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Abstract

Two clinical science training issues that are relevant to the Delaware Project on Clinical Science Training are addressed: (a) the value of problem-based learning for training clinical scientists and (b) the implications of the National Institute of Mental Health's Research Domain Criteria (RDoC) project. Problem-based learning puts less emphasis on mastering procedures and applying existing solutions and more emphasis on learning how to identify problems and to design, implement, and assess solutions. This approach is illustrated using Berkeley's specialty clinic training model. RDoC is described along with the ways that clinical science training would need to change to embrace associated opportunities and overcome potential obstacles. Common to both issues are (a) the value of problem-based pedagogical approaches that prepare students to be creators, discoverers, assessors, and disseminators; and (b) the importance of training students to play central and significant roles in future approaches to the assessment and treatment of mental illness.

Keywords

training, clinical science, research domain criteria, treatment development, dissemination

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The training of clinical psychologists during the six decades since the end of the Second World War has largely been shaped by two highly influential models: (a) the Boulder model (Committee on Training in Clinical Psychology, 1947), which reigned supreme for most of this period; and (b) the clinical science model (Baker, McFall, & Shoham, 2008; McFall, 1991), which has had a much shorter run but has been equally transformative. Both models grapple with foundational issues concerning the roles of science and practice in clinical training. Although some people might argue that the differences between the two models are slight, I think there is an important difference of emphasis. Borrowing the colloquial example of walking and talking, the Boulder model envisions clinical psychologists who can both walk well and talk well, whereas the clinical science model argues that they should be able to do both well together.

A Hunger for Treatments

Although the Delaware Project on Clinical Science Training (held in October 2011) was broadly concerned with redefining clinical science training (see Shoham, Rohrbaugh, Onken, & Cuthbert, 2014, this issue), treatment development and dissemination quickly emerged as a focal

concern. The National Institutes of Health model for intervention development (see Onken et al., 2014, this issue)—which spans basic research, translational research, efficacy research, dissemination, and implementation—was presented at the start of the conference and served as a reference point for many of the subsequent presentations and discussions.

Why has this focus on treatment development arisen? Even a casual observer cannot help but notice the growing number of National Institute of Mental Health (NIMH) program announcements and conferences in recent years that emphasize developing new treatments and disseminating information concerning existing treatments. One reason for this growth may be the plethora of data indicating that mental illness is an enormous public-health concern. A 1999 report from the Office of the Surgeon General estimated that the annual indirect cost of mental illness was \$79 billion. According to a report by the World Health Organization (2004), major depressive disorder was the leading cause of disability in the United States

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and Canada among those aged 15 to 44. A survey conducted by the Substance Abuse and Mental Health Services Administration (2010) found that 11 million adults in the United States (approximately 5% of the population) were deemed to have a serious mental illness.

The annual federal appropriation for NIMH has ranged from \$1.3 to \$1.5 billion annually between 2003 and 2010 (according to congressional appropriation records). This appropriation is a huge investment, but it is dwarfed by estimates of the costs of mental illness. And how are we doing in the battle with mental illness? This question begets two related questions: (a) Are we making progress in reducing the prevalence of mental illness (by prevention, curative treatments, etc.)? and (b) Are we making progress in reducing the disability and costs associated with mental illness (by treatments and rehabilitation programs that improve functioning and reduce disability)? It turns out that answering the first of these questions is extremely difficult. Attempts to compare mental health-prevalence data that were collected at different times and by different investigators are confounded by inconsistencies in the ways that disorders were diagnosed and reference samples were constructed.

One of the best sources of information on changes in rates of mental illness over time comes from the National Comorbidity Survey, which was conducted from 1990 to 1992 and then replicated a decade later from 2001 to 2003 (Kessler, Chiu, Demler, & Walters, 2005). The results from these surveys are not encouraging. Examining the prevalence of disorders in the United States, that is, people between the ages of 18 to 54 who met *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*; American Psychiatric Association, 1994) criteria for a disorder during the preceding 12-month period, there is no indication that the nation's mental health improved. Rather, the prevalence actually increased slightly over the decade (from 29.4% to 30.5%). In terms of the second question, reducing disability and improving function, there have been enormous problems with treatment dissemination. In one study (also based on the National Comorbidity Survey), the delay between the onset of symptoms and receiving appropriate treatments was from 6 to 8 years for mood disorders and from 9 to 23 years for anxiety disorders (Wang et al., 2005). Although inequities in access and use of mental-health services undoubtedly play a significant role in explaining these delays, they also reflect the continuing challenges involved in getting community-based practitioners to use empirically supported treatments (McHugh & Barlow, 2010; Weisz et al., 2009). With these extremely sobering numbers and the attendant increases in public pressures, the increasing emphasis on treatment development and dissemination is not surprising.

