ARTICLE
The Clinical Neuroscience Course: Viewing Mental Health from Neurobiological Perspectives

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Although the field of neuroscience is booming, a challenge for researchers in mental health disciplines is the integration of basic research findings into applied clinical approaches leading to effective therapies. Recently the National Institute of Mental Health called for *translational* research grants to encourage collaboration between neuroscientists and mental health professionals. In order for this "clinical neuroscience" to emerge and thrive, an important first step is the provision of appropriate course offerings so that future neuroscience researchers and mental health practitioners will have a common neurobiological base from which to make informed decisions about the most efficacious treatments for mental illnesses. Accordingly, an integrative course, Clinical Neuroscience, was developed to address these issues. After reviewing the historical origins of this emerging discipline, students are exposed to fundamental overviews of neuroanatomy, neurochemistry, and neural development before approaching the neurobiological components of several disorders (e.g., schizophrenia, depression, Tourette's syndrome, drug abuse, obsessive compulsive disorder). Finally, the maintenance of mental health is emphasized as topics such as psychoneuroimmunology, coping with stress, and eating regulation are discussed. Important themes emphasized in this course include (1) the consideration of only empirically based evidence, (2) the view that mental illness represents a disruption of neurobiological homeostasis, (3) the acknowledgement that, because the brain is a plastic organ, the clinical relevance of environmental and behavioral influences is difficult to overestimate, and (4) the recognition of the value of ecologically relevant animal models in the investigation of various aspects of mental illness. Because of the importance of stress maintenance in mental health, exercises have been developed to increase students' awareness of their own coping strategies. Finally, several books and movies are incorporated to provide additional points of view of the topics discussed in the course.

Key Words: clinical neuroscience, neurobiological homeostasis, stress response, mental illness

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As a professor of behavioral neuroscience, I became increasingly frustrated with the level of preparation I was providing students for future careers as neuroscientists and mental health practitioners. Although students were exposed to fundamental psychobiological content in my Behavioral Neuroscience course, the amount of time allotted to the coverage of the neurobiological bases of mental health was very limited—about two lectures at the end of the course. Students interested in careers in the mental health profession were encouraged to take courses such as psychopathology in the psychology department but the students interested in the role of the brain in mental illness were frustrated that so little coverage of the brain was included in that course. Thus, a divergence in the way we were educating our students was apparent; students were either exposed to neuroscience-related courses with very little information about applied mental illnesses or to mental illness information with very little coverage of neuroscience.

I was also troubled by several *disconnects* between information covered in our classes and information gathered by students outside of the classroom. For example, although the complexity of the serotonergic system is thoroughly covered in the Behavioral Neuroscience course, complete with all the sub-type receptors, synthesis pathways, agonistic and antagonistic pharmacological influences, and an extremely confusing literature about the role of serotonin in mood functions, students get a different perspective when they look at media advertisements for antidepressants and see a bouncing ball with a sad face taking a drug that makes it immediately smile. Students learn in the popular Pfizer ads that the drug Zoloft (a selective serotonin reuptake inhibitor; SSRI) causes neurons A and B to share more neurochemicals, resulting in the lifting of the emotional dark clouds and the emergence of the sun. Further, as displayed on the Pfizer website (www.pfizer.com), this very simplistic explanation for the treatment of depression is extended to at least four other disorders: social anxiety disorder, post traumatic stress disorder, panic disorder, and obsessive-compulsive disorder. In class, students are forced to struggle with the roles of glucocorticoids, dopamine, noradrenaline, and many other neurochemicals (including serotonin) when considering key factors in the genesis of these disorders only to learn by authoritative pharmaceutical companies that one simple answer extends to five major mental illnesses.

Another disconnect is related to career choices for students interested in both neuroscience and mental health. Several students, after taking courses in both neuroscience and clinical psychology, are very excited about a career that merges both these perspectives. These students hit a wall when they begin searching for graduate programs as they learn that many clinical

psychology programs offer and require very few courses on the brain; alternatively, their searches for neuroscience graduate programs rarely yield programs offering practical, clinical experience. It is true that a few integrative programs are emerging, but they are still very rare and students are often forced to choose between their interest in neuroscience research and their desire to develop and test actual therapies for patients suffering from mental illness.

