The Psychology Research Handbook: A Guide for Graduate Students and Research Assistants

Research as a Script

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Two questions often arise near the beginning of any course on research methods: Why is it important to have sound research skills? How are research skills acquired? Answers to both questions are multi-faceted, a point that will be reinforced throughout the opening chapter of this handbook. Before attempting to answer those two questions, however, imagine the following scenario:

> Two first-year graduate students were talking about psychology late one evening. During the course of their discussion, the two came up with what they believed to be a fascinating research idea, so they designed an empirical study to explore the topic. Over the course of the following year, they collected and analyzed data and prepared a manuscript for publication. The day they dropped the manuscript in the mail to the journal editor, the two were overjoyed by the fact that they had accomplished this major task without assistance from their advisors. They were certain the paper would be published, and they could hardly wait for the editor's confirmation.
>
> When the envelope containing reviews of their manuscript arrived 10 weeks later, imagine their surprise when they read the opening sentence of the editor's letter: “We regret to inform you that after soliciting three different reviews of your work, we find your manuscript unsuitable for publication.” Enclosed were three detailed sets of comments pointing out numerous critical flaws in their work. One reviewer pointed out that a number of studies had already been published on this same topic and that the students' findings failed to offer new insights. Another identified methodological flaws in the design of the study that failed to rule out alternative interpretations, thus calling into question the authors' conclusions. And all three reviewers mentioned that the statistics used to analyze the data were inappropriate given the nature of the research questions that had been asked. Furthermore, in her cover letter, the editor indicated that the manuscript was a poor fit given the interests of the readers of the journal. Seriously disappointed, the two students went to see their advisors to discuss what they should have done differently.

Before reading further, take a minute or two and think about what the students might have done differently. What additional steps could they have taken to help ensure a successful outcome? The students spent a year working on the project, but from the gist of the reviews, it was clear that several important steps of the research process had been overlooked. It appears that not only did they fail to conduct a thorough review of the literature before beginning the project, but they also failed to critically evaluate the design for weaknesses or flaws. Moreover, the students would have been well served by consulting with a quantitative specialist (or their advisor) about the analysis plan, and they would have benefited by contacting the editor of the journal (or looking through back issues) to determine whether their paper represented an appropriate fit in light of the journal's audience.

In answer to the first question posed at the beginning of this chapter, it is important to possess a sound understanding of the research process because it allows us to work more efficiently. In conducting their study, the two students presumably learned important lessons about the research process, but at what cost? Think of the hundreds of hours that were

wasted: time contributed by members of the institutional review board, the participants, the journal editor, reviewers, and the investigators themselves. Think of how just a bit more knowledge on their part, and assistance from others, might have led to a different, more positive outcome. Answers to the second question posed above (How are research skills acquired?) will be spelled out in detail later in the chapter when student learning and the development of expertise are discussed.

Most veteran researchers would not have experienced the same difficulties our two hypothetical graduate students encountered; in fact, errors, flaws, omissions, and conceptual gaps are not uncommon when it comes to conducting research in the social sciences. Even experienced researchers make critical errors, as suggested by the high rejection rates among top journals (in some instances greater than 90%). One key to avoiding mistakes is to develop a strong understanding of the complex set of steps involved in the research process, which, from the perspective of the novice investigator, may initially seem relatively straightforward.

Some of you may now be thinking: “Okay, so learning about the research process will help me to earn my degree and publish scientific papers, but will I benefit in other ways?” The answer is a resounding *yes!* First, strong research skills will allow you to better understand and evaluate the work of others. Second, from a more applied perspective, a good working knowledge of research methods will help you become not only a better scholar but also a better mentor, practitioner, or professor (depending on your career goals). Third, a solid set of research skills will help you to contribute quality scientific findings to the cutting edge of the psychological literature. Finally, a thorough grounding in research methods will make you a more careful and critical observer of the world around you. That is, knowledge of the scientific method will allow you to more accurately evaluate advertising claims, critically evaluate stories that appear in the press, and separate fact from fiction when participating in an intellectual debate. For these reasons (and many others), it is strongly in your best interests to actively work at developing your skills as a methodologist, not only during your graduate school years but on an ongoing basis throughout the remainder of your career.

Scope of Present Chapter

The primary goal of this chapter is to introduce you to the concept of a research method script. In its most basic form, a script is a series of ordered steps or events that occur when completing a task. More specifically, one can think of a script as a compiled mental event sequence, containing those activities typically associated with a commonly experienced event. In previous studies, individuals have been shown to possess psychological scripts for a variety of everyday events such as doing the grocery shopping (Light & Anderson, 1983), solving financial planning problems (Hershey, Jacobs-Lawson, & Walsh, 2003), attending a lecture, and visiting the dentist (Bower, Black, & Turner, 1979). In conducting a psychological study, the research script dictates the various stages of work that will take place and the sequence in which those stages should be completed. As will be discussed below, individuals' research scripts tend to evolve with experience over time; therefore, the script that currently guides your research efforts will likely differ from the one you follow 5 years from now. At this point, it is recommended that you turn to the end of the chapter and complete the first exercise, which is designed to elicit your current research script.

A second goal of this chapter is to provide a general overview of the procedures involved in a typical psychological research project. The processes and concepts presented in this chapter will be amplified and discussed in greater detail in subsequent chapters. This handbook is organized into a five-stage framework that includes (a) research planning; (b) design,

instrument selection, and sampling; (c) data collection; (d) data analyses; and (e) research writing. It is no coincidence that these five stages correspond to the major goals of a psychological research project. Also note that the structural model introduced later in this chapter is organized around these same five general topics. This handbook concludes with a section on special topics not typically considered part of the research process per se, such as working as part of a research team (Chapter 27), grantsmanship (Chapter 30), and the role of theory in research (Chapter 32). Although these topics may not be central to the empirical research process, they are, as you will see, important areas to understand for those who aspire to become productive psychologists.

As will be revealed throughout this book, computers have become an indispensable tool in the research process, and as such, computer-based tasks are prominently represented in the research methods script. Long gone are the days when researchers manually searched through dusty paper files and bound journals to locate articles, wait for hours (or even days) for the results of statistical analyses, or use manual typewriters to prepare manuscripts. We can now conveniently locate, download, and print articles from the comfort of our offices; we obtain statistical findings at the click of a mouse; and we can even edit, submit, and revise manuscripts working from a laptop at the local coffee shop. Although the technological advances brought about by computers have unquestionably improved the quality of our science, learning how to effectively use computers can be difficult and can try one's patience. Take for example the fairly common experience of getting 1,000 or more hits when conducting a literature review on PsycINFO, a search engine for psychological research papers. You revise your search by adding one or two additional keywords, only to receive the frustrating message “No articles could be found—try broadening your search.”

Learning the tricks of the trade when it comes to getting computers to do what you want, whether it involves conducting a literature review, specifying a complex statistical analysis, or drawing a figure that conforms to APA style, will necessarily take time and practice. As you read the chapters that follow, you will not only increase your knowledge of research methods but you will also come to better appreciate the integral role of computers in each stage of the research process.

In the following section, the psychological research process is described in further detail. It is characterized as a complex, highly varied, and extended problem-solving task that requires the application of specific and effective solution strategies. One such strategy, an empirically derived *expert script* of the psychological research process, is introduced. Presentation of this script is accompanied by a discussion of what it means to be an expert research psychologist.

