Science Forum

Teaching Students to Think Like Scientists

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Future psychologists must be well versed in the critical thinking skills that enable them to distinguish science from pseudoscience. Without formal training in these skills, the proliferation of pseudoscience through popular media threatens the legitimacy and integrity of our field. One way to confront this ongoing challenge is to train students to think scientifically, rationally, and skeptically.

At the 2005 ABCT conference in Washington, DC, five experts in clinical science were invited to participate in a panel discussion titled "Teaching Students to Think Like Scientists." Panel members included Scott O. Lilienfeld (Emory University), Jeffrey M. Lohr (University of Arkansas), Richard J. McNally (Harvard University), Timothy R. Stickle (University of Vermont), and Sheila Woody (University of British Columbia). The session was well attended and enthusiastically praised by attendees. The success of the panel discussion was doubtless a function of the renown of the panel members, but also suggested that teaching aspects of scientific thinking skills may be a neglected topic within ABCT. To facilitate dissemination of the discussion proceedings to a broader audience, each panelist was asked to prepare responses to the set of questions that follows. The present work reflects the authors' written responses to questions originally posed during the panel discussion , which was moderated by Carmen P. McLean and Nathan A. Miller from the University of Nebraska–Lincoln. Although Sheila Woody was unable to contribute directly to this paper, her contributions to the panel discussion are reflected in the responses of the other panel members appearing below.

What does it mean to be a "scientist" as a behavior therapist?

JEFFREY M. LOHR: It means that at a minimum, the behavior therapist should be a scientific clinician, and at best, a clinical scientist. The behavior therapist's knowledge base should almost exclusively contain empirical principles of change. The therapist should learn sufficient breadth of application to accommodate empirically derived procedures to the functional analysis of the single case. That is, the student in training should acquire knowledge of empirically supported principles of change and the experimental methods used to validate treatment efficacy. The therapist should know how to apply experimental methods to the single case in order to conduct empirical treatment evaluations to determine whether the empirically validated procedures applied have resulted in benefit to the individual.

SCOTT O. LILIENFELD: To me, most of what we mean by scientific thinking is best summed up by the late Nobel Prize–winning physicist Richard J. Feynman's aphorism that the essence of science is bending over backward to prove ourselves wrong. In more technical lingo, we can perhaps say that the essence of science is the continual effort to compensate for confirmation bias, a propensity that afflicts clinical researchers and practitioners alike. I would even go so far as to say that most of the skills that fall under the broad rubric of "critical thinking" in psychology can be thought of as tools designed to overcome cognitive biases, confirmation bias foremost among them. I would argue that two sets of critical thinking skills are paramount: (1) knowledge of biasing factors that can lead all of us toward cognitive illusions (e.g., confirmation bias, illusory correlation, hindsight bias) and (2) an understanding of research designs that can help us to overcome these ubiquitous biasing factors.

RICHARD J. McNALLY: There are at least three senses in which a behavior therapist might function as a scientist. First, a therapist may conduct and publish research in addition to treating patients. But this is more a matter of the person having two distinct jobs—therapist and researcher—rather than functioning as a scientific therapist per se. Second, a therapist may track the progress of patients by collecting data. Single-case experimental designs applied to therapy cases constitute the clearest exemplar. Third, a therapist's clinical work may be informed and guided by the best knowledge we have regarding efficacious interventions. This amounts to evidence-based practice, and is the most important sense in which a therapist can function scientifically. Large social and economic forces are transforming the practice landscape, and a failure of therapists to keep abreast of developments in evidence-based therapy will be fatal to the therapist's career.

What skills are most relevant to clinical training?

JEFFREY M. LOHR: Experimental methods are the most technically teachable aspect of the self-corrective process that separates empirical epistemology from other forms of knowing. It is based on the concept of disconfirmability of theories, hypotheses, and predictions that follow from them. Unfortunately, training in intensive design methodology in clinical application is no longer provided in many clinical training programs that identify themselves as "evidence-based." If students do not acquire these skills, they can claim no special expertise in science-based practice.

TIMOTHY R. STICKLE: Numerous errors in perception, judgment, and assessment can be minimized by developing multiple, plausible hypotheses. Working from knowledge of the literature on cognitive biases and heuristics from cognitive psychology helps to understand cognitive errors that we as clinicians (and all humans) may need to confront in clinical situations. Additionally, knowledge of the limits of clinical (vs. statistical) prediction can temper some of the reinforcement that being an expert in clinical transactions can carry. Because it is very reinforcing as a clinician to have the client praise you for perceived wisdom, insight, and helpfulness, it is critical to understand that we are wrong more often than we are right in overriding well-established evidence.