A final concern relates to students' frustrations as they began writing papers in their neuroscience related courses. As they choose disorders for paper topics or research projects, students are amazed at the huge number of research articles related to these disorders only to learn in their classes that so many disorders lack real efficacious therapies, much less a cure. For example, as I am writing this manuscript, I visited the *PubMed* database (www.ncbi.nih.gov/entrez) and found that there are 147,812 research articles on depression and 65,682 articles on schizophrenia. This resource base seems to be overflowing in relevant articles, so much so that it is difficult for anyone to review all of the relevant research that has been conducted (many studies representing impressive research carried out by the best scientists in the world); yet, for a patient trying to determine the most effective treatment strategies, it is not clear that all of this research has produced true advances in the treatment of these devastating conditions. In fact, by 2025, even with all the relevant research and production of antidepressant medications, depression is forecast to become the second leading illness in the United States (McEwen and Lashley, 2002).

A colleague, Craig Kinsley (University of Richmond), experienced similar frustrations in his courses and developed a course to address these and other concerns—a course he called Clinical Neuroscience. I followed suit the next year and decided to incorporate the course into the Randolph-Macon College psychology curriculum. It is important to convey that students quickly learn that there are no easy answers to the troubling issues described above, but by learning about mental illness and mental health in the context of a neurobiological backdrop, students are more likely to identify the most effective and innovative mental health career and treatment paths in the future.

THEMES OF THE CLINICAL NEUROSCIENCE COURSE

Empirical Evidence

Although students are exposed to research methods courses in their various majors, it is important to revisit the relevance of certain methodological issues within the context of specific disciplines. To emphasize the importance of evidence-based therapeutic approaches, Clinical Neuroscience students are exposed to the real world consequences of exposing patients to therapeutic approaches that lack empirical support. For example, they learn about the recent tragic therapeutic fad in which patients diagnosed with multiple personality disorder MPD (now known as dissociative identity disorder; DID) were exposed to prolonged therapies consisting of hypnosis, multiple drugs, and talk therapy—i.e., therapeutic approaches that lacked empirical evidence for this particular disorder. To illustrate this point, the students are introduced to the case of Nadean Cool. Cool, a homemaker in Wisconsin, consulted a psychiatrist in the early 1990s seeking treatment for depression she was experiencing following an assault on her teenage daughter. Following seven months of extensive hypnosis and use of up to 13 different psychotropic drugs, Cool was diagnosed with MPD. She was told by her psychiatrist that her father was the leader of a cult that had exposed her to satanic rituals (including cannibalism of babies) as a child. Subsequently, the psychiatrist encouraged Cool to confront her father with accusations of childhood abuse; her father had no reply and, a week later, died. During her six long years of therapy (paid by her insurance in this case), she learned that she possessed 126 personalities including a heroin addict, the bride of Satan, a teenage boy, and a duck. At one point her psychiatrist conducted an exorcism in the hospital, an event that prompted Cool's husband to doubt the effectiveness of this therapeutic approach. Indeed, after all this time, Cool was in worse condition than when she initially visited her psychiatrist. Cool filed a malpractice suit against her former psychiatrist, and the jury, agreeing that her therapy was not supported by empirical evidence and contributed to her mental decline, awarded her $2.4 million. After ceasing her MPD/DID therapy, Cool suffers from mild depression but is much better today; the psychiatrist did not lose his license and still practices, although in a different state (Lambert and Kinsley, 2005).

Cases such as the one described above convey to students that some therapies offered by clinicians, even when delivered with the best of intentions, can provide more harm than benefits. As techniques that are new on the therapeutic horizon are discussed in the Clinical Neuroscience course, such as repetitive transcranial magnetic stimulation (rTMS), eye movement desensitization and reprocessing (EMDR), dietary treatment for autism, and new psychotropic drugs, students learn that a close analysis of the scientific literature is essential before adopting a particular approach.

