place it on open access in the Open Science Framework. Recall that the first of the Ioannidis problems is selective publication, and the Open Science solution is for every study carried out to a reasonable standard to be made publicly available, whatever the results. Make sure you fulfill your responsibilities by making your report available, so your findings will be available for possible inclusion in future meta-analyses.

To summarize, here's a five- stage view of a research study:

1. *Pilot exploration*— Use pilot studies to explore as you wish. Refine your research questions, tasks, and measures. Decide the details of a study that's likely to be most informative. Formulate a detailed research plan, including your planned data analysis.
2. *Registration, planned analysis*— If possible, preregister the research plan. Run the study and carry out the planned analysis.
3. *Exploratory analysis*— If you wish, explore the data further. Watch out for exciting discoveries, although any conclusions are speculative.
4. *Full report*— Report the whole study in full detail. Make the materials and data openly available, to the extent that's possible.
5. *Seek replication*— You expected this to appear in the list, didn't you? Even if your main finding was planned— and even more so if it was exploratory— you should seek, if possible, to investigate how robust and replicable it is by either conducting a replication yourself, or seeing if you can arrange for others to replicate your work. Then meta- analysis can integrate the results. More broadly, always have meta- analysis in mind as you consider what further studies would be valuable.

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QUIZ 10.1

1. What are the three problems identified by Ioannidis?

2. State whether or not each of the following is a questionable research practice:
   a. Deciding to drop some outliers from the analysis.
   b. Examining the data, then deciding to run some additional participants.
   c. Reporting full details of the data analysis.
   d. Preregistration of a research plan.
   e. Seeing the results and then deciding to use Cohen's d.

3. p-hacking is
   a. the use of questionable research practices to achieve statistical significance.
   b. the combination of p values from different studies, as a form of meta- analysis.
   c. appreciation that larger p values (values → .05) can be valuable.
   d. an important component of Open Science.

4. Researchers have been reluctant to carry out replications because
   a. there seems little point, once a finding has achieved statistical significance.
   b. journals prefer to publish new findings, not replications.
   c. journal publication is required for career advancement.
   d. All of the above.

5. Psychological Science recommends use of NHST / estimation, to avoid problems associated with NHST / estimation.

6.The three Open Science badges are for ____, ____, and ____.

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ANSWERS TO QUIZZES QUIZ 10.1

1) Selective publication, the $p \leftarrow .05$ imperative (or questionable research practices, or p- hacking), lack of replication;

2) yes, yes, no, no, yes;

3) a;

4) d;

5) estimation, NHST;

6) open data, open materials, preregistration.