How can we teach students to become aware of the factors that can lead individuals to conclude that psychotherapies are efficacious even when they are not?

RICHARD J. McNALLY: These issues can best be taught within the required psychotherapy research course in graduate school. In principle, one might cover these topics in general methods and statistics courses. But doing so in the abstract will likely be less pedagogically effective than

doing so in the psychotherapy research course itself.

SCOTT O. LILIENFELD: One great paper along these lines—and one that should be required reading for all clinically oriented students—is Beyerstein (1997). As Beyerstein and others have noted, a host of factors, including regression to the mean, spontaneous remission, placebo effects, demand characteristics, selective attrition, effort justification, and the like, can lead even highly intelligent and thoughtful people to be fooled by therapies that are ineffective, even harmful. In my own teaching, I continually force my students to generate alternative explanations for observations of the apparent positive effects of interventions, and to get them to understand what does—and does not—constitute adequate evidence for the efficacy of a treatment.

JEFFREY M. LOHR: I am not sure that we can teach "awareness" or that awareness is a sufficient condition for the critical analysis of such empirical issues. The teaching of open-minded skepticism and problem-solving skills provides a much stronger basis for evaluating treatment efficacy and effectiveness. The application of experimental analyses to separate common factors from disorder-specific and procedure-specific factors will help in the identification change processes that are supported by scientific evidence. If students also learn the strengths and limitations of intensive (single-subject) experimental methods, they can then be in a better position to replicate additive or subtractive component treatment strategies to the people they serve directly. They will also be better research consumers.

What is the relevance of critically evaluating therapy research for students who are not interested in a research-oriented career?

TIMOTHY R. STICKLE: All students, regardless of specific career goals, benefit from training in evaluating therapy and therapy outcome studies. More extensive training in measurement, philosophy of science, research methodology, and statistics is badly needed in our training programs. When one learns to evaluate the strengths and weaknesses of an evidence base, one can be well-informed about the quality of evidence supporting and weakening claims about effectiveness of treatments. Medicine, psychology, and related fields are rich with examples of misguided and ineffective approaches. Clear thinking based on solid knowledge of how scientific evidence is generated and of its inherent and specific limits puts clinicians and researchers in the strongest position to make informed judgments.

SCOTT O. LILIENFELD: All students—arguably especially those who are not interested in research-oriented careers—need such training. Practitioners need to remain cognizant of the factors that can fool them into concluding that their interventions are working even when they're not. They also need to become active and discerning consumers of the basic psychology and psychotherapy outcome literatures, and to incorporate basic scientific findings on both (a) the workings of emotions, memory, personality traits, and the like, and (b) comparative treatment efficacy into their clinical practice.

What strategies should programs use to teach students these important skills?

RICHARD J. McNALLY: I cover issues such as placebos, regression to the mean, randomization in controlled trials, etc., in various undergraduate courses. For our graduate clinical students, these topics are typically covered in the psychotherapy research course. I believe that when the abstract principles are learned in concrete contexts, students will learn them better than when taught in other contexts (e.g., a generic statistics and methods course).

SCOTT O. LILIENFELD: I think it's helpful to expose students to the fallible, but nevertheless useful, indicators of pseudoscience, such as overuse of ad hoc hypotheses designed to immunize claims against falsification, absence of self-correction, excessive reliance on anecdotal evidence, and so on. Such indicators can serve as helpful "warning signs" to students that researchers or practitioners are not playing by the rules of science. Of course, it's also important for students to understand that even scientists occasionally engage in such tactics, so that the distinction between science and pseudoscience isn't clear-cut. In my experience, many undergraduate and graduate programs accord surprisingly short shrift to these skills. Students need to understand that research designs are critical safeguards against human error. Anyone who doubts this point should watch the 1993 *Frontline* special "The Prisoners of Silence," which provides a devastating exposé of how psychological research methods demolished the claims of the proponents of facilitated communication for autism.

Are these training objectives best addressed in a specific course or integrated across curricula?

SCOTT O. LILIENFELD: I believe it's essential that such critical thinking skills not be offered in a single course, but that they instead be integrated throughout the didactic and applied components of the clinical curriculum. Addressing these skills in a single course sends the wrong message—namely, that they are self-contained pieces of knowledge that need to be applied only in certain contexts. As Richard J. McFall (1991) reminds us, clinical psychology students should be operating as scientists in all domains of their clinical research and practice.