Maintenance of Neurobiological Homeostasis

Clinical Neuroscience students learn about the *Diagnostic and Statistical Manual* (DSM) and the relevant mental illness categories and associated diagnostic criteria; however, this traditional diagnostic and categorical system is critically reviewed. An alternative approach to understanding mental illness, emphasizing the brain's adaptive strategy to attempt to compensate for disruptions in neurobiological processes associated with mental functions, is introduced in this course. This new perspective suggests that symptoms of mental illness may emerge in the context of the following conditions: (1) as compensatory actions result in the disruption of normal actions (e.g., obsessive-compulsive disorder), (2) when the neurobiological disruption is so severe that it compromises the brain's ability to respond (e.g., Alzheimer's), or (3) some combination of 1 and 2 (e.g., depression). Thus, mental illness is viewed as a disruption

of neurobiological homeostasis and an emphasis is placed on the maintenance of homeostasis as a protection against the genesis of mental illness symptoms. Accordingly, topics such as coping with stress, eating regulation, and psychoneuroimmunology are presented to inform students about various ways to prevent the disruption of neurobiological homeostasis.

Clinical Neuroscience students quickly learn that the most powerful threat to neurobiological homeostasis is chronic stress. As potential causes for disorders are discussed in the course (e.g., depression, OCD, Tourette's, schizophrenia, addiction), stress keeps coming up as a predisposing factor. Students become familiar with the neurobiology of the acute and chronic stress responses, and the relevance of the terms allostasis and allostatic load (Schulkin, 2003). The importance of coping strategies and their consequential effects on stress responsivity are discussed at several points throughout the course.

Neuroplasticity

In my opinion, one of the most influential studies conducted in the field of behavioral neuroscience was the elegant and simplistic research conducted by Bennett, et al. (1964) demonstrating that rats exposed to complex environments developed heavier cerebral cortices, larger cortical cell bodies, and more neuronal connections than impoverished controls. Parallel studies focusing on the health and lifestyles of nuns suggest that these effects extend to humans as well (Snowden, 2001). Following the research conducted by Fred Gage and his colleagues confirming that enriched environments also stimulate neurogenesis, there is new excitement about the potential role of the environment in human neuroplasticity (Kemperman et al., 1997). A recent related study reported that a three-month juggling training program resulted in grey matter expansion in temporal and parietal cortical areas—an effect that was lost after three months of no practice—suggesting that the adage *use it or lose it* has relevance for the brain (Draganski et al., 2004).

Case studies are also presented to demonstrate the plasticity of the nervous system in response to various developmental challenges and medical threats. For example, children suffering from severe epilepsy have had an entire hemisphere removed and, subsequently, regained functions after behavioral rehabilitation. Further, individuals faced with the challenge of being born without arms (due to prenatal exposure to teratogens such as thalidomide) have developed amazing flexibility and control of their feet. The ability of humans to use their feet as hands is a powerful example of a plastic nervous system (Lambert and Kinsley, 2005).

Throughout this course students are encouraged to examine the role of neuroplasticity in the maintenance of mental health. In the mood disorder component of the course, for example, students learn that neurochemicals associated with neuroplasticity are appearing increasingly important as depressed patients are reporting relief following activities such as exercise that lead to upregulated brain derived neurotrophic factor (BDNF; a growth factor) (Hill et al, 1993). Further, the combination of exercise and antidepressant pharmacotherapy leads to increased levels of BDNF mRNA (Russo-Neustadt et al., 2000). Finally, even ECT has been shown to significantly increase neurogenesis in a dose-dependent fashion (Madsen et al., 2000). Thus, depression is just one example of a disorder that clearly seems to be influenced by modifications in factors associated with neurotrophic/neuroplastic factors.

Importance of Animal Models

Considering the complexity of humans and the challenges associated with systematically investigating neurobiological mechanisms of various forms of mental illness, animal models are presented as a valuable tool for learning more about clinical neuroscience. When conducted appropriately, the development and use of animal models, and the accompanying degree of scientific control, comprise a critical step to gaining fundamental knowledge about conditions that affect other species, including humans. Consequently, the importance of relevant animal models is discussed at several points throughout the Clinical Neuroscience course—even in areas in which animal models are a challenge to develop. For example, although it is difficult to reproduce hallucinations and delusions in animals, researchers have developed a model simulating an interesting characteristic behavior in schizophrenia patients. Whereas most individuals demonstrate prepulse inhibition (PPI), meaning that, after conditioning, a "warning" conditioned stimulus typically reduces the startle response to a second more threatening stimulus, individuals with schizophrenia continue to exhibit the startle response with the same intensity, showing no evidence of habituation. Researchers have found that neonatal male rats treated with a nitric oxide (a gaseous neurotransmitter) antagonist subsequently developed hypersensitivity to DA agonists and PPI deficits, as seen in schizophrenia patients (Black et al., 1999). Accordingly, several researchers have used animal models of PPI as a bridge between humans and animals (Paylor and Crawley, 1997).

