PRESIDENTIAL ADDRESS

Methodology is more than research design and technology

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The Society for Computers in Psychology has been at the forefront of disseminating information about advances in computer technology and their applications for psychologists. Although technological advances, as well as clean research designs, are key contributors to progress in psychological research, the justification of methodological rules for interpreting data and making theory choices is at least as important. Historically, methodological beliefs and practices have been justified through intuition and logic, an approach known as *foundationism*. However, *naturalism*, a modern approach in the philosophy of science inspired by the work of Thomas S. Kuhn, indicates that all aspects of scientific practice, including its methodology, should be evaluated empirically. This article examines implications of the naturalistic approach for psychological research methods in general and for the current debate that is often framed as one of qualitative versus quantitative methods.

When I was asked in the summer of 2004 to provide a title for my presidential address to the Society for Computers in Psychology, better known as SCiP, I started thinking about what previous addresses had entailed. My impression was that in addition to being relatively informal, they typically conveyed a “take home” message of general significance that went beyond data and theory. Since I have never been very technologically minded and have typically been behind the curve in the adoption and use of new technology, a talk on emerging technology seemed out of the question. Also, although I use computers extensively in my research, I am not involved in the development of computer applications for psychological research or teaching. My research interests in computer-related areas primarily pertain to human factors applications to information security and Web design, both of which concern application of psychology to computing issues more than computers to psychology. Of the triumvirate of research methods, instruments, and computers—reflected in the previous title of this journal—the remaining member is methodology. Because I regard myself as a methodologist and have been working with E. J. Capaldi in the area of scientific methodology that has valuable messages for the conduct of psychological research, I decided to focus my talk primarily on scientific methodology. This is an important aspect of scientific research in

general and psychological research in particular that often gets short shrift in psychological research methods courses and in the field more generally.

Personal Background

To set the stage, I will describe my personal background and how I became involved in the SCiP. I entered graduate school at the University of Texas at Arlington in 1970, the year before the first meeting of SCiP's predecessor, the National Conference on the Use of On-Line Computers in Psychology. I attended the meetings of the Psychonomic Society in St. Louis during the 1970s, including several sessions at the computer conference. One talk that stands out in my mind from the second conference was that given by Donald Norman, entitled “The Computer in Your Briefcase,” in which he predicted the appearance of the laptop computer, which was still several years in the future.

In his proceedings paper from that conference, Norman (1973) said,

The object shown in Fig. 1 is a computer. It is the size of a ream of typing paper As you can see, it has a high resolution display screen and a typewriter keyboard There are also connectors in back so it can be used over telephone lines as a terminal. (p. 83)

He continued on, saying,

Unfortunately, the computer I have just described exists only as a cardboard mock-up: it is only a dream, not a reality. But according to its designer, Alan Kay of the Xerox Palo Alto Research Center, it will exist soon enough that now is the time to plan for it. (p. 83)

Later in the paper, Norman examined the implications of personal computers for research and education, not-

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Figure 1. Illustration of Norman's vision of laptop computers. From "The Computer in Your Briefcase," by D. A. Norman, 1973, *Behavior Research Methods & Instrumentation*, 5, p. 83. Copyright 1973 by the Psychonomic Society, Inc.

ing with regard to the former, "Our laboratory equipment will suddenly become immensely more powerful and intelligent than it presently is. The memory drum, tachistoscope, psychophysical apparatus, and operant lab will change dramatically as a result" (p. 84). Norman's prediction about the immense increase in power and intelligence of laboratory equipment was clearly prescient. His talk provides a good example of what SCiP has contributed to the field of psychology since its inception: information concerning cutting-edge advances in computer technology about which psychologists should be aware and how this technology may be used in the service of research, education, and practice. A more recent example is the leadership played by SCiP in applications of the Internet and World Wide Web to psychology (e.g., Levy, 1995).