Expertise and the Research Script

Psychological Research as a Problem-Solving Endeavor

From an information processing perspective, the act of engaging in scientific research can be thought of as a complex problem-solving endeavor (Hunt, 1991). In a problem-solving situation, the task is to transform an initial state into a qualitatively different goal state through the application of a series of steps leading to a solution (sometimes referred to as *operators).* In a psychological research context, the *initial state* often consists of an existing theory and its base of empirical findings. The *goal state* is typically some extension of that theory based on findings from a new investigation. From this perspective, the ability to reach one's research goal depends on the selection and application of an appropriate set of operators (Newell &

Simon, 1972). Stated in terms of the empirical research process, conducting a proper experiment will involve making a series of critical decisions about *how* your study should be carried out. When the research process is considered from this point of view, it almost goes without saying that one's methodological knowledge will determine, to a great extent, whether or not those critical decisions will be made in an intelligent fashion.

In discussing the concept of a research methods script, it is useful to distinguish between a structural model of the research process and an individual's mental representation of that same process. A *structural model* is a veridical and relatively complete representation of the various solutions that are applicable in a particular problem-solving context (Merrienboer, Clark, & Croock, 2002). Thus, a structural model of the research process would represent the various investigative approaches one might adopt, different data analytic strategies, methods used to disseminate findings, and so on. *Mental representations* (referred to by some as mental models) of the research process, in contrast, almost always fall short of a structural model. Mental representations in all but the simplest of domains tend to be incomplete or contain mis-specifications, perceptual biases, or other types of distortions. One of the key objectives of this handbook is that the reader develop his or her mental model of the research process into a reasonable approximation of a structural model. Of particular relevance to this chapter is the fact that structural models have been shown to be valuable tools for training individuals to become more efficient and competent problem solvers (Hershey & Walsh, 2000/2001). It is on the combined mental models of experts that these structural models are based.

In one empirical investigation, Hershey, Wilson, and Mitchell-Copeland (1996; see also Wilson & Hershey, 1996) examined the research scripts of 49 “expert” psychologists, each of whom held appointments at major academic institutions. Participants were considered experts by virtue of their high level of training in research methods and the fact that all were actively engaged in research as a condition of their employment. As characterized in the article, a *psychological script* is a specialized type of procedural knowledge representation containing an ordered set of actions that are linked together in long-term memory (Abelson, 1975; Schank & Abelson, 1977). In the Hershey et al. (1996) study, participants were asked to list about twenty actions or steps that characterize the process psychologists go through when working on a research problem. In order to establish common anchor events (across individuals) at the two ends of the event sequence, the phrase “Get Idea for Project” was printed at the top of the response form, and “Publish the Research Paper” was printed at the bottom.

A composite research script is shown in Table 1.1 that is based on the individual scripts of the 49 psychologists. This composite representation contains 23 of the most commonly mentioned events that occur over the course of a psychological investigation. Five different high-consensus events (printed in all capital letters in the table, mentioned by more than 60% of respondents) were identified: read literature, design experimental methods, data collection, data analysis, and write a draft of the paper. Notably, this set of events forms what might be thought of as a “meta-script” of the research process. That is, there is evidence to suggest that scripts are hierarchically organized, with major events representing superordinate procedural goals (Abelson, 1981; Galambos, 1986) and minor events representing subgoals. Presumably, when a superordinate goal is triggered, the scripts for various subordinate goals are activated in a prespecified order until the entire subroutine of constituent tasks has been carried out (Merrienboer etal., 2002). At that point, the next superordinate goal is activated, and a new series of steps in the overall event sequence is enacted.

The Expert Researcher

One of the hallmarks of expertise in a problem-solving domain is possession of a well-specified semantic and procedural knowledge network (Ericsson & Smith, 2002; Glaser & Chi, 1988). This does not suggest there is a single best solution for every problem or there exists a gold standard against which one's problem-solving efforts can be compared. That is because when dealing with ill-structured problems (such as how to conduct a psychological investigation), there are many different methodological approaches from which to choose, a myriad of ways to examine the data, countless ways to communicate the results, and so on. This last point suggests that there is no single research methods script that will *always* lead to an optimal outcome. Rather, the knowledge structures of experts are dynamic and contextually organized and thus able to accommodate subtle differences in environmental and situational demands (e.g., resource availability, participant considerations, ethical concerns) when the goal is to select and apply an appropriate solution strategy.

Table 1.1 Composite Research Script Based on Responses From 49 Psychology Professors

Get idea for project (anchor)
READ LITERATURE ON TOPIC
Discuss idea with colleagues
Conceptualize project
Determine appropriate subject population
Formulate Hypotheses
DESIGN EXPERIMENTAL METHODS
Obtain available materials and measures
Construct experimental materials and measures
Obtain research assistants
Pilot Test Procedures and Measures
Refine experiment based on pilot results
Obtain Subjects
DATA COLLECTION

Code and organize data

DATA ANALYSIS

Determine if hypotheses were supported

Make a conference or brown-bag presentation

Conduct a final literature review

WRITE DRAFT OF PAPER

Get feedback on paper

Submit Paper for Publication

Make post-review revisions

Publish the research paper (anchor)

SOURCE: Hershey et al., 1996.

NOTE: High-consensus events (mentioned by more than 60% of professors) are shown in capital letters. Moderate-consensus events (mentioned by 40–59% of professors) are shown in upper and lower case. Low-consensus events (mentioned by 20–39% of professors) are shown in italics.

Moreover, an expert's knowledge base is constantly growing and changing to accommodate new advances in the field. To that end, a well-qualified empiricist must stay abreast of methodological developments, read about new data collection and analysis techniques as they become available, and learn about new and different ways to communicate findings to peers. That said, it is worth pointing out that expert status is not a goal state in and of itself. Rather, it may be better conceptualized as a life-long attitude toward learning. Certainly, possessing a large body of knowledge about research is a prerequisite to being considered an expert, but the humble and accomplished investigator realizes that the sine qua non of expertise involves a sincere commitment to a never-ending learning process.

As mentioned above, one of the chief objectives of this chapter is to present a detailed structural representation of the psychological research script. This structural script expands on the 23-item expert script shown in Table 1.1 to include a much broader set of issues involved in conducting a psychological investigation. One caveat should be raised, however, before proceeding. Until this point, it has implicitly been suggested that the research script is based on a linear process, a process in which one activity naturally and logically follows from the one that precedes it. Unfortunately, the sequence of steps involved in conducting real-world psychological research is not always unambiguous and straightforward. There are instances when two or more tasks within a script may be simultaneously enacted. For example, one might choose to pilot test a new measure while concurrently developing an application for the institutional review board. There may even be times when an investigator

might need to leave a step out of the research process, such as the task of debriefing subjects when working with animals or recruiting subjects when conducting naturalistic observations. To further complicate matters, in some studies certain stages of the research process may be carried out in a recursive fashion. For instance, if during the data analysis stage one finds a statistical test has yielded insufficient power, then the investigator may return to the data collection phase of the process in an attempt to increase power.

As you read about the elements of the research process described on the following pages, it is important to recognize that the condensed structural model presented is not intended to be prescriptive in all cases. The structural model of the research script is designed to have heuristic value as a foundation for the set of activities associated with most empirical investigations. Therefore, deviations from the structural model that appears on the following pages might not be unreasonable if particular methodologies are adopted.

Structural Elements of the Research Script

Let us walk through the research methods script and focus on each of the higher-level event sequences, or phases of research, in logical order. As a generalized event sequence of the scientific process, the research script begins with a representation of the scientific problem and ends with the goal of publishing the results of the investigation. Alternatively stated, the scientific process typically begins with an idea or question that requires an empirical answer, and in most cases it ends with the scientist publicly disseminating major findings in writing (see Chapter 23), and pointing out the implications.