Caught Between Two Worlds: *DSM* and Research Domain Criteria

The National Institutes of Health model for treatment development (see Onken et al., 2014) affords little attention to the assessment of mental illness. This is probably because the model was formulated under the assumption that the *DSM* would continue to serve as the primary basis for organizing treatment development in the future. Thus, the targets of treatment development and dissemination would largely be Axis I (e.g., bipolar disorder) and Axis II (e.g., borderline personality disorder) disorders. However, by the time the Delaware Project occurred, there clearly was an 800-lb gorilla in the room. Many of the attendees were quite familiar with the new NIMH Research Domain Criteria (RDoC) project (Cuthbert & Insel, 2010b, 2013), having participated in the various RDoC planning meetings. RDoC (discussed in detail later) does not focus on *DSM* clinical syndromes, such as bipolar disorder or borderline personality disorder. Rather, it focuses on behaviors, neural circuits, biomarkers, and dimensions of functioning. In an RDoC-centric world, a treatment development model would also need to place major emphasis on assessment, including developing, evaluating, and disseminating new assessment methods that could be used to identify targets for intervention and to evaluate treatments. As an attendee at the Delaware Project (and a participant in the RDoC process), I found myself often thinking about how radically different treatment development and dissemination might look in an RDoC-centric world.

The Present Article

This article focuses on two clinical science training issues that are directly relevant to treatment development and dissemination. The first issue is the value of problem-based learning as a general pedagogical model for training clinical scientists. In problem-based learning, the emphasis is less on mastering procedures and applying existing solutions and more on learning how to identify problems and to design, implement, and assess solutions. The article illustrates the problem-based approach using the specialty clinic training model that was developed at Berkeley (Levenson, Cowan, & Cowan, 2010) as a new way to provide applied clinical practicum training. The second issue concerns the implications that RDoC has for clinical science training. Here, the article discusses ways that clinical science training will need to change to embrace the opportunities and overcome the obstacles associated with the RDoC approach. The connective threads between the two parts of this article are (a) the value of problem-based pedagogical approaches that

prepare clinical students to be creators, discoverers, assessors, and disseminators; and (b) the importance of training clinical students in ways that will enable them to play central and significant roles in the future, and not be marginalized, as new approaches are taken to the assessment and treatment of mental illness.

Problem-Based Learning: Specialty Clinics at Berkeley

In both Boulder-model and clinical science-model training programs, students typically receive part of their applied clinical training in the classroom and part in the clinic. In the classroom, they learn about theories of intervention and about research on therapy process and outcomes. In the clinic, two pedagogical approaches are common: (a) Students learn particular treatment procedures and then use them with appropriate clients or (b) students are thrown into the deep end with clients, initially acting in accordance with their readings and intuitions and later shaped by guidance and feedback from supervisors. Even before the emergence of the empirically supported treatment movement (Chambless & Hollon, 1998; Chambless & Ollendick, 2001), students were made aware of approaches that had a stronger evidentiary base. Thus, for example, students trained in the 1970s and 1980s typically learned client-centered therapy (Rogers, 1951, 1957) for dealing with a broad range of psychological issues and systematic desensitization (Wolpe, 1958) for treating fears and phobias. Central elements of client-centered therapy were supported by empirical evidence (e.g., the importance of therapist empathy for fostering change in the client; Truax et al., 1966). Similarly, support for the efficacy of systematic desensitization was quite strong (Paul, 1968; Paul & Shannon, 1966).

At the same time, students in these eras might also have been exposed to a rogues' gallery of more exotic approaches, including psychodrama, movement therapy, primal scream therapy, psychodynamic group dream interpretation, bioenergetics, and Reichian therapy. Each of these treatments had its passionate advocates, carefully articulated rationales, elaborate procedures, and unique charms. However, to my knowledge, none were ever evaluated using even minimally adequate research methods. Fast forward to contemporary times, and what has happened to all of these procedures (both those with and those without empirical support)? Although some of these treatments undoubtedly continue to have their advocates, few, if any, are still being taught to graduate students in clinical science programs.

The ephemeral nature of clinical science procedures

Ultimately, all procedures in clinical science come with an expiration date. Whether it is therapeutic practices,

assessment techniques, research questions, research measures, or data analytic approaches, all have their moment on center stage and then the spotlight moves elsewhere. If this observation is correct, then we do our students a great disservice by training them primarily to be proceduralists, regardless of whether that involves training them to administer a particular set of empirically supported treatments or to apply a particular set of research methods to a particular set of research questions. In both clinical practice and research, our students are best served if we prepare them to identify problems, synthesize available knowledge, develop solutions, test those solutions, and inspire others to use and advance what they have learned. This is certainly not to say that training should be content or procedure free but, rather, that learning content and mastering procedures should not be the primary goals of doctoral-level clinical science training.