Although I had some interests in computers and learned to program in Basic and Fortran during my graduate training, my primary interests were not in computers but in research. The psychology department at UTA had not yet fully converted to computerized labs, and much of the research with which I was involved was conducted on tachistoscopes, which although electronically powered, required manual setting of switches, changes of stimuli, and recording of response times. The department acquired a Digital Equipment Corporation PDP 11 minicomputer, but it was not used for conducting much research while I was in graduate school. When I joined the faculty at Auburn University as an assistant professor in 1976, I continued to conduct most of my research on tachistoscopes until the early 1980s, at which time the first personal computers were becoming widely available. I

ventured into computerized research with Radio Shack TRS-80 microcomputers, which came with 16 KB of memory. Although limited in capability compared with the computers of today, they were an immense step forward in the ability to collect and analyze data. My lab experiments are currently conducted on relatively old personal computers using Micro Experimental Laboratory software, which is no longer available or supported, thus continuing my tradition of being behind the curve with respect to computer technology.

My involvement with SCiP began in 1994, when I was appointed editor of *Behavior Research Methods, Instruments, & Computers* by the Psychonomic Society Publications Board. I took over on short notice, after the death of the prior editor, John Castellan, and inherited a large backlog of manuscripts, including those for that year's SCiP proceedings. As an ex officio member of SCiP's steering committee, I began regularly attending its meetings and those of SCiP. Through this association, I came to appreciate more fully than I had before the contribution made by SCiP to psychology. I have maintained my involvement in SCiP since my term as editor expired because of the vital role that it continues to play in pushing the boundaries of computer use in psychology.

Research Design and Technology

As a research methodologist, one thing that I admire is clean experimental designs. The importance of a strong background in research design and rigorous in research cannot be overestimated. In my graduate training, I was fortunate to receive a heavy emphasis on experimental rigor, with a premium placed on well-designed experiments with appropriate control conditions. This emphasis was stressed by one of my mentors in particular, Ira Bernstein. A study that I conducted with Gil Reeve exemplifies the value of appropriate control conditions (Reeve & Proctor, 1984). It had previously been reported that when four-choice spatial reactions were made with the index and middle fingers of each hand, precuing two of the four responses benefited performance only when the two responses were on the same hand. We introduced an overlapped-hand placement (for which the fingers from the two hands were alternated), in addition to a normal adjacent-hand placement, to demonstrate that this apparent advantage for precuing pairs of fingers on the same hand was really an advantage for precuing the two left or two right spatial positions.

In addition to research design being central to advances in psychological research and theory, it is obvious that technological advances are crucial. Much that is done today either could not have been done 30–35 years ago, around the time of Norman's (1973) paper, or was much more laborious. Data collection is much faster and easier today than it was in the past. Technological advances have allowed new types of data, such as images of brain activity, to be collected that simply were not available previously. Sophisticated data analyses can be performed

easily, allowing routine reporting of analyses of sequential effects and response time distributions, for example. Also, modern word processors make manuscript preparation much easier. However, as Bill Uttal indicated in his invited address to SCiP 3 years ago, which was critical of the attempt to localize cognitive functions in the brain based on cognitive imaging technologies, sophisticated technology is not enough. Uttal (2002) stated, "It is naive, from a purely psychological point of view, to assume that we can simply define vague cognitive constructs and then seek their spatial locus in a highly nonlinear and incredibly complex system—no matter how wonderful the physical measuring tool."

More generally, sophisticated technologies and research designs are only part of what is needed to conduct meaningful research. Without an appropriate understanding of scientific methodology in the broad sense and how methods are evaluated and justified, much of our technology and sophisticated research designs may be spent on research that provides little useful information for the issues of concern.

Methodology is More Than Research Design and Technology

The remainder of this article will focus on the central theme that methodology is more than research design and technology. By *methodology*, I mean core methodological practices and beliefs, or what is sometimes called *metamethodology* in psychology. Examples of methodological rules of this type include the following: theoretical propositions should be falsifiable; reject falsified theories; theories should be parsimonious; theories should be stated mathematically; accept elegant theories; theories should be broad in scope; theories should make surprising predictions; and the experimental method is the ideal for psychology.

Scientific methodology can thus be defined as the means for making decisions about the adequacy of empirical and theoretical statements. Two approaches have been used historically for making such decisions: foundationism and naturalism. In *foundationism*, we justify core methodological beliefs and practices through intuition and logic. Virtually all philosophies of science prior to the last half of the 20th century followed this approach, with logical positivism and falsificationism being the two dominant views. *Logical positivism* is associated with a group of philosophers in the first half of the 20th century called the Vienna Circle, and the two terms refer to the use of symbolic logic and emphasis on the central role of experience. The logical positivists stressed induction and a verificationist criterion for establishing truth. *Falsificationism*, which is the view associated with Sir Karl Popper, took the position that being able to disconfirm a proposition was critical. According to falsificationism, scientists should attempt to falsify their theories and, when a falsifying outcome was obtained, postulation of auxiliary hypotheses to "save" the theory should be avoided.