As indicated earlier, the research events that transpire between a script's beginning and ending can vary depending on purpose, methodology, and resources. Very often a single project intended to test one or more hypotheses is part of a larger program of research that includes multiple projects that are either planned or simultaneously underway. Thus, most research projects do not end with the publication of one's data; rather, public presentation starts the script all over again, as the investigator continues on to another project and then another within the same general research program. For much of the remainder of this chapter, we will present a structural model of the research process. In the section that follows, we describe the five major stages of the research process, with each stage represented by a corresponding figure. Let us now turn to the first stage of the process, which involves formulating a viable research idea.

Formulating the Idea

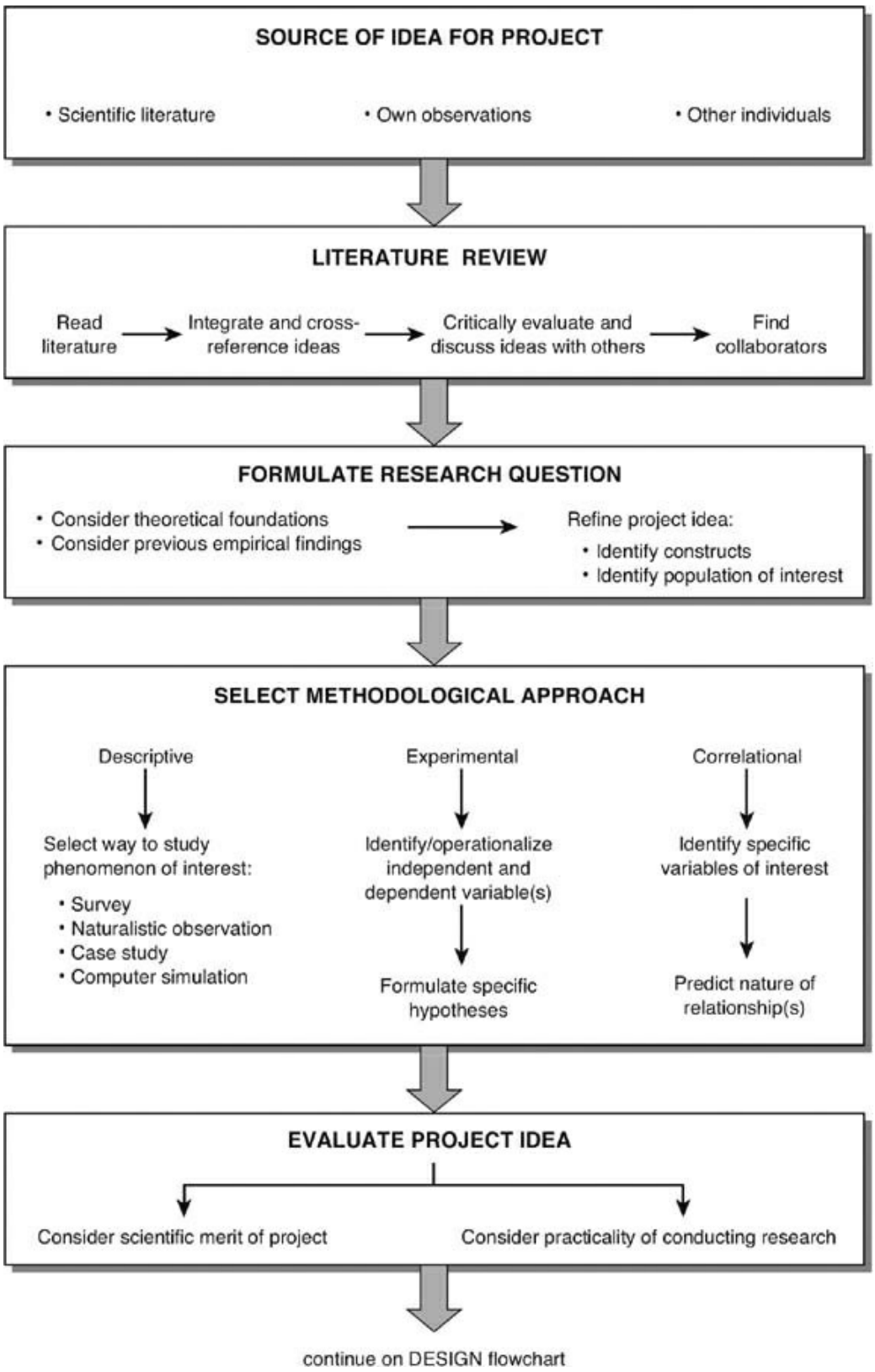
For any given research project, the process begins when the researcher entertains a question to be put to scientific test (see Figure 1.1). At that point, an investigation has been launched. Sources for research ideas include one's specific knowledge of the scientific literature in a given domain and one's general knowledge of the ideas of other theorists. In terms of modern philosophy of science, the researcher is aware of the theoretical network within which the initial question resides. Experienced researchers know that each project begins at this rather broad conceptual level. There are often significant unanswered questions related to currently held theories and novel hypotheses that may be proposed to account for specific effects. In fact, the true source of research ideas, that is, the source of one's scientific inspiration, is considered by some to be an area of research in and of itself. Many original ideas come from scientists' private observations of phenomena in the world; others frame scientific questions by attempting to extend existing knowledge. Whether a researcher's project idea grows out of

contradictions in the scientific literature, incredulity regarding the conclusions drawn from another study, the need to replicate previous findings, or private experience, the original project idea is the starting point that will largely determine the scripted events that follow.

Before selecting an appropriate methodology to address the research question of interest, it is necessary to be familiar with the body of work concerning the domain one plans to investigate. Most researchers tend to work in one or two specific domains, so they may already possess this knowledge. In fact, perhaps it was one of the investigator's previous findings that led to the new project idea in the first place; however, irrespective of the source of the inspiration, even leading theorists in a field must review the relevant and current literature. Others, in contrast, including a majority of students, may be preparing to conduct research in an area that is unfamiliar. To a large extent, when one is working in a novel research area, the literature review can reveal to the investigator dominant paradigms and possible methodologies. In Chapters 2–4, information is presented about how one might arrive at project ideas, how to conduct literature searches, and how to effectively evaluate the existing body of scientific work.

One benefit of representing research activities as a carefully planned script is that it increases the likelihood of producing findings that will be valued by the scientific community. Therefore, reading the literature, integrating results across laboratories and studies, and critically evaluating the work of others will all help the researcher to determine whether a project idea has merit. Often the literature review leads one back to a new starting question, or it may even lead to relationships with others who will contribute valuable ideas and refinements to the project.

Figure 1.1 Stages Involved in Formulating the Research Idea



With a project idea and the pertinent literature now in hand, it is time to formulate the original research question into a clearly specified hypothesis. To formulate a hypothesis, a few specific activities are in order. First, the researcher must identify two or more theoretical constructs that take center stage in relation to the original idea. Second, the researcher attempts to specify *how* these constructs are related to one another in order to answer the original

research question. Is a difference among groups expected on the dependent measure? Is a linear relationship anticipated, or will a quadratic trend emerge? Are there assumptions regarding the direction and magnitude of effects?