From boulders to bowlers: The two-hat problem

The Boulder model (Committee on Training in Clinical Psychology, 1947) envisioned clinical psychology training that included the concepts and skills needed for both science and practice. As I have noted previously,

In its canonical form, the scientist-practitioner model envisioned a tightly integrated, seamless blending of science and practice. But lurking behind this idealized unity was a far less integrated reality. Most scientist-practitioner programs were characterized by two parallel tracks: the science track, which was supervised by the academic faculty, and the practice track, which was supervised by the clinical faculty. . . . Invariably, we found ourselves adopting a "two-hat" metaphor, speaking of wearing our "scientist hat" in the laboratory and our "clinician hat" in the Psychology Clinic . . . the hats represented different paradigms with wholly different epistemologies. When donning the scientist hat, our assertions were typically based on tested theory and empirical evidence. When donning the clinician hat, our assertions were often based on untested theory and accumulated clinical experience. (Levenson et al., 2010, p. 198)

This two-hat problem has been endemic in clinical psychology training for decades. For example, Meehl (1973) made similar observations when explaining why he stopped attending case conferences (e.g., in his view, critical scientific thinking was often left at the door). Perhaps the most disheartening part of the situation was the ready adoption of this language by students who hearing faculty use these terms, soon became

comfortable with partitioning their own thinking about science and practice in these ways.

Specialty clinic training at Berkeley

In 1999, two of my colleagues¹ and I in Berkeley's clinical psychology program decided to develop a new problem-based learning model for practicum training that would explicitly combine science and practice. Reflecting our research and clinical interests, we decided to focus on treatment for couples.

Integrating research and practice. To forge the integration between research and practice, we eschewed the standard practice of having a separate intervention theory course that preceded the practicum experience. Instead, students enrolled in a yearlong combined course and practicum. By design, all participating faculty (academic and clinical) were full participants in all aspects of the specialty clinic, including a weekly 30-min faculty meeting, a 2-hr weekly seminar (which also periodically included a case conference once students began seeing clients), all treatment evaluation activities, and case supervision. Students received 30 min of supervision each week per case. A faculty supervisor was assigned to each case so that each student would be supervised by as many of the participating faculty as possible.

Choosing the target problem. The first specialty clinic had eight students. The seminar began with general readings on couples, couples therapy, and couples research. A schedule was established for critical implementation milestones that needed to be reached by particular dates (e.g., deciding on the focal problem for the clinic, finalizing the evaluation, beginning client recruitment, beginning treatment). For this first specialty clinic, the group considered a number of quite specific intervention foci (e.g., same-sex couples, newlyweds) but finally decided on a more general focus—couples dealing with relationship issues related to life transitions. This decision was based on the need for this kind of service in the community and the evidentiary basis available for designing an intervention. In subsequent iterations of the couples clinic, the problem-selection process sometimes led to a narrower focus. For example, one year the focus was on couples dealing with a potentially terminal medical condition, whereas another year the focus was on couples dealing with dementia.

Encompassing the full process of treatment development. Regardless of the focal problem selected, each specialty clinic encompassed the full range of activities related to treatment development: (a) reviewing current theories and research relevant to foundational processes

related to the identified problem (e.g., attachment, emotion regulation); (b) reviewing current theories and research relevant to treatment of the identified problem; (c) designing an evidence-based, time-limited intervention; (d) marketing the intervention (i.e., arranging for referrals, talking to relevant community organizations, advertising in local media); (e) designing a treatment assessment (which always included a traditional pretreatment and posttreatment battery as well as briefer measures that were completed each week); (f) delivering the treatment under supervision; (g) assessing the efficacy of the treatment; and (h) preparing a report or colloquium presentation on the training and the efficacy of the intervention.

Student and faculty participation in designing the learning experience. In the specialty clinic model, students are often asked, "What do you need to learn to be able to work effectively with clients?" This question guides a host of activities, including discussions about topics for assigned reading, experts to invite to talk to the seminar, visits to community agencies, and audiovisual training materials to view. Once treatment has started, there are discussions about additional readings, cases to present to the entire group, and consultants to bring in for help with particular issues that arise. Specialty clinic students and faculty all participate fully in making these decisions. This models an approach that we expect students will use in the future when they are faced with the need to expand their expertise to address new clinical (and research) problems.