The second approach to justifying methodology, that of *naturalism*, is of relatively recent origin. Its premise to scientific methods and practice is that methodological statements are empirical and should be evaluated like any other empirical statements. This approach was advocated initially by Willard Quine and, more notably, by Thomas S. Kuhn. Since Kuhn's (1962/1970) seminal monograph, *The Structure of Scientific Revolutions*, naturalism has come to dominate what is called the *post-positivist* philosophy of science (see, e.g., Callebaut, 1993). Naturalism bridges the gap between the philosophy of science and science itself, with the emphasis being that a variety of empirical procedures should be employed to evaluate many aspects of scientific practice, including scientific methodology.

Kuhn (1962/1970) examined how science is actually carried out, studying the history of particular scientific practices. As one example, he took the widely accepted proposition that a new theory should be able to explain everything that its predecessor explained, plus additional findings, and determined that the historical record shows that this is a rarity. Kuhn is best known in psychology for the widely accepted view that there is a level of scientific approaches more general than the theories they encompass, which he referred to as *paradigms*. A paradigm consists of a worldview, or ontology, about the types of entities that exist, and a methodology, or research procedures favored by the paradigm. Kuhn's view is that the paradigm determines the types of theories that are developed, the research questions that are considered important, and the methods used to try to answer those questions.

Psychologists tended to focus on Kuhn's specific theory of science, but more important was that his arguments for it were based on empirical evidence. Much subsequent work in the philosophy of science has been devoted to proposing alternatives and evaluating some of the central propositions of Kuhn's theory. For example, Laudan (1996) uses the term *research traditions* to refer to what Kuhn calls paradigms, arguing, among other things, that changes in ontology, methodology, and epistemology occur independently, rather than as a whole, as Kuhn argued. The largest part of this subsequent work has been from the naturalistic perspective. Regarding a naturalistic approach to methodology, Laudan wrote:

What it does not promise is any a priori or incorrigible demonstrations of methodology; to the contrary, it makes methodology every bit as precarious epistemically as science itself. But that is just to say that our knowledge about how to conduct inquiry hangs on the same thread from which dangle our best guesses about how the world is. (p. 141)

Naturalism has several important implications for psychology. One is that specific methodological statements and practices in science in general, and psychology in particular, should be evaluated empirically. Methodological rules should be assessed with regard to whether they enable us to make progress toward specific ends. An example of an empirical evaluation of methodological rules is

Tweney's (1989) analysis of the strategy of eminent physicist Michael Faraday. Tweney concluded that Faraday followed a conscious heuristic strategy of attempting to confirm a theory early in its development and attending to apparent disconfirmations only later. A second implication of naturalism is that psychology has much to offer to an understanding of scientific methodology more generally. Tweney's research, conducted with the intent of providing a cognitive psychology of science, focused on personal reports provided by Faraday in his notebooks. There are numerous other methods for studying science and the behavior of scientists, including historical, in vivo observation, controlled experiments, computer simulations, and personality studies (Dunbar & Fugelsang, 2005). With respect to SCiP, of particular note is the use of computer models to simulate the specific solution of an important scientific problem, as in Kulkarni and Simon's (1988) simulation of Hans Krebs's discovery of the ornithine cycle (a series of chemical reactions in living cells of humans and nonhuman animals concerning the oxidative metabolism of pyruvic acid and release of energy).

Qualitative Inquiry

A specific and important methodological issue within psychology is that of qualitative research methods, in contrast to quantitative methods. There is currently an upsurge of interest in and advocacy of qualitative methods, as indicated by numerous recent books on the topic (see Capaldi & Proctor, 2005; the qualitative methods perspective is well represented in Camic, Rhodes, & Yardley, 2003). However, this is not qualitative methods with a little q, as understood by most psychologists, but qualitative methods with a Big Q (Willig, 2001). It is a particular approach that concerns the lived experience of human beings, and its methods include narrative analysis, discourse analysis, ethnography, and participatory action research, among others, all of which focus on the reported experience of individual people. Many adherents suggest that such reports of experience should be the most important, if not the sole, approach to psychological phenomena. For example, in the foreword to Camic et al. (p. ix), Bamberg describes "qualitative methods as the preferred inquiry method in psychology."