Identification of constructs at this point is not yet definition at the empirical level (i.e., at the level of an operational definition); the researcher simply wants to formulate an empirically verifiable proposition regarding the theoretical constructs. That is, at this stage the researcher should be able to make a purely conceptual statement about one possible answer to the original research question, and that statement should afford meaning specification at the empirical level. The proposition must be, according to the principles of the scientific method, testable. In addition, this “conceptual hypothesis” should provide clues about the population to which the eventual findings will generalize. From this conceptual development stage, the researcher has now identified the central constructs, predicted relationships, and the population in question. As one can see, much development can take place at a purely conceptual level, perhaps leading the researcher back to the literature again for further review and discussion with colleagues. Conceptual formulation is, therefore, a critical step that precedes the selection of a method and the formation of operational definitions.

The task of selecting a methodological approach may be rather straightforward at this point in the research process; it certainly must be accomplished before consideration of the study's practicality and merit. Whether the question is best addressed with a descriptive approach, using survey methods, questionnaires, observations or simulations, or best answered by experimental manipulations and controls, the conceptual work of selecting a scientific approach is clearly crucial for the remainder of the enterprise. Often researchers focus attention on the variables of interest in order to select the approach, by considering how constructs may be operationalized to address the project idea.

As every student of research methodology learns, the approach one takes will determine the kinds of inferences one will be able to draw from the study. Perhaps this is why most researchers include this conceptual step of method selection in their script, prior to the formal design and preparation of materials. The typical result of method selection is the transformation of conceptual hypotheses into specific hypotheses or predictions that will later be empirically tested. With a decision made regarding the methodological approach, one can begin to evaluate whether the project idea is developing appropriately in light of specific working hypotheses and the ultimate purpose of the research.

Experienced researchers often engage in a predesign stage during which the project idea is evaluated along two dimensions: merit and practicality. Considerations of merit include, among other things, whether one will be able to draw valid conclusions, whether the study will have external or ecological validity, and ultimately whether the findings will contribute to the scientific literature. With respect to practicality, it is clear that most research is neither cheap nor easy to conduct. Therefore, investigators must evaluate the project idea in terms of existing resources, potential sources of funding, equipment, and laboratory costs. Concerns about practicality may also include ethical considerations. Does the project idea pose any severe ethical dilemmas? Do the potential benefits of the study outweigh any anticipated risks? Thus, before moving on to the design stage, the researcher must balance the contributive value, resource value, and ethical value of the study in order to determine the best possible course of action.

Formulating the Design

Suppose one has done the conceptual work and thoroughly considered the potential of the project in terms of merit and practicality. It is then time to move on to more formal aspects of the research design (see design flowchart, Figure 1.2). At this stage of the research process, there is often a second level of project conceptualization, but this time at a more concrete level. In the design stage of the research methods script, questions regarding treatment groups, the appropriateness of the experimental task, and a variety of procedural details are addressed. (Chapter 6 presents a thorough look into the formal designs used in research studies.) Furthermore, there are two essential types of variables that are evaluated at this time: independent variables (IVs, or *predictors)* and dependent variables (DVs, or *criterion measures)*. When considering IVs, it is necessary to identify all possible confounding variables and experimental biases that could reduce the internal validity of the investigation. In terms of DVs, for the research to pass any form of peer review, the measures must be both *reliable* and *valid*. It also behooves the investigator to use measures that are sufficiently *sensitive* to reveal meaningful relationships in the data. Often, researchers address these issues under a separate preparation period. For example, developing standardized procedures and writing survey questions are represented in the preparation phase of the method. Many of the considerations dealt with at this stage are treated in Chapters 8 and 9 of this handbook.

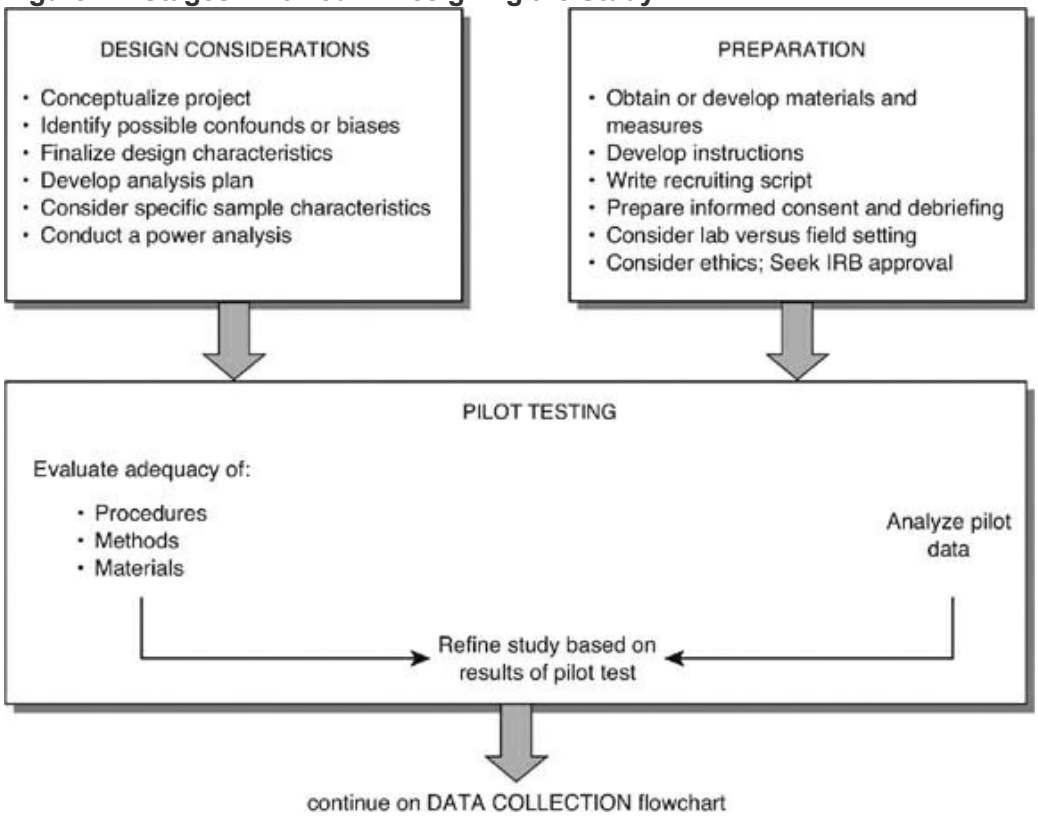
When the specific design characteristics of the investigation are clear (including decisions about variables, measures, and the sequencing of experimental events), then researchers can determine the number of participants to recruit for the study. Most investigators make preliminary specifications regarding the sample, long before the recruiting process begins. Well before advertisements are posted and classroom solicitations are scheduled, researchers typically develop a plan for their analyses that corresponds to the hypotheses they plan to entertain. These decisions regarding statistical procedures will help to inform decisions regarding the number of participants in the study and any special characteristics of the sample that will ultimately be drawn. It is becoming increasingly common to conduct an a priori power analysis to help determine the size of the sample in relation to the magnitude of the anticipated effect. Such an analysis is a particularly important step for those who seek external funding inasmuch as review panels have come to expect this information in major grant applications. Chapter 18 guides the reader through the statistical planning process, and Chapter 11 presents ways to conceptualize and maximize statistical power.

Note the activities researchers engage in as part of the preparation phase. In addition to developing materials and making logistical arrangements for the work, the investigator must submit a plan of the proposed research for review by the institutional review board (IRB) to ensure adequate protections are met. A good description of this approval process and suggestions for preparing a successful IRB proposal are given in Chapter 12. With IRB approval and materials ready, the research script indicates one other activity prior to data collection. Very often a period of preliminary research takes place that is designed to fine-tune measures and try out new experimental methods. This step is commonly referred to as “pilot testing.” During this process researchers carefully evaluate the appropriateness of their method and the adequacy of the procedures they have planned. Often a small (and perhaps known to be biased) sample is used solely for purposes of timing experimental events, testing for instruction comprehension, and identifying undesired demand characteristics. Although pilot testing involves the collection of data, this step is not generally recognized by investigators to be part of the data collection process. Rather, it is conceived of as a preliminary step aimed at refining elements of the material and procedure.