Students also learn to be critical evaluators of existing animal models. They learn that various models designed to assess a single behavior (e.g., learning) can potentially tap into very different neurobiological systems or that, contrary to Selye's original thoughts, all stressors are not created equal when individual responses are evaluated. Considering the important differences in animal models designed to assess a single behavior/emotion, caution is necessary when selecting the most appropriate animal model for a research project. Finally, after learning about the impact of biological predispositions in neurobiological responses, an emphasis is placed on the importance of the use of animal models that employ ecologically relevant tasks for a specific species.

EMPHASIS OF INTEGRATION

Clinical Neuroscience students are taught that it is beneficial to use multiple perspectives to evaluate causes and treatments of various mental illnesses. Exploring mental illness from multiple perspectives is comparable to

Window/Perspective	Focus on Depression
Genetic	Concordance rates in identical twins as high as 70% in mood disorders suggest that certain, although unidentified, genetic factors influence the expression of depression (Sanders et al., 1999)
Neuroanatomical	Areas such as the prefrontal cortex, cingulate cortex, hippocampus, amygdala, hypothalamus, thalamus, raphe nuclei, and locus coeruleus have been implicated in depression (Nemeroff, 1998; Ressler and Nemeroff, 2000)
Neurochemical	Although serotonin is the most celebrated neurochemical associated with depression, norepinephrine, corticosteroids, and neural growth factors are additional relevant substances (Holsboer, 2000; Russo-Neustadt et al., 2001)
Neurophysiological	Success rates of ECT and, more recently rTMS, suggest that altered neurophysiological activity influences depression symptoms (George et al., 1999; Krystal et al., 2000)
Developmental	Childhood sexual abuse leaves humans more susceptible to adult-onset depression (Heim et al., 2001); intensity of attention received by mother rats influences stress responsivity later in life (Meaney et al., 1991)
Environmental	Some individuals suffer from depression symptoms when daylight hours shorten during the winter months (Soldatos and Bergiannaki, 1999)
Behavioral/Cognitive	Rats exhibiting a bold exploratory response upon exposure to novel stimuli have lower levels of stress hormones (viewed as protection against onset of depression) and live longer lives (Cavigelli and McClintock, 2003); animals exposed to learning paradigms that diminish strength of response/outcome contingencies, as seen in the learned helplessness model, exhibit depression symptomology (Seligman and Weiss, 1980)
Cultural	Rates of depression are different in various cultures; relationships between degree of westernization and depression rates implicate cultural importance (Kleinman and Cohen, 1997)
Evolutionary	According to Sloman and Gilbert (2000), as complex social behaviors evolved, submissive and passive behaviors (similar to behaviors observed in some aspects of depression) became a strategic defense against social threats

Table 1. Windows (perspectives) of Clinical Neuroscience and relevant information applied to depression. For more information applying the windows perspective to additional mental illnesses see Lambert and Kinsley (2005).

viewing a house through multiple windows. Each window provides a valuable view of the subject (in this case a house), although this view provides an incomplete view of the entire house. After peering through all the windows, however, a more complete view can be constructed. Analogies are made between the endeavor of learning more about a house through the accumulation of these views from individual windows and learning more about the neurobiology of a particular mental illness by considering multiple views. Continuing with this analogy, most students can not imagine purchasing a house based on the view from a single window, a realization that forces them to consider the danger of diagnosing or treating a mental illness from the limited view of just one perspective (e.g., a purported imbalance of one neurochemical). Even when integrative perspectives are considered, however, students are cautioned that this information can rarely replicate the experiences of the person actually living day-to-day with a particular brain in his/her particular environment. See Table 1 for a list of perspectives emphasized in the field of Clinical Neuroscience and how they apply to the representative mental disorder depression.