TIMOTHY R. STICKLE: Optimally, learning methodology and other key science and pseudoscience content should be integrated into a variety of undergraduate and graduate courses that cover clinical assessment (e.g., clinical vs. statistical prediction), clinical practice (e.g., cognitive biases and heuristics), and statistics and methods (e.g., philosophy of science, causal inference, probabilistic thinking, how form and method of presentation of quantitative information can be misleading).

RICHARD J. McNALLY: For graduate students, this material is best incorporated in preexisting courses. Scientific thinking can best be fostered by taking scientific principles out of abstract methods courses and embedding them in psychotherapy research courses. The problem with having a pseudoscience course at the graduate level is that clinical students may have too many courses to take, which can detract from their research.

JEFFREY M. LOHR: I think we should target undergraduate psychology majors who have intentions of postgraduate training. Perhaps a two-track major would provide for the opportunity to teach the material to graduate school–bound students in their junior or senior year. At the graduate level, I think the material would be best presented in a specific course on critical thinking and analysis, and that such a course should precede or be taught concurrent with the first research methods or statistics course. I believe that spreading it across several teaching contexts would risk dilution of content. In this, I disagree with my colleagues. Without an early instructional focus, the message may be lost.

Why do so few programs offer courses in science and pseudoscience?

SCOTT O. LILIENFELD: I suspect that there's often a sense that pseudoscience isn't especially important in the education and training of mental health professionals because it exists only on the "fringes" of research and practice. Therefore, it can be safely ignored. Many academics seem to hold the view that it's best to let sleeping dogs lie. The problem, of course, is that the dogs aren't sleeping. With the increasing proliferation of fad and fringe therapies of various stripes, it's clear that pseudoscience is alive and well in much of clinical psychology. Indeed, I believe that our benign neglect of psychological pseudoscience has inadvertently laid the groundwork for its continuing popularity. To a substantial extent, it's we academics who are at fault. For example, with only a handful of notable exceptions, the response of the academic clinical science community to the recovered memory and multiple personality disorder crazes over the past several decades has been deafening silence. Regrettably, most of the pressure to curtail the dubious psychological practices that generated these crazes came not from within psychology but from outside of it—from managed care and the legal profession, for example.

JEFFREY M. LOHR: I suspect that many academic faculty are unaware of the nature or dangers of pseudoscientific psychology and its clinical applications. By labeling such dangers as "fringe" phenomenon, it may marginalize our concerns about such dangers. Moreover, I believe many believe that we are somehow "above it all" and that graduate education is somehow immune to such risks. Furthermore, because faculty have a great deal to teach in a limited amount of time, adding new curricular content may require current curricula to be deleted.

TIMOTHY R. STICKLE: In part, the "tail wags the dog" when it comes to curriculum decisions for many training programs. Ph.D. programs in clinical psychology have heavy course demand in order to fulfill accreditation requirements and to prepare students for professional licensing. Additionally, there must be time for essential training experiences in research and treatment. The goals of creating curricula to foster well-trained clinical scientists are not always best served by the many requirements for accreditation and licensure. Many doctoral programs already have average completion times of beyond 6 years. Emphasis on key domains such as measurement, statistics, and research methodology appears to have declined to levels that are troubling (Aiken, West, Sechrest, & Reno, 1990). Adding additional courses to demanding and apparently lengthening training programs is difficult.

What is the role of professional organizations?

SCOTT O. LILIENFELD: Professional organizations, such as APA, APS, and ABCT, should be on the forefront of combating unsubstantiated or invalid claims regarding psychotherapy and assessment. They should be responding forcefully to counteract inaccurate media coverage of mental health practice; they should be encouraging continuing education programs and workshops based on sound psychological science; and they should be promoting initiatives to develop undergraduate and graduate curricula focusing on the application of critical thinking skills to psychotherapy and assessment.

What specific recommendations would you give to improve training and foster scientific thinking?