Data Collection

The research methods script places the subject recruitment process squarely within the data collection phase. Applications of sampling procedures are the topic of Chapter 10. As seen in Figure 1.3, the period of actually collecting the data and the stage at which the data are coded and organized logically follow the recruitment phase. Chapters 13, 14, and 15 present a variety of considerations related to the data collection process. Whatever method of sampling is used, be it naturalistic observation, surveys, phone calls, or use of a subject pool, the event is clearly represented as part of the general data collection process. Researchers almost always have specific subgoals nested within the act of observation, such as obtaining informed consent, checking to see that subjects complete the task, and ensuring that all participants are treated fairly and ethically.

Figure 1.2 Stages Involved in Designing the Study



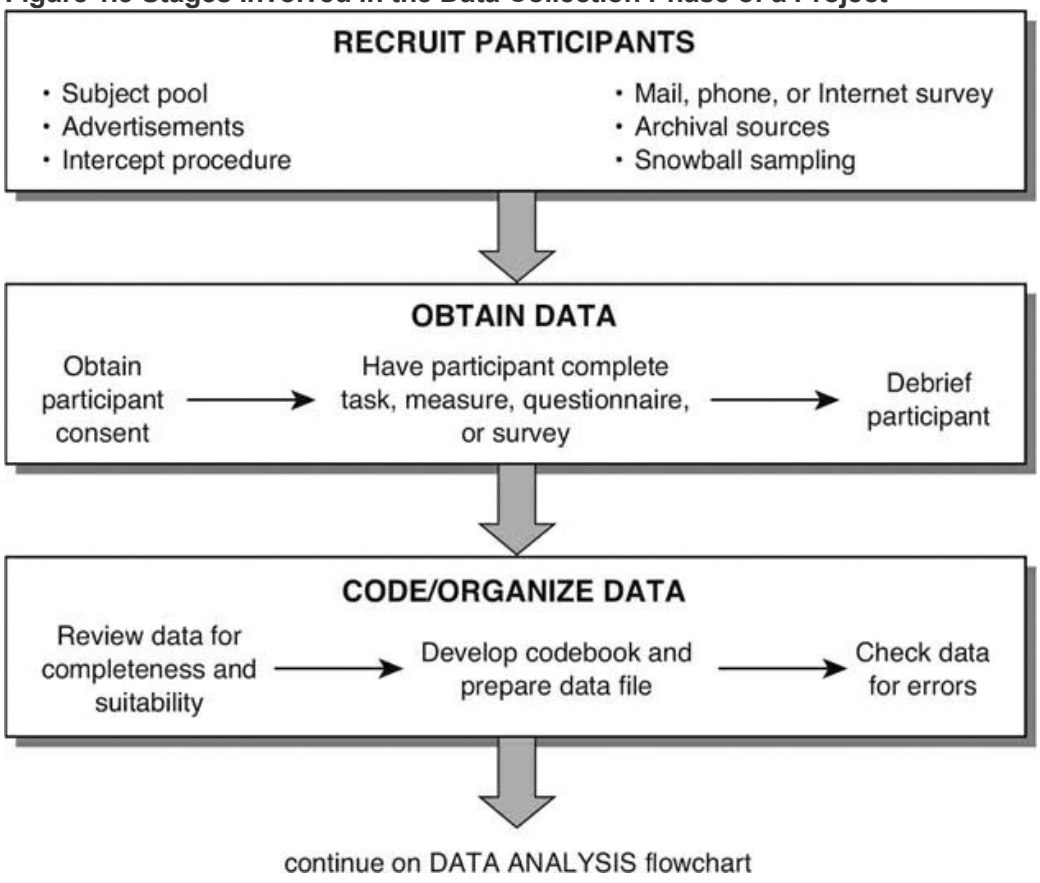
Once sufficient data have been obtained, they can be coded and entered into a database for analysis. Responses to surveys, questionnaires, verbal protocols, and tests containing subscales all must be coded for analysis. When this process is complete, the experimenter examines the data, checking for any input errors or unintentional mistakes in the assigned values. Double data entry procedures may be used (in which two different individuals code and enter the same data set) to help ensure the reliability of the data entry process. Chapter 16 presents ways in which data can be cleaned up and refined; Chapter 17 introduces the reader to various qualitative research techniques.

Data Analysis

Researchers often begin the data analysis phase by refamiliarizing themselves with the original hypotheses and the general data analysis plan (see Figure 1.4). The formal analysis

begins with the computation of descriptive statistics (which may include computing measures of central tendency and variability and graphing scatterplots and frequency distributions). This step is carried out not only to determine whether there are outliers among the data but also to ensure that the skew and kurtosis of the data distributions are not unreasonable. When applicable, an item analysis is performed. A discussion of these basic analyses can be found in Chapter 19. Most of these preliminary computations are intended to evaluate the adequacy of the method, and they may include assessments of reliability, cross-validation of measures, and analysis of manipulation check items. Thus, a significant part of the process at this stage is to verify that the method and procedures were, in fact, successful in terms of their intended purpose. At this point, measurement weaknesses in the study can be identified and addressed, including problems brought on by low levels of interrater or observer reliability, selection biases, and order effects.