The treatment toolbox. We have found it useful to identify a set of procedures and materials that can be used by students when working with couples. Most of these procedures and materials are identified from reviewing relevant literatures, but some are designed in-house to deal with particular issues. For example, we often use a video-recall procedure adapted from couples research (Levenson & Gottman, 1983) in which couples are videotaped while they discuss a marital problem. They later watch the tape together with their therapist, stopping to examine moments at which troublesome interactions occur (e.g., demand-withdraw cycles; Christensen & Heavey, 1990). These can lead to psychoeducational interventions, role-plays of alternative ways of dealing with the interactions, homework assignments, and so forth. Although far from meeting double-blind, random-assignment clinical research standards, data collected as part of our weekly assessments are useful in gauging the utility of particular tools. For example, in one year's treatment evaluation, we found that session-to-session increases in marital satisfaction for couples were

greatest following the session in which the video-recall tool was used.

Student and faculty reactions. Although clearly labor intensive and somewhat nerve racking (i.e., the pressures of starting the specialty clinic from scratch each year without knowing in advance exactly where the clinic would be headed), we found the specialty clinic model to be an extremely satisfying teaching experience. A good indicator of this satisfaction is that we have now offered the couples clinic six times (perhaps most telling, my cofounders came back postretirement to colead one of these iterations). Student evaluations have been uniformly positive. For a book chapter written about this project (Levenson et al., 2010), we contacted all previous student participants and asked them to reflect on this experience and how it had influenced their careers. Many of their responses were included in the chapter. To summarize, there was a strong sense that participation in the couples clinic was a transformative and empowering experience, one that truly seemed to capture the elusive goal of more fully integrating science and practice.

Scaling up and reaching out. After several successful iterations of the couples clinic, other program faculty began using the model to offer practicum experience in additional areas. In 2005, the clinical science program officially adopted the specialty clinic model as the primary training model for applied clinical training. Over the years, specialty clinics have been offered by other faculty in areas including (a) mood disorders, (b) emotion awareness and management, (c) immigrant mothers dealing with divorce, and (d) sleep disorders. In many iterations, prominent clinicians from the community were invited to colead specialty clinics with core academic faculty.² This involvement of academic and clinical faculty provides an important collaborative model for students. This approach can also pay dividends in helping disseminate knowledge about evidence-based practice into the general clinical community and in getting invaluable input from frontline clinicians about intervention strategies that are being developed based on clinical research.

RDoC: New challenges and opportunities for clinical science training

RDoC aims to provide a new way of classifying mental disorders that is based on dimensions of neurobiology and observable behavior (Cuthbert & Insel, 2010b, 2013). This approach is quite different from that found in the current psychiatric diagnostic systems (e.g., the American Psychiatric Association's 2013 *DSM-5* and the World

Health Organization's 2010 *International Classification of Diseases*, ICD-10, and upcoming 11th revision, ICD-11), which seek to identify particular syndromes on the basis of presenting signs and symptoms. Although the framers of RDoC have gone to some length to note that it is designed as a research classification system rather than one intended for routine clinical use (Cuthbert & Insel, 2013), it may be difficult to maintain this distinction. If RDoC generates a new body of exciting, clinically relevant research findings, the "just for research" mantra will likely be drowned out by questions concerning what this system can do to help relieve the burden of mental illness. Regardless, clinical scientists are going to want to be deeply involved in this new approach to clinical research. Thus, their students will need to be trained in ways that enable them to function productively in an RDoC-centric world.

The problems inherent in the *DSM* have been well documented over the decades (Cuthbert & Insel, 2010a; Widiger & Sankis, 2000). Although significant progress has been made in increasing the reliability of certain diagnoses, the ultimate validity and utility of these diagnoses is undercut by a host of factors, including (a) high levels of comorbidity across disorders, (b) lack of specificity in etiology, (c) lack of specificity in pharmacological and behavioral treatments, (d) particular symptoms (e.g., fear) appear in multiple disorders, and (e) broad syndromes (e.g., schizophrenia, major depression) have multiple variants that could be better characterized as different disorders.

Moreover, as the tools for assessing the genes, molecules, and neural circuits that determine behavior have become dramatically more precise and refined in recent years, attempts to link them with the broad, heterogeneous *DSM* syndromes have seemed increasingly misguided. Finally, increases in the reliability of *DSM* diagnosis have not produced improvements in the sobering public-health statistics described earlier in relation to the prevalence of mental illness, the associated burden, the need for more effective treatments, and the challenges of getting the best available treatments to those most in need. For all of these reasons, there is a building momentum for trying a different approach.