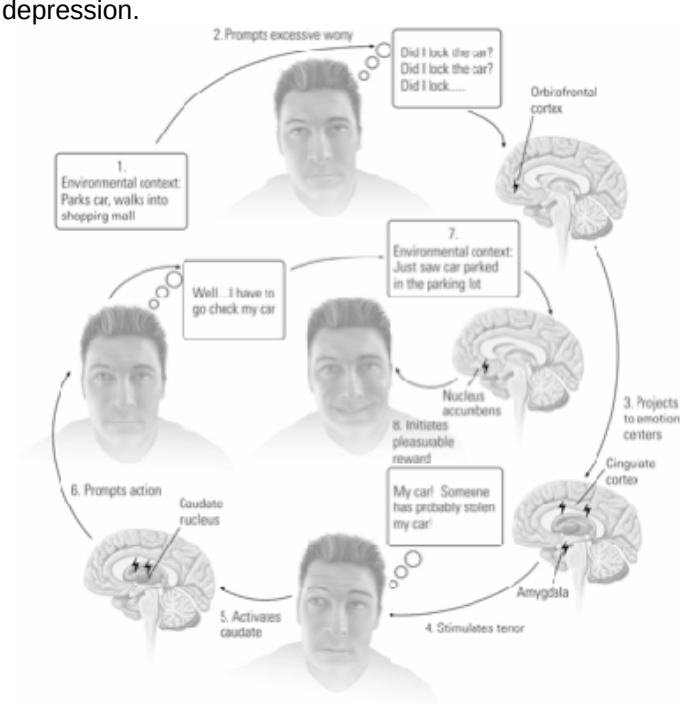

Figure 1. This figure, depicting the spiraling behavioral pattern associated with an OCD patient's simple trip to the shopping mall, illustrates the integration of cognitive/behavioral phases with proposed OCD neurocircuitry. Such integrative approaches encourage students to think about neurobiological components of specific symptoms associated with various disorders, a necessary strategy for gaining a complete understanding of underlying mechanisms of such disorders (Lambert and Kinsley, 2005).

As students are trained to consider multiple neurobiological perspectives when learning about a particular disorder, they are also encouraged to consider how these factors integrate with specific cognitive and behavioral symptoms experienced by individuals suffering from mental illness. For example, in Figure 1 the thoughts

and emotions of an OCD patient are mapped on to the brain areas associated with the various phases of a typical obsessive-compulsive episode. In this example of an individual walking from his car to a shopping mall, his orbitofrontal cortex is implicated in the initial doubt that the car is unlocked, the cingulate cortex and amygdala are likely involved in the onset of fear associated with the potentially stolen car, the caudate nucleus is shown to trigger the behavioral response of returning to the car to check if it had been stolen, and the nucleus accumbens may play a role in reinforcing the entire sequence once the car is observed in the parking lot. This approach is not only helpful to students as they begin to make connections between neurobiological factors and mental illness symptoms, it is immensely beneficial to OCD patients. Joe Dee, an aspiring screenwriter in California and a patient of Jeffrey Schwartz [neuropsychiatrist and author of *Brain Lock* (1996)] reports that he felt a heavy "emotional" weight lifted as he learned that there were actual brain areas that were responsible for the OCD symptoms he had experienced most of his life. Once thought to be some mystical curse, he learned that there were tangible reasons for his OCD symptoms, and, if he could learn to influence those brain areas through cognitive-behavioral therapy, he could exert some control over the frustrating symptoms. In fact, to this day he carries a piece of paper in his pocket with the words *caudate nucleus* written on it and when he feels OCD symptoms approaching, he reaches into his pocket to remind himself that the anxiety is a result of an overactive brain area, not an actual impending threat (Lambert and Kinsley, 2005). The effect described in this case study is confirmed by a PET investigation demonstrating less caudate metabolic activity in OCD patients following participation in a behavioral modification program (Schwartz et al., 1996).