TIMOTHY R. STICKLE: The key change I recommend, beyond those implied above, is to increase the direct involvement of faculty members in both research and clinical training. In many doctoral clinical training programs, the primary activity of core faculty is research. This is not entirely problematic and it has many desirable effects. The result for clinical training, however, is that many programs collaborate with community clinicians to provide most or all clinical training for clinical scientist trainees. This is unfortunate for several reasons. First, the so-called science-practice split is inadvertently reinforced when students have mostly or exclusively separate experiences with individuals who provide training in either research or clinical work. Rather than an integrated clinical science curriculum involving didactics, research experiences, and clinical supervision with an integrated set of scientific values, goals, and key experiences, present training approaches frequently offer little integration and consistency among these components. Although many collaborating community clinicians provide excellent training and training that is consistent with program goals and scientific values, this is also often not the case.

For example, although all Ph.D. programs in clinical psychology offer some kind of training in at least one evidence-based treatment (EBT), only 56% of these programs require both didactic training and clinical supervision in at least one EBT (Weissman et al., 2006). One alternative is to provide clinical training primarily "in-house," under the direction of core faculty members or a primary faculty member hired for this function. This approach offers several advantages for the goal of teaching students to think and act as scientists. Graduate students should be actively involved in research programs and in evidence-based clinical training across all years of graduate training. When core faculty direct training, students can observe and model the behavior of faculty who are active in research and in clinical training. However, this approach would require programs to persuade department and university administration that clinical training should be credited to faculty workload. Providing clinical supervision can be time intensive and faculty should be credited with the same time as teaching a classroom-based course. If clinical training remains an added activity on top of teaching, research, graduate student supervision, and so forth, it will not be adopted because it will impede the ability of junior faculty to develop and sustain research programs and to be promoted and it will impede senior faculty in sustaining research programs.

JEFFREY M. LOHR: The process needs to start earlier than postsecondary education. Most secondary science education involves the accumulation and assemblage of "facts" as end-products of the scientific enterprise. However, the most important part of science education focuses on the process by which knowledge is slowly accumulated in the face of ignorance. Skeptical open-mindedness is difficult to find and even more difficult to teach in the face of fact accumulators. I suggest that general science education should incorporate the work of people like Sagan (1986) and Feynman (2005), who can help students appreciate the critical thinking process as a way recognizing ignorance and how to sift through piles of "facts." That can be done in the domain of the life and physical sciences, but it might have more impact if done in the domain of the social sciences, like psychology, where the students live on a day-to-day basis. If this can be done, we might attract more open-minded skeptics to major in psychology who might make their way to graduate studies in psychological science.

Any final thoughts on the best way to maintain a healthy balance between cynicism and credulity?

JEFFREY M. LOHR: The first step is to distinguish cynicism from skepticism. I think most students and professors think this is a semantic quibble. It is not. Cynicism is founded in suspicion. Skepticism is founded on humility-based doubt. It is the distinction between "Who cares?" and "I want to know more and better." Teaching not only "the burden of skepticism" (Sagan, 1987) but the kind of skepticism that leads to the joy of discovery is an essential educational task.

SCOTT O. LILIENFELD: My office door at Emory University features a piece of paper reminding visitors of Oberg's dictum, named after space engineer James Oberg: "Keeping an open mind is a virtue, just so long as it's not so open that our brains fall out." The best means of achieving this balance is to avoid a dismissive posture and to be just as critical of individuals who prematurely dismiss novel claims as we are of those who prematurely promote and market such claims before they have been subjected to empirical scrutiny. We need to model open-minded skepticism for our students. The best means of doing this is to remind them of the Missouri state motto: SHOW ME. As Dawes (2003), points out, "show me" should always be the proper epistemic stance of the clinical scientist. Clinical scientists should promote an attitude of being willing to investigate novel claims, but of suspending acceptance of these claims before they have passed adequate scientific tests.

RICHARD J. McNALLY: Students must learn that no study is perfect, and that all studies have their limitations. Accordingly, the key question for them to ask is, *Given its strengths and limitations, what can this study tell us? What can we reasonably infer about the efficacy of this therapy?* They must also learn to ask, *How do you know? What is the evidence?* when a person makes a claim about a therapy. They should not confuse epistemic nihilism or cynicism with sophistication. Both cynicism and credulity are forms of intellectual laziness, and both are substitutes for thought. The best way to maintain a healthy balance is to keep one's eyes focused on the important questions and on the evidence.

TIMOTHY R. STICKLE: Albert Einstein is credited with saying, "All our science, measured against reality, is primitive and childlike—and yet it is the most precious thing we have." I try to remember that although I believe a scientific approach to psychology is the best we have, it is imperfect and incomplete. Remaining open-minded is essential or our approach becomes ideological and ceases to be scientific.

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