RDoC: The basic framework

RDoC focuses on behavior and neurobiology. It begins by asking what the range of behaviors are that the brain has evolved to carry out and what the neural systems are that are responsible for implementing these behaviors (Cuthbert & Insel, 2013). Thus, for a behavior to be included in RDoC, there must be a plausibly associated brain circuit. Because the granularity of RDoC is

constrained by the state of current neurobiological knowledge, the behavioral units are called constructs (leaving the door open for additional validation and revision on the basis of future knowledge).

RDoC next specifies the range of variation in each behavioral construct from normal to abnormal. Thus, behaviors in RDoC are inherently neither good nor bad but, rather, represent dimensions that encompass a range of functioning. Moreover, these dimensions are not necessarily unipolar. For many behaviors, abnormality is associated with both extremes (e.g., having too much or having too little fear are both problematic).

The October 2012 iteration of RDoC (Cuthbert & Insel, 2013) dramatically illustrates how it differs from the DSM syndromes. In this version, five domains are elaborated along with their associated behavioral constructs: (a) negative valence domain (acute threat, potential threat, sustained threat, loss, frustrative nonreward), (b) positive valence systems (approach motivation, initial responsiveness to reward, sustained responsiveness to reward, reward learning, habit), (c) cognitive systems (attention, perception, working memory, declarative memory, language behavior, cognitive control), (d) systems for social processes (affiliation and attachment, social communication, perception and understanding of self, perception and understanding of others), and (e) arousal/modulatory systems (arousal, biological rhythms, sleep-wake).

RDoC also provides a framework for examining behavioral constructs at multiple levels of analysis, including genes, molecules, cells, physiology, behavior, and self-reports. In addition, it specifies laboratory paradigms that are used to assess these constructs. Thus, RDoC applies precise behavioral and biological measures developed in the laboratory to clinical phenomena that have traditionally been assessed using clinician and caregiver observations and patient self-reports.

Clinical psychology in an RDoC-centric world: An imaginary scenario

Jim, a 50-year-old man with no prior history of major psychiatric illness, is experiencing what he describes as emotional “numbness.” This is manifested in a general low level of enthusiasm and lack of enjoyment for work and family activities, things that used to be sources of great joy. He has been effective enough at work to keep his job and his family has remained intact, but he expresses concerns about how his problems will affect his work and family in the future.

Jim makes an appointment at the psychological services center at a major university for evaluation and treatment. He participates in a daylong assessment that includes structured clinical interviews, functional and

structural neuroimaging, genotyping, and laboratory-based observational tests of emotional and cognitive functioning. The results of the assessment are reviewed by a multidisciplinary team that represents psychology, psychiatry, pharmacology, social work, neurology, affective science, and cognitive science. The team concludes that (a) the emotional deficits are characterized by blunted responding in facial expressive behavior, but autonomic responding is at normal levels; (b) the emotional deficits are more pronounced in experienced affect than in anticipated affect; (c) there are pervasive deficits in executive functioning, especially in the realm of measures of cognitive flexibility; (d) volumetric analysis of structural brain scans indicate that brain regions involved in emotion generation and regulation show no evidence of accelerated neurodegeneration; (e) diffusion tensor imaging indicates that major frontal-subcortical networks are intact; (f) genetic analyses reveal a pattern of allelic variations in serotonin and dopamine genes consistent with high levels of environmental sensitivity; and (g) the medical history includes a cardiac arrhythmia that is being treated with a high dose of a broad spectrum beta-blocker.

In consultation with the multidisciplinary team, a clinical scientist formulates a treatment plan that includes (a) systematic evaluation of the extent to which the current cardiac medication is contributing to the depressed emotional functioning to determine whether medication changes are indicated, (b) careful examination of the patients’ home and work environments to identify contextual triggers and reinforcers that are contributing to reduced emotional reactivity and formulating a plan for modifying these environmental factors, (c) targeted intervention that focuses on enhancing moment-to-moment emotional experience and expression, and (d) a training program designed to improve low-level executive functioning.

The plan is to treat Jim for 3 months and then, if there is no significant improvement, to refer him for evaluation for suitability for two new treatments for emotional blunting, one using a targeted drug delivery system that increases serotonin levels in mesolimbic brain areas critical to emotion generation and the other using deep-brain stimulation to activate these same brain areas combined with transcranial magnetic stimulation to inhibit emotion regulatory centers in the dorsolateral prefrontal cortex.

Implications for clinical science training: How and where do we fit in?

The foregoing scenario is, of course, fictional. It attempts to extrapolate from the RDoC framework and current scientific trends to envision what the practice of clinical

psychology might look like in the not-too-distant future. How accurately this scenario portrays that future remains to be seen, but this kind of a science-based, multidisciplinary approach to case formulation and treatment is already being used in some areas of medicine and could easily be applied to mental illness as well.