Real-world case studies are also presented in this course to illustrate how multiple factors converge to increase or decrease symptoms of a mental illness. Mort Doran, for example, in spite of the challenges associated with Tourette's syndrome, worked diligently to become a surgeon and a pilot. He reports that his synchronous tapping is continuous as he progresses through most of his day, but amazingly, once he enters the operating room, the tics subside for hours as he conducts delicate surgeries. There is no denying that the environment in this case is an important factor in the suppression of his tics. Further, Doran calms himself each morning by pedaling furiously on a stationary bike while smoking a pipe and reading a pathology journal. His tics are completely suppressed during this time. After learning about the multiple aspects of Tourette's syndrome, it is relatively easy for students to consider this calming behavior and hypothesize about why this seemingly bizarre coping response may be effective. Exercise is related to endogenous opioid release; additionally, the rhythmic circular motion and repeated pedaling may be related to increased serotonergic release and a subsequent reduction in anxiety. Further, the nicotine in the pipe tobacco likely potentiates the effect of other medication or alters the cholinergic receptors in a way that calms the tics. Finally, the pathology text provides a cognitive activity that directs Doran's thoughts away from the impending tics (Lambert and Kinsley, 2005).

In sum, in a contemporary mental health climate that focuses primarily on the single neurochemical perspective, students are reminded throughout the Clinical Neuroscience course that mental illness is the product of multiple factors and, if that is the case, there are typically multiple therapeutic approaches for specific mental disorders.

THINKING ABOUT THE FUTURE

As the field of clinical neuroscience grows, knowledge gained from the discipline has the potential to influence many aspects of our society. Accordingly, it is appropriate to end the course with a brief discussion of some of these controversial issues. For example, the role of neuroscience in the exploration and definition of criminal behavior is explored in this course. New techniques such as brain fingerprinting have been introduced to the field with claims that relevant information for specific crimes held in the minds of suspects can be systematically determined with a narrow margin of error (Farwell, 2000).

The potential danger of the continuation of the pharmaceutical trend of marketing drugs for "designer" rather than medicinal reasons is also discussed. A satirical view of the *medicalization* of emotions published in the tabloid parody, *The Onion*, is used as a springboard to initiate conversation about this issue.

Zoloft for Everything Ad Campaign

Zoloft for Everything campaign will employ print and TV ads to inform potential users about the literally "thousands" of new applications for Zoloft. Among the conditions the drug can be used to treat: anxiety associated with summer swimsuit season, insecurity over sexual potency and performance, feelings of shame over taking an antidepressant, and a sense of hollowness stemming from losing an online auction….Do you find yourself feeling excited or sad? No one should have to suffer through those harrowing peaks and valleys. (The Onion, May 14, 2003).

Although students rarely want to admit the value of emotions such as sadness, a discussion about the evolution and adaptive significance of sadness and anxiety is appropriate as the prospect of the creation of a society that is systematically removing uncomfortable emotions from the texture of our emotional lives is emerging. Will such actions reduce our motivation to help others? to fight for meaningful causes? Related to such cosmetic pharmacology, a discussion of *euneurics*, a movement to design "better" brains, typically provokes heated discussion in the Clinical Neuroscience course.

Finally, we discuss the role politics plays in the direction of neuroscience research by reviewing the stem cell debates currently being played out in our society. Science is no longer restricted to the laboratory bench—it is becoming more and more necessary for scientists to leave the comfort of their laboratories to speak to the public about the value of certain scientific pursuits. Additionally, with the ethical implications of so many

relevant clinical neuroscience topics, great caution is necessary as the discipline plays more significant roles in our everyday lives.