Figure 1.3 Stages Involved in the Data Collection Phase of a Project

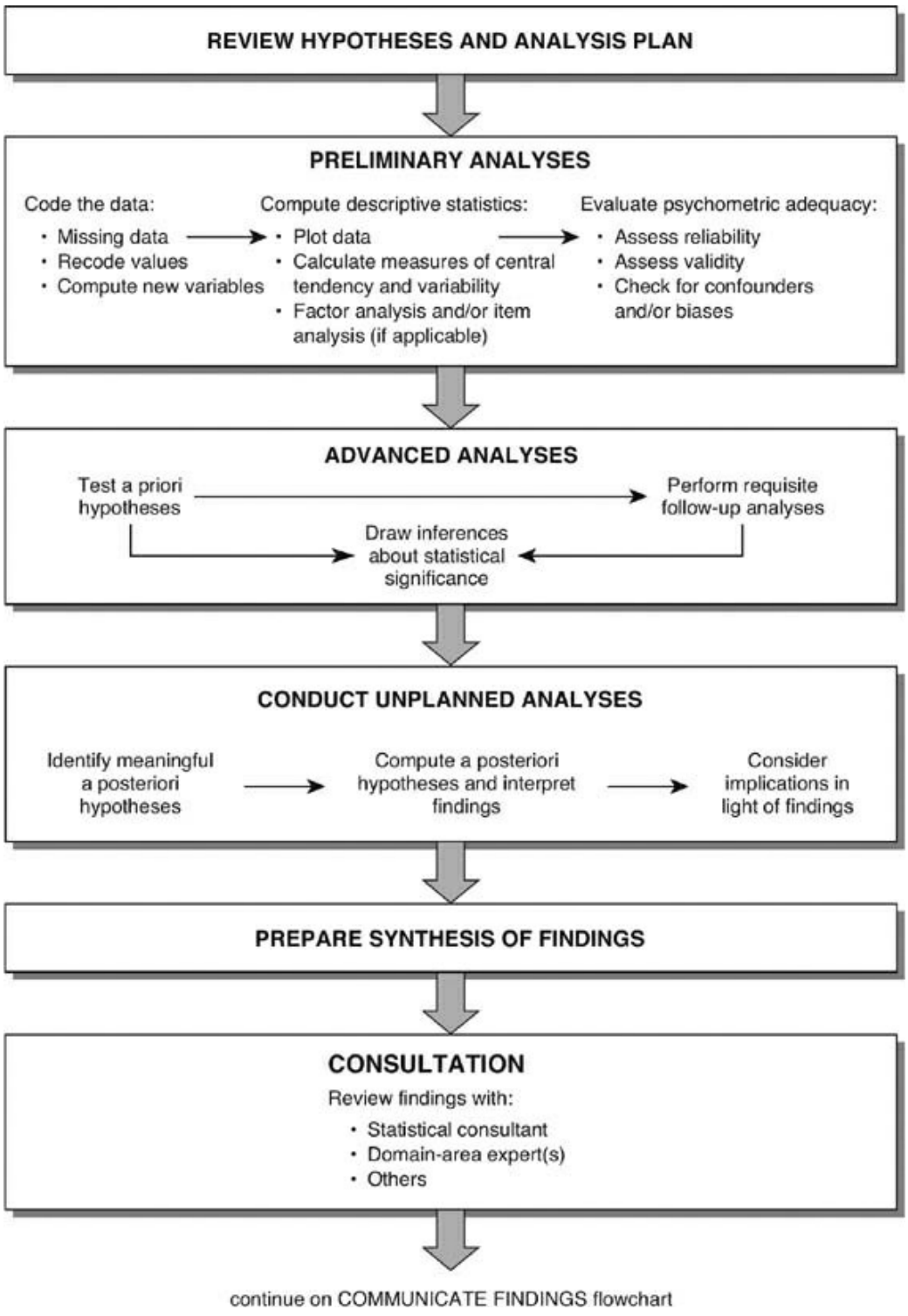


Following the preliminary analyses, advanced statistical analyses are carried out (see a discussion of advanced analyses in Chapter 20). Most investigators perform *planned* tests first, after which any number of follow-up tests may be performed. Examples of follow-up tests include post hoc comparisons, trend analyses, and residual analysis. At this stage, the researcher may seek to determine power levels and effect sizes for individual tests, assess whether the Type I error rate may be inflated, and evaluate whether key statistical assumptions have been met. Chapters 19–21 address the variety of tests and mathematical models available to researchers in the formal analysis stage of the research process.

Unplanned, or a posteriori, hypotheses are then tested when appropriate. In the research script, it is clear that investigators often discover new hypotheses suggested by the results of the advanced analysis. Students are often taught to avoid “hypothesis myopia” and

encouraged to examine the data beyond their primary hypotheses. This is done to reveal other potentially interesting aspects of the study that have not yet been brought to light. The results of such unplanned analyses may reveal implications about the a priori hypotheses and suggest new hypotheses for future research. The sequence of preliminary analysis, advanced analysis, and unplanned analysis often produces such a mass of results that there becomes a need to synthesize and cross-reference findings (organizationally, diagrammatically, or in written form) in order to return the focus of one's attention back to the question or questions that originally inspired the research. This particular step in the data analysis process can often yield “big-picture” insights about the work not previously recognized when one is in the midst of analyzing the data. The data analysis phase often ends with some informal sharing of the results of the study with consultants, peers, and other experts in the theoretical domain.

Figure 1.4 Stages Involved in the Data Analysis Phase of an Investigation



Communication of Findings

It is wise to begin the communication phase of the work by reflecting on the results of the study on a number of different levels (see Figure 1.5). Both depth of thought and integrative conceptual analysis are critical at this stage of the process, as both are necessary in order to tell an accurate and interesting story about the research. Investigators do well to critically evaluate their own studies and report any known difficulties or limitations to the consumers of the research. Considerations here may include the level of reliability of observations, the

strength of treatment and control, and the generalizability of the findings. In addition, it is important for investigators to describe their work in relation to the existing body of research. Other reflections may include thoughts regarding the implications of the findings at the theoretical and applied levels. Engaging in reflective thought at this stage of the research process will serve to improve the quality of one's discussion when findings are communicated to members of the scientific community.

A year or more may elapse between the time an investigation is launched and the time one seeks to formally communicate the findings. In light of this fact, many researchers include a final literature review step in the final stage of the research process. The ability to discuss your work in relation to the most recently published findings will help to locate your efforts on the cutting edge and, at the same time, help advance scientific research at a more rapid pace. One may chose to share findings orally with a small group, such as at a brown-bag presentation, or in a larger, more formal setting, such as at a regional or national conference. For most investigators, however, the ultimate goal of the research is publication of a peer-reviewed manuscript. To accomplish this goal, the author must decide which journal or periodical would serve as the best home for the work. This includes considering not only factors such as the scope, quality, and focus of different journals but also any special editorial objectives a journal may have (e.g., an upcoming special issue on your topic) or unique manuscript preparation guidelines.