If we assume that this envisioning of the post-RDoC world is at least partially accurate, begs the question: Are clinical scientists being trained to play major roles in this new world or will they become marginalized and irrelevant? For those with long memories, predictions of an imminent revolution in the practice of clinical psychology along with an associated tsunami of changes ripping through traditional clinical training may seem familiar. Are we in fact on the verge of a true revolution in clinical science, or will this be yet another instance that proves the adage “The more things change, the more they remain the same”? The ultimate answer to this question will be revealed only over time. But for now, I believe that there is great value in seriously entertaining the possibility that the changes that lie ahead for clinical psychology are going to be pervasive and profound. If this does prove to be the case, then we should do everything possible to ensure that graduates of our training programs are prepared to assume leadership roles in this new version of clinical science.

Coursework. In an RDoC-centric world, clinical science students will need to take substantial coursework in genetics, physiology, anatomy, and neuroscience, areas that are not typically required in current clinical science curricula. They will also need to take courses in the other areas of psychology that are most relevant to RDoC domains, including cognition, emotion, social, development, learning, and personality. Such courses will need to provide focused, in-depth exposure to the newest paradigms, theories, and methods, a far cry from the “broad and general” exposure currently required for American Psychological Association (APA) accreditation of clinical science programs (APA Commission on Accreditation, 2009). In addition, rather than having separate courses that cover normal and abnormal behavior, all courses (e.g., including those that consider cognition, emotion, and learning) will need to address the full range of functioning. In many departments, such courses do not currently exist, creating challenges in curriculum development for faculty in both clinical and nonclinical areas.

Research training. Program faculty will need to consider the level of expertise their students should have in the various subareas that are relevant to the new clinical science. If the goal is to train students who are capable of assuming leadership roles in the multidisciplinary research teams that will work on these complex,

multilevel problems, then it will be critical that students gain experience working on these kinds of problems in these kinds of teams. Work in the laboratory of the primary mentor will need to be augmented with experiences working with other mentors and in other laboratories if students are to obtain the necessary breadth and depth of research experience. Problem-centered learning will play a critical role as clinical science students learn how to incorporate multiple research perspectives and collaborate with scientists from other areas of psychology and from other disciplines.

In the current version of clinical science training, students often struggle to find time for research with a single mentor amid the demands of required courses, teaching assistantships, clinical work, and other obligations. In this new era, as clinical science students engage in multiple training rotations and pursue demanding, time-intensive research projects, it will be critical to find ways to make more time available for research training.

Practicum training. Practicum training will also need to change in the new clinical science era. Opportunities will need to be developed that allow for extensive observation and direct exposure to a range of patients with different kinds and severities of dysfunction. Because many forms of dysfunction will be identified and treated in laboratory settings, a significant amount of experience with clinical assessment and treatment will need to be obtained in these kinds of settings to in addition traditional clinical training sites. With the increasing importance afforded to underlying neural circuits, clinical science students will benefit from extensive exposure to neuropathology in addition to psychopathology. Particularly valuable will be experience with neurological disorders that produce psychiatric-like syndromes (e.g., affective blunting in frontotemporal dementia, hallucinations in Lewy body disease, depression in Parkinson's disease, and affective dysregulation in amyotrophic lateral sclerosis; Levenson & Miller, 2007; Olney et al., 2011).

The new era will be characterized by many different treatment options, some traditional and some not. In terms of the former, behavioral and psychosocial treatments will continue to play an important role, but they will be oriented toward smaller units of dysfunction (e.g., reward prediction errors) rather than to larger problems (e.g., anhedonia) or syndromes (e.g., schizoaffective disorder). Other treatments will be more biological, targeting the neural circuits and genes that underlie specific areas of functioning. Already, there are treatments that target neural circuits using deep-brain stimulation (Holtzheimer et al., 2012), transcranial magnetic stimulation, and biofeedback. As new drug delivery systems become available, pharmacological treatments may become more targeted and more effective and have fewer

side effects. New research on gene expression and new methods for controlling the action of genes (Deisseroth et al., 2006) represent another frontier for new treatment approaches.

Treatment will always be a moving target. As new understanding of dysfunction and new approaches to its alleviation are developed, new treatments will come on line. Thus, problem-centered learning with the goal of developing expertise in the entire process of treatment development and dissemination will continue to be critical.

Assessment training. Clinical science students will need to gain experience with a broad range of new assessment techniques, including genetic assays, structural and functional neuroimaging, observational coding of behavior, and laboratory-based paradigms (e.g., for testing executive functioning, emotion regulation, and reward estimation). Moreover, clinical scientists will play an increasingly important role in the development of new, effective assessment methods that can be moved from the laboratory to the university clinic and ultimately into the hands of community practitioners. Again, problem-centered learning that provides students with experience with the full process of developing and disseminating assessment tools will be of the highest value.