The nature of what qualitative researchers are advocating can be illustrated by using some of the characteristics that qualitative methodologists Ponterotto and Grieger (1999) see as distinguishing quantitative and qualitative methods. According to these authors, quantitative researchers take a natural science perspective, believe in one true measurable reality, emphasize prediction and quantification, seek laws and causes, and rely on experimental designs. In contrast, qualitative researchers take a social science perspective, believe in multiple realities that are socially constructed and context dependent, emphasize understanding and description, seek meaning rather than laws and causes, and rely on in-depth interviews and participant observation. The characteristics that Ponterotto and Grieger ascribe to qualitative re-

searchers, particularly the emphasis on multiple realities, are also those of postmodernism.

Although many of the arguments made by qualitative researchers against the quantitative methods prevalent in mainstream psychology have serious faults (Capaldi & Proctor, 2005), their arguments and proposals should be treated seriously. Psychologists need to become more familiar with these arguments and evaluate them, but, for the most part, they are not equipped to deal with the arguments. From a naturalistic perspective, a good starting point for a rejoinder to the arguments that qualitative methods are the "preferred inquiry method" in psychology is that the arguments are based primarily on ontology. For example, the qualitative researcher Shweder (1996) wrote, "I actually think that the well-publicized tension between quantitative and qualitative approaches has a greater ring of truth when formulated as a problem in ontology rather than as a problem in method" (p. 177). In other words, the issue is not really about the relative merits of different research methods but of the modern versus the postmodern worldview.

This method of argumentation seems to stem from acceptance of Kuhn's (1962/1970) position that the paradigm determines the appropriate methods of investigation. However, this tight linking of methodological choices with ontological and epistemological choices is not accepted by many philosophers of science, such as Laudan (1996), who has presented evidence that the three are independent. More important, though, from a naturalistic perspective, methodologies cannot be justified on the basis of ontological arguments but must be justified empirically. That is, one cannot justify methods by saying that they are implied by a particular worldview, but only by showing that they in fact are more productive than alternative methods for specific purposes. At least one qualitative researcher, Weinberg (2002), agrees that a naturalistic approach to justification of qualitative methods is necessary, stating, "My basic argument, then, is that the scientific validity and importance of qualitative research methods can only be sensibly decided within the context of specific *dispute domains*" (p. 2). The basic point is that, as with other scientific propositions, the full value of any methodology can only be determined through critical, empirically based argumentation between advocates of alternative methodologies.

Conclusions

Although today's sophisticated computer technology is marvelous in many respects, it and the research designs we use are only tools for answering questions. These tools can be used to best advantage in the conduct of psychological science if one is knowledgeable of current and historical thought regarding scientific methodology. Naturalism is the predominant approach in the contemporary philosophy of science. Its central message with regard to methodology is that methodological statements must be justified empirically rather than only logically. In other words, methodological rules should be evaluated scientif-

ically in much the same way that any hypothesis or theory within a particular content domain is evaluated. One cannot merely assert, for example, that researchers should strive to falsify their theories simply because, according to Popper (1959), this is the approach to take. Rather, this methodological rule, as well as all others, must be evaluated with respect to relevant empirical evidence.

Recently, advocates of qualitative inquiry have argued strongly for the primacy in psychological research of qualitative research methods that emphasize reported experience. Most of the arguments for the widespread use of these Big Q qualitative methods have been ontologically based; that is, the methods have been justified on the basis of a particular ontology that emphasizes lived experience. From a naturalistic perspective, this type of argument is insufficient. Instead, justification of qualitative research methods, as well as quantitative ones, must be empirically based. Because the naturalistic approach to methodology lacks a long history, the grounds for advocating one type of method or another for specific purposes are not as strong as researchers often assume. Adopting the naturalistic attitude toward evaluation of qualitative and quantitative research methods should lead to a better understanding of the roles that each can, and should, play as the field of psychology progresses.

Treatment of the issues discussed in this article has, by necessity, been brief. More extensive discussion of them can be found in Capaldi and Proctor (2000, 2005) and Proctor and Capaldi (2001a), and with respect to teaching of research methodology, in Proctor and Capaldi (2001b, 2004).

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