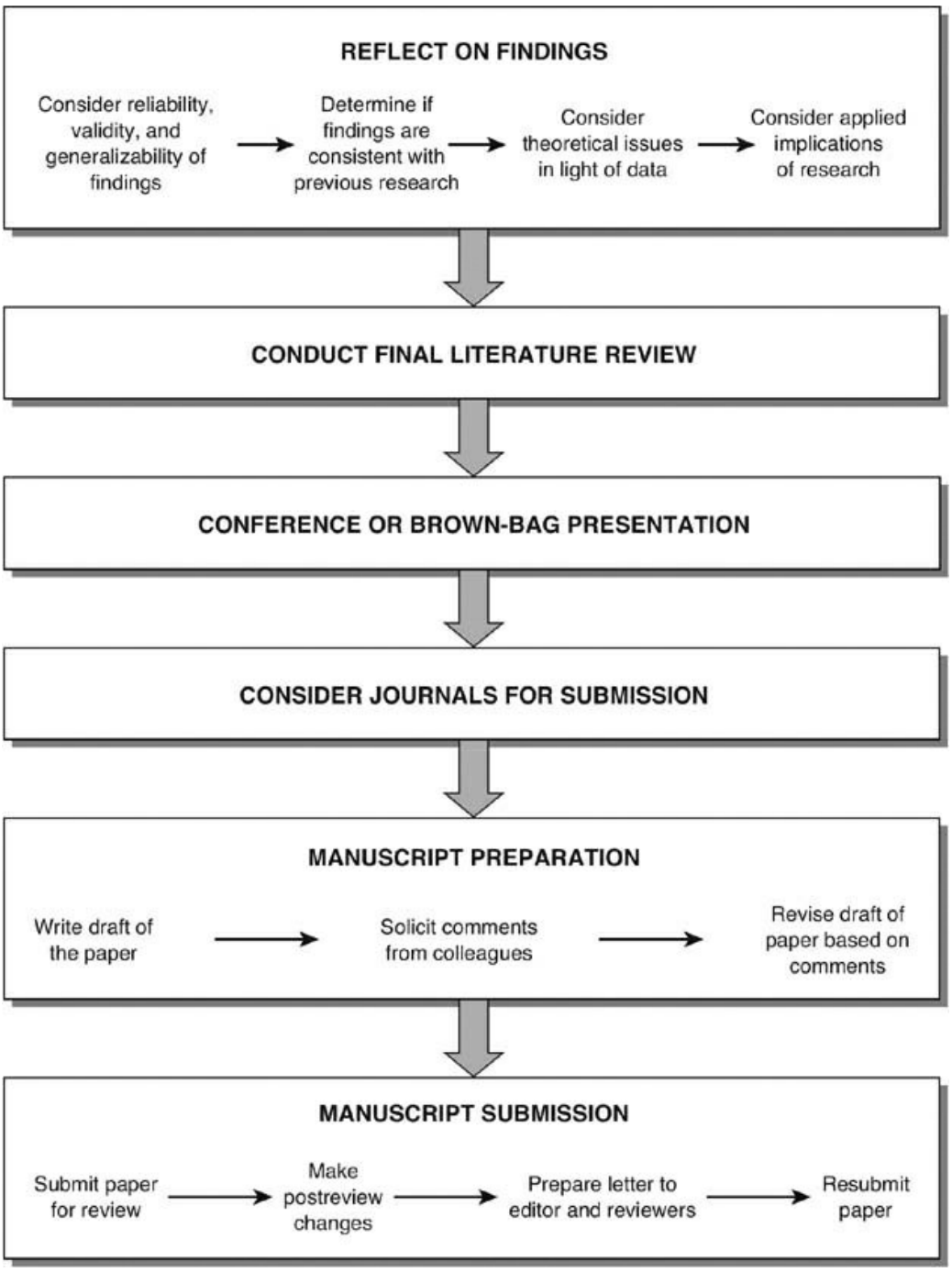
The chapters in Part V of this handbook, “Research Writing,” contain valuable information about manuscript preparation in the final communication phase. Generally speaking, the manuscript preparation phase entails developing a draft of a paper that is then shared with colleagues. The manuscript is then typically revised based on the comments and suggestions of others, at which point it is ready for submission and peer review. Following that review, the best case scenario would be one in which the author receives word that the paper has been accepted; however, acceptance letters following first-time submissions are rare, and they generally should not be expected. If the peer review process results in a rejection, the researchers then are faced with a choice. They can decide to scrap the project, choosing to start the process again from scratch, or they may attempt to publish the paper in a different journal (sometimes without making substantive changes). Alternatively, the editor may return the manuscript following peer review requesting that revisions be made prior to its being accepted. In this case, the author makes postreview changes to the manuscript and often includes with the second submission a detailed letter outlining specific modifications that were made to address reviewers' concerns. Secondary review of the manuscript will almost invariably result in either the disappointment of rejection or the satisfaction of reading an editor's letter of congratulations. In either case, the research methods script begins all over again with a search for new project ideas.

This concludes the structural description of the research methods script. In the next section, we address the issue of how one learns the research script, with a focus on how instruction and practice influence the development of methodological expertise.

Instruction, Experience, and the Development of Expertise

At the beginning of this chapter, we introduced the notion of a research script, followed by a discussion of the research scripts of experts.

Figure 1.5 Stages Involved in Communicating One's Findings



Next, we presented a structural model of the research process, which outlined key events that are part of a typical psychological investigation. Inasmuch as this handbook is intended as a primer for graduate students and research assistants, it is worth discussing how individuals learn about the research process. What are the different sources of instruction when it comes to learning about the research process? What effect will hands-on experience have on the development of individuals' research scripts? And by what mechanisms do the scripts of novices develop into those of experts? Each of these questions will be addressed in this final section of the chapter.

Learning and Instructional Support

Fortunately, none of us start out from scratch when it comes to learning many of the fundamental principles of the research process. Long before our first formal introduction to the topic, we develop rudimentary schemata (i.e., knowledge structures) about science, and represented within those schemata are ideas about how research is typically conducted. By the time students enter college, noticeable differences in scientific skills and aptitudes are evident. At the collegiate level, the chief goals of research methods instruction are to fill in gaps, correct mistaken ideas, foster critical-thinking abilities, and connect scientific questions with solution paths. Taken together, this will serve to broaden the student's base of thinking about the workings of the investigative process.

Perhaps the most readily thought of source of instructional support is classroom instruction. Those reading this book will probably have completed at least one course in research methods and a second in introductory statistics. Both of these courses will help to lay the groundwork for acquisition of a detailed psychological research script. Those who have taken research methods at the graduate level are likely to have gone well beyond this basic stage of knowledge acquisition. At the graduate level, students have undoubtedly read journal articles that focus on specific methodological paradigms, and they have been privy to stimulating discussions about the philosophy of science. Methods courses at this level of education go well beyond fact building to forge deep conceptual linkages that cut across designs, empirical objectives, and sometimes even academic disciplines.

Numerous additional sources of learning about the research process can be found beyond the classroom. One source of learning is from role models, such as an instructor, advisor, or peer. By observing the research practices of others, we can discover much about the specifics of the process, such as how to properly debrief a participant or how to make an effective brown-bag presentation. It can be particularly beneficial to talk with more advanced investigators about the obstacles and opportunities associated with the research process. A second source of learning beyond the classroom involves hands-on research experiences. This may involve working in an established psychological laboratory or testing a research idea of your own. From a learning perspective, working in an academic lab can be a uniquely valuable experience because research activities are often well structured and clearly defined. Lab manuals are sometimes provided that describe critical project-related tasks and responsibilities and give the student a big picture of where the research program has come from and where it's headed. One other valuable source of learning about the research process comes from observing formal presentations made by one's peers in a research methods course or by professionals at a colloquium or a regional or national psychological conference. By fostering an interest in a wide range of research topics, you increase your breadth of knowledge, not only about the field but also about the variety of methods and procedures that are available to you as an investigator.

Most undergraduate psychology programs and the apprenticeship model of research training at the graduate level have been designed and refined over the years to facilitate the acquisition of the research script. From an instructional design perspective, cognitive learning objectives are typically *scaffolded* (i.e., sequentially ordered into what educational psychologists refer to as *zones of proximal development)* so as to build on themselves (Goldman, Petrosino, & Cognition and Technology Group at Vanderbilt, 1999; Samaras & Shelly, 1998). The goal of this progressive set of learning experiences is to ensure that one acquires the competence to conduct independent research by the time graduate school is completed.

In most cases, the uninitiated freshman psychology major transitions into a skilled and

proficient researcher over a 7- to 10-year period. To maximize the success of this training objective, specific procedures associated with clearly defined research tasks are presented at precisely the right time in the student's cognitive development (Kester, Kirschner, van Merrienboer, & Baumer, 2001). Provision of this procedural information, coupled with supportive assistance during the student's practice of the new skill, appears to lead to the most efficient learning (Kester, Kirschner, & van Merrienboer, 2004). A fading process is built into the educational experience in order to facilitate this transition toward independence. This means that many sources of instructional support (e.g., formal course work) are gradually phased out over time (Merrienboer, Kirschner, & Kester, 2003) in favor of more individualized types of research experiences. Consequently, sources of learning about the research process normally change or shift in import as the student progresses through an extended program of studies.

Experience and Script Development

As the old story goes, a New York City tourist asked the violin virtuoso, “How do you get to Carnegie Hall?”

“Practice, my good man, practice!” he was advised.