Obstacles to overcome

When it comes to mental health, change will not come easily. Any change in how mental illness is conceptualized, classified, or treated will have profound impacts on practitioners, scientists, educators, insurers, advocacy groups, drug companies, patients, families, and many, many others. As compelling as the RDoC approach might seem, it is bound to encounter obstacles.

Inertia in academia. The scope of changes envisioned here would have profound implications both for clinical science programs and for their parent psychology departments. Many faculty members, trained in more traditional clinical psychology models, may feel unprepared to teach and supervise research and practica in these new ways. Getting consensus for these kinds of changes will be an enormous challenge. Although a wait-and-see approach may have its appeal, this may be a once-in-a-generation opportunity for clinical science programs to assume leadership roles in moving their departments and the mental-health system in important new directions.

The DSM. The *DSM-5* has numerous improvements and refinements that should help advance the reliability of diagnosis. However, as noted earlier, there are many reasons to doubt that it represents the best approach for

guiding future research, assessment, and clinical practice. Here again, change will not come easily. Every diagnosis in the *DSM* has an associated cottage industry of measures, theories, treatments, paradigms, affordances, reimbursements, streams of research funding, and careers that create a huge vested interest in maintaining some version of the status quo.

Accreditation. Clinical science programs are now confronted with two accreditation options. The new kid on the block is the Psychological Science Accreditation System (PCSAS), which as of this writing has accredited 21 research-focused clinical science programs. PCSAS accreditation places heavy emphasis on outcomes, carefully examining whether graduates are creating and applying science in their careers. Because it affords less emphasis on process, it allows programs maximal flexibility in the ways they train their students to produce the desired outcomes. This flexibility will greatly facilitate the changes in training necessary in an RDoC-centric world.

The grand dame of accreditation is the APA Commission on Accreditation. Because APA accreditation is required for professional licensure in all states and for certain internship placements and careers, even PCSAS-accredited clinical science programs still seek APA accreditation. Compared with PCSAS, APA accreditation places far greater emphasis on the training process. APA accreditation recognizes alternative training models (including clinical science); however, the core requirements for curriculum and practicum experiences are the same for all models (APA Commission on Accreditation, 2009). An area of increasing contention in recent years has been the requirement that students receive broad and general training (Zlotlow, Nelson, & Peterson, 2011) through graduate-level coursework in a number of designated areas of psychology (e.g., human development, biological aspects of behavior, cognitive and affective aspects of behavior, history and systems). For clinical science programs, and especially in an RDoC-centric world, it makes more sense to have students take focused and specific courses that cover the more specialized, cutting-edge knowledge in the other areas of psychology (Berenbaum & Shoham, 2011). Unfortunately, the rift between clinical science programs and APA accreditation on these and other training issues seems to be widening, not narrowing.

RDoC vulnerabilities. RDoC was not designed to be a compendium of all behaviors. Rather, the RDoC framework explicitly requires each included behavioral construct to have a plausibly associated brain circuit. In addition, by considering behaviors to have manifestations that fall on dimensions of normal to abnormal, RDoC behaviors need to have manifestations that are associated

with mental illness (RDoC is not as explicit about this, but it is implied). These requirements are extremely useful for building the catalogue of RDoC behaviors, but they quickly run up against the limits of current knowledge. Some behaviors and brain-behavior relationships are well understood, whereas others are not (including those involving some of the highly complex cognitive, emotional, and social functions that are often disrupted in mental illness). Thus, RDoC is vulnerable to false positives (behaviors that are included that should not be) and false negatives (behaviors that are not included that should be).

The founders of RDoC were clearly aware of these limitations, envisioning the framework as organic and evolving in response to new knowledge about brain-behavior relationships (Cuthbert & Insel, 2013). However, even with greater knowledge, there will always be a subjective element in determining at what point the evidence is sufficient for including or excluding a particular behavior. Despite RDoC still being in its early stages of development, the stakes are already high. A behavior that is included in the framework will be eligible for future RDoC-earmarked research funding; one that is excluded will have a more difficult path. For some potential RDoC inclusions, specialized assessment techniques, paradigms, and even interventions already exist. As scientists, we all have blind spots when it comes to the work we do and care passionately about. Under these conditions, RDoC, like the *DSM* before it, faces the potential problems of guild interests and personal preferences trumping objective decisions.