RELEVANT ACTIVITIES AND ASSIGNMENTS

Stressographies

As previously mentioned, stress is emphasized as a common denominator in many mental illnesses. If stress responsivity is a critical factor in one's mental health, students should develop an increased awareness of how the stress in their lives influences their mental and physical health. To address this topic, research on coping strategies is presented in the Clinical Neuroscience course and students learn about the impact of day-to-day reactions to stress. For example, in a powerful example using an animal model of coping, Cavigelli and McClintock (2003) recently showed that two male rat siblings have vastly different life spans based on how bold they are when presented with a novel stimulus. Rats that quickly explore the stimulus have lower levels of stress hormones and live approximately 30% longer than their shy brother counterparts. It is important to emphasize that neither of these rat groups were exposed to a significant rat trauma—it was just the day-to-day responses to challenging stimuli that seemed to make the difference in this study. Based on the notion that these daily responses are important health mediating factors, students are asked to keep a journal in which they evaluate the stressors and stress responses in their own lives. At the completion of the project, as students review their stress response patterns, they develop a coping profile (based on an informal type of meta-analysis) as they determine their own coping strategies—active, passive, flexible—and the impact stress has on their medical and mental conditions. We also discuss strategies to mitigate stress responsivity and students evaluate their success utilizing these strategies (e.g., increased perception of control, affiliative social contact, exercise). Just as individuals with diabetes consider the relationship between blood glucose and insulin as being critical for their physical health, students learn to think of the relationship between stress levels and coping strategies as being important for maintaining mental health. Daily evaluations of one's stress levels and an increased awareness of the effectiveness of coping strategies employed to meet life's challenges may lead to more efficient responding and serve as a buffer, a mental insulin of sorts, against stress-induced mental illness.

Although this activity can be used in many ways, I have asked students to turn in reaction-type papers based on their journals. In these papers, they are asked to discuss the types of stressors encountered in their lives, coping strategies/profiles utilized, evidence of impact on the immune system, and success at incorporating new strategies to mitigate chronic stress activation. Students are also asked to identify an original research article related to some aspect of stress and coping that interests them and describe the hypothesis, methodology, and results of this study—as well as a description of how such research is relevant to clinical neuroscience. In these assignments, the appropriate use of the relevant terms, the justification of the students' determination of coping strategies (e.g., did they provide appropriate examples to support their "profile"?), and the accuracy of their descriptions of the original research are assessed. Although students report that it is difficult to evaluate their stress responses in the beginning, as they learn about the toxicity of chronic stress, they become increasingly motivated to learn more about their coping tendencies and incorporate new strategies to maintain neurobiological homeostasis. The most valuable aspect of this exercise, getting students to become more aware of potential threats to their mental health, is more difficult to assess; however, this point is brought up many times throughout the course and students are asked to think about examples from their own lives. Students are certainly more cognizant of the stress and subsequent responses in their lives after participating in this self-exploratory exercise and, when they choose to disclose examples in class, they are meaningful additions to lectures and discussions.

Spit Happens

Still focusing on stress, this activity was developed to reinforce the relationship between stress hormones and stress responses. The students learn a good bit about the hypothalamic-pituitary-adrenal (HPA) axis during formal lectures in the course, but a hands-on demonstration is more powerful. The purpose of this demonstration is to illustrate differences in cortisol levels during non-stressed and stressful conditions. One stressful activity that I have used, rock climbing, is very effective. In Richmond, VA, the facility *Peak Experiences* houses a 50 ft. wall that has a "leap of faith" component in which students are asked to jump from a tiny platform to a bar that looks too far away to grasp. Of course, the students wear protective gear and a qualified person belays them from below. Although, the activity is technically safe, my personal experience is that the prospect of jumping to that tiny bar from such a dangerous height provokes a "terror-like" response. The limbic brain structures seem to trump the higher cortical structures as they send danger messages throughout the CNS.

Cortisol samples are collected using salivette tubes purchased from Salimetrics (State College, PA; www.salimetrics.com). Because it takes a few minutes for cortisol to reach peak levels, saliva samples are collected about a minute following the jump (the climb and jump take about three to five minutes). Using this collection technique (described in detail in the materials provided by Salimetrics), students hold a small cotton dental roll in their mouths for a minute and then place the saliva-soaked rolls in a tube that will later be centrifuged to extract the saliva. Saliva samples can be sent to Salimetrics for enzyme immune assays (EIAs), or, if an instructor has access to a microplate reader, complete kits can be purchased for assays [see Kalman and Grahn (2004) for a comprehensive account of incorporating EIAs into the behavioral neuroscience laboratory; additionally, Salimetrics provides day-long workshops for anyone interested in learning how to do the salivary cortisol assays]. Assays conducted at Salimetrics run about $13 per sample. Also relevant in this activity, students notice

their high adrenaline levels as they find themselves shaking so much that it is nearly impossible to place the cotton tube in the containers. The cortisol levels from this stressful activity are subsequently compared to baseline levels; additionally, many issues can be discussed when the data are eventually evaluated (e.g., sex differences, circadian effects). Focusing on behavior, the diverse individual behavioral responses observed during this activity are discussed. For example, in my most recent class, some students managed to climb the wall and promptly sit on the platform, refusing to even stand up, much less jump (passive response), whereas others climbed and quickly jumped to the bar (active response). Students are asked if their responses to this significant threat correspond to coping responses to less threatening stressors (as described in their stressographies).

Movie Title	Relevant content
A Beautiful Mind	Living with schizophrenia; early treatments for schizophrenia; overcoming challenges of disorder to win and accept a Nobel Prize
At First Sight	Development of sensory perceptions; challenges faced when the brain is suddenly exposed to a new sensory stimulus (in this case visual stimuli); plasticity of the brain
Awakenings	Neurochemistry of movement disorders; sensitivity of the brain to endogenous neurochemicals/drugs; adventure of scientific discovery
Gattaca	Ethics and personal consequences associated with the utilization of genetic engineering to produce a "perfect" society; story-line suggests that one's potential in life can rarely be determined by genetic screening (also interesting is that the letters in the title of this film are derived from the letters used to label the nucleotide bases of DNA)
Life is Beautiful	Powerful story of the impact of an altered coping strategy (in this case a father influences his son's perception of the horror of being in a concentration camp)
Lorenzo's Oil	Neurodegenerative disease; excitement of the scientific process; dietary treatments
Osmosis Jones	Fundamental information relating to the immune system (but presented in a very entertaining, humorous manner!)
Supersize Me	Toxic impact of fast-food consumption
The Aviator	Living with OCD; power of OCD in disrupting one's life [Leonardo DiCaprio (Howard Hughes character) was coached by neuropsychiatrist Jeffrey Schwartz; hence, the portrayal of OCD symptoms is very realistic]

Table 2. Representative popular movies used in the *Clinical Neuroscience* course. (For additional popular movies appropriate for neuroscience courses see Wiertelak, 2002.)

Of course, it may not be possible to arrange such a dramatic activity for all courses. The same point can be made with other creative stressors; for example, prior to taking a challenging exam. The behavioral responses may not be as elaborate in some stressful situations, but the HPA axis response will still be affected.

Book	Relevance for course
Why Zebras Don't Get Ulcers (Sapolsky)	Informative and entertaining review of the stress literature; Sapolsky includes interesting stories and analogies that facilitate understanding and perceived relevance of the stress research.
Mad in America (Whitaker)	An investigative report of the genesis of pharmacotherapy—especially for the treatment of schizophrenia; this critical account will prompt many questions from students related to the ethics of how the mentally ill have been treated in this country and the future of the development of the most efficacious treatments for mental illness.
An Unquiet Mind (Jamison)	A beautifully written first-hand account of what it is like to suffer from bipolar disorder; being a psychologist herself, Jamison's personal accounts and insights are especially interesting for psychology and neuroscience students.
Blaming the Brain: The truth about drugs And mental health (Valenstein)	Written by an accomplished behavioral neuroscientist, this book emphasizes the point that, although pharmacological treatments are standard fare in psychiatric care, there is no clear evidence that disorders such as depression are directly caused by a chemical imbalance that is best treated by chemical intervention (i.e., drugs). On the contrary, Valenstein reminds us that a stimulating and nourishing environment is important in the maintenance of a healthy brain.
Minds Behind the Brain (Finger)	If students are interested in the origin of the many fundamental aspects of neuroscience, they'll enjoy this wonderful account of the real lives of the pioneers of clinical neuroscience. Finger is a superb historian who tells compelling stories about these bold individuals and the context of their lives that led to the genesis of many groundbreaking discoveries and theories in neuroscience.
Time on Fire: My comedy of terrors (Handler)	This autobiographical book provides an honest account of what it is like to have your immune system taken hostage by a disease, in this case, leukemia. Handler, then a young aspiring actor, describes his emotions, desires, fears, and strategies for survival. After becoming acquainted with the field of psychoneuroimmunology, this book will help students appreciate the clinical impact of emotional ups and downs on the challenged, fragile immune system. Students also enjoy learning that Handler survived his battle with leukemia and went on