The story may be corny, but the take-away message is clear: The skill acquisition process is rarely, if ever, easy. In most real-world problem-solving domains, practice is the key to learning a complex set of procedures, based in large part on the principle of learning by doing (Anzai & Simon, 1979). Moreover, the constructivist learning perspective suggests that individuals' schemata are built-up through the process of induction (Merrienboer et al., 2002), which in the psychological research context suggests students cull general lessons from the range of different problems they encounter. “Mindful abstraction” of the salient elements of different psychological studies results in the differentiation of one's research scripts. This, in turn, leads to the formation of specialized scripts, each with its own unique triggering conditions and application. Also, with practice, elements of scripts that occur frequently with one another become bundled into a unit, or compiled, so that they may be efficiently retrieved from long-term memory as a set (Anderson, 1996; Anderson & Lebiere, 1998). Moreover, repetitive application of a particular script leads to the strengthening of a procedural representation, thus increasing the probability that script will be appropriately applied in the future.

Any discussion of the role of experience in acquiring the research script would be incomplete without also discussing the importance of performance feedback. Feedback, whether it comes from an instructor, peers, or perhaps a review panel, can help shape individuals' thinking about the research process. Constructive criticism, in particular, can sometimes broaden, other times fine-tune, or fill in gaps in one's mental model of the scientific method. At this stage, however, two problems may arise. First, sometimes feedback is destructively offered; and second, performance feedback in psychology is often delayed. This can make it difficult to evaluate the quality of one's project-related decisions when one is immersed in the research process. The difficulties associated with making the right decisions when designing (and for that matter, carrying out) psychological investigations have been referred to by Jung (1971, 1982) as the experimenter's dilemma. Fortunately, acquiring expertise in the scientific process will help one meet the challenges that we all face as researchers.

The Development of Expertise

Early in this chapter, an expert script of the research process was introduced, although

relatively little was said at that point about what it means to be an expert from an information-processing perspective. What *does* it mean to be an expert? There seems to be no debate on one key point: that experts possess a larger declarative knowledge base than novices and that they perceive and represent problems in their domain at a deeper (more principled) level (Glaser & Chi, 1988; Goldman et al., 1999). Moreover, relative to novices, experts have the ability to think creatively (Holyoak, 1991). This flexibly in thinking benefits experienced researchers in two different ways: It allows them to construct and apply new scripts as needed (Merrienboer et al., 2002), and it allows them to adjust existing problem-solving strategies to adapt to the unique demands of the situation (Dennis & Sternberg, 1999; Hatano & Inagaki, 1986).

Not only do experts process information differently than novices when solving a problem, but there is evidence that they learn differently as well. In an investigation of the development of skilled nursing abilities, Daley (1999) found that novices prefer more passive approaches to learning (e.g., learning from textbooks and lectures). Experts, in contrast, were more likely to engage in self-initiated learning approaches (e.g., making direct contact with other experts, actively seeking out information at conferences). Moreover, Daley found novices spent a great deal of time forming new concepts and assimilating information into their existing schemata. Experts, in contrast, spent time forging “blueprints in their minds” of what it would take to solve qualitatively different types of problems. Consistent with this observation, Scardamalia and Bereiter (1991) concluded that experts use a knowledge-building schema that lends itself to provisional interpretations, open-mindedness, and to the active pursuit of fuller understanding. This helps to explain why, when planning and designing psychological investigations, expert researchers are able to see subtleties across methodologies not perceived by novices.

By all accounts, the development of expertise in the psychological research arena is not something that comes quickly. Contemporary views of expertise suggest that the learning process is nonmonotonic with respect to time. That is, as individuals' knowledge structures grow and change, they pass through a series of qualitatively different developmental stages, each characterized by different skills and abilities (cf., Patel & Groen, 1991; Holyoak, 1991).

Conclusion

In this chapter, we presented the psychological research methods script and its specific components. Our goal was to characterize the research process as a coherent and coordinated set of activities. Ideally, you will have read this chapter and completed the accompanying exercises before exploring other parts of this handbook, as it was designed to lay a foundation for the sections that follow.

Any psychologist-in-training who is reading this handbook is already well on the way to becoming a skilled researcher. As you develop your investigative skills, we trust you will find the research process provides excitement, challenges, and intellectual rewards. By way of closing, we encourage you to reflect on the changing nature of your research scripts as they grow and expand over the years. Doing so will not only provide you with an appreciation of milestones in your own development but, at the same time, provide insights into where your scientific thinking may lead.

Exercises

1. Write at the top of a blank sheet of paper *Get Idea for Project*, and at the bottom write the words *Publish Paper*. Then list as many activities involved in the research process as you can think of that occur between these anchors, placing them in what you believe to be the correct serial order. Make this list now, before reading further.

   Next, reflect on the nature of your mental representation of the research process. Can you group events in your research methods script into general categories, in much the same way the flowcharts in this chapter are organized? Are all superordinate events in the process (e.g., design, data collection) represented in your script? Compare your research methods script with the empirically derived expert script presented in Table 1.1. Are there differences in the ordering of the scripts? Do the scripts differ in terms of their level of specificity?

2. Look through the previous pages of this chapter and write down 20 or so research script events on separate slips of paper. Fold the slips and place them in a bowl or hat, shake, then withdraw them one at a time at random. For each event, write down the event in the research methods script that immediately precedes it and the event that follows. Check your answers against the structural script presented in the five flow diagrams. Compared with the serially ordered script generation task in Exercise 1, did you find it easier or more difficult to generate elements of the script when they were taken out of order?

   Next, reflect on *why* it is important for the earlier event to precede the event drawn from the hat, and why it is important for the later event to follow.

3. Visit with colleagues, professors, or researchers in your field to discuss the idea of research as a form of scripted knowledge. Informally interview the individual to discover elements of his or her research script. Ask the person to describe the activities a researcher goes through for one or more of the higher-level event sequences, such as data analysis or communication of findings. For instance, one might ask, “What have you found takes place during the data analysis phase of research? What do you do first, and what goals are you trying to accomplish?” Notice the extent to which there are commonalities across individuals in terms of the big-picture dimensions of the script and how differences begin to emerge when it comes to specifying the individual elements that make up those major dimensions.

Recommended Readings

A variety of both basic and advanced readings on the research methods process can be found in the literature. For a more detailed discussion of the research methods script, see Hershey et al. (1996) and Wilson and Hershey (1996). A classic and lucid discussion of the procedural aspects of the research process can also be found in Runkel and McGrath (1972). Theirs is a cyclic model of the research process, which includes a number of major steps that overlap with those outlined in this chapter. Moreover, good basic coverage of many elements of the psychological research process can be found in most undergraduate level, experimental-methods textbooks. At the more technical end of the spectrum, Kirk's text, titled *Experimental Design* (1994) provides an excellent treatment of the topic, as does Maxwell and Delaney's book, titled *Designing Experiments and Analyzing Data* (2004). In contrast, a highly readable introduction to the research process is found in the text *Research Methods in Psychology* (2002) by Elmes, Kantowitz, and Roediger. The book *Experimental and Quasi-Experimental Designs for Research* by Campbell and Stanley (1963) is considered by many to

be a classic primer on research design, still well worth reading in spite of its age. An updated version of many of the key ideas outlined in Cambell and Stanley (1963) can be found in a recent book by Shadish, Cook, & Campbell (2002). And finally, an advanced treatment of validity in designing and conducting social science experiments is contained in an edited volume by Bickman (2000).

In addition to the readings on the topic of research methods listed above, numerous informative Web sites exist. Four of the better sites include Web Center for Social Research Methods, hosted by Cornell University (http://www.socialresearchmethods.net); Centre for Psychology Resources, maintained by Athabasca University (psych.athabascau.ca/html/aupr/tools.shtml); Research Methods Resources on the WWW, hosted by the University of British Columbia (http://www.slais.ubc.ca/resources/research_methods/measurem.htm); and for a first-rate statistical site, visit http://www.statistics.com.

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