An unfortunate firewall. Within psychology, research on mental illness has historically largely been the exclusive province of clinical psychology. In fact, students from other areas of psychology are often actively excluded from receiving clinical training and from being exposed to clinical phenomena. A strong movement at NIMH in recent years toward a greater investment in mission-critical research and the related increased emphasis on translational science has encouraged scientists from nonclinical areas of psychology to work on problems related to mental health and illness. These trends could be strengthened by providing some applied clinical training and exposure to clinical phenomena to students in nonclinical areas of psychology. Broadening training in this way would dramatically increase the number of scientists who work on issues related to mental illness in the future. Fresh eyes combined with new energy, methods, and insights can help lead to the kind of scientific breakthroughs that are sorely needed in mental illness research. RDoC, with its stated agnosticism regarding existing *DSM* diagnoses and its focus on behaviors that have well-established neural underpinnings,

seems particularly well suited to this more inclusive approach to training.

Conclusions

The Delaware Project on Clinical Science Training highlighted the need for progress in developing treatments for mental illness and in disseminating available treatments. The importance of developing scientifically based treatments is also clearly seen in the increased emphasis at NIMH on translational research (NIMH, 1999), the emergence of the clinical science movement (Baker et al., 2008), and the new RDoC framework for guiding mental-health research (Cuthbert & Insel, 2013). All of these trends have profound implications for clinical science training. But what kind of training will be needed to produce clinical scientists who thrive in this new era, assume leadership positions in the field of assessment and treatment development, and help lead the charge for needed reforms in the diagnosis and treatment of mental illness?

This article addresses two issues related to this question. The first is the value of problem-based learning as a pedagogical model for clinical science training. As applied to clinical practicum training, in this approach, students learn how to identify treatment needs, design evidence-based treatments, market interventions, evaluate treatment efficacy, and disseminate the products and outcomes to others. This approach is an alternative to training that primarily prepares students to be experts in administering a set of evidence-based treatment procedures, most of which will likely be supplanted by new approaches in the future. Here pedagogical models and public-health finances converge, with ample evidence that evidence-based treatments can be delivered as effectively and at much lower cost by mental-health specialists with associate, bachelor's, and master's degrees compared with those with doctoral training (Berman & Norton, 1985; Christensen & Jacobson, 1994).

The specialty clinic model at Berkeley is an example of how problem-based learning can be implemented for practicum training in a typical research-oriented clinical science program. The fact that this model is still going strong after 12 years suggests that it is both feasible and sustainable. Moreover, the model integrates science and practice in ways that have been quite elusive in traditional two-hat systems in which applied clinical training follows a very different epistemology, uses a different kind of language, and is staffed by different faculty than clinical research training.

The emergence of RDoC shows promise of being a major game changer. Symptom-based and dimensional approaches to clinical diagnosis have certainly been proposed before (e.g., Krueger, Watson, & Barlow, 2005).

However, RDoC differs in its focus on small units of behaviors that are plausibly linked to underlying neural circuits, molecules, and genes that can be precisely measured and that span a range of normal to abnormal functioning. At this juncture, it is impossible to know whether RDoC will endure and flourish or just be another interesting idea that did not gain sufficient traction to survive. But the weight of the NIMH bully pulpit, the commitment of a significant portion of NIMH research funding to RDoC-based research, and the promise of having a set of mental illness-relevant constructs that are of sufficiently fine granularity to forge links with recent advances in neuroscience and molecular genetics may create the perfect storm for fomenting a revolutionary change in the understanding, assessment, and treatment of mental illness.

An RDoC-centric world would have profound implications for clinical science training. The kinds of knowledge and expertise needed to navigate the RDoC framework successfully draw heavily on neuroscience and genetics and on laboratory paradigms used to measure behavioral functioning developed in other areas of psychology. Clinical science students currently do not receive a great deal of training in these areas, even in the most science-oriented training programs. It is clear that with so much that is new, this is another excellent opportunity for problem-based learning approaches, which do not give students answers (which in these domains do not yet exist) but, rather, give them the tools to seek those answers. Faced with the disparities between the demands of the RDoC world and current training emphases, and confronted with powerful impediments to change (e.g., APA accreditation requirements, existing allegiances to the *DSM*), clinical science may soon find itself at a crossroads. Clinical science training can remain where it is, waiting on the sidelines to see what changes actually occur, and then try mightily to catch up. Or the field can begin to change now, seize the moment, figure out how to move the immovable, and set out to train a new generation of students who can help lead the way into the next era of clinical science.

Declaration of Conflicting Interests

The author declared no conflicts of interest with respect to the authorship or the publication of this article.

Notes

1. Carolyn Cowan and Philip Cowan.
2. Including Jacqueline Persons (mood) and Dan Wile (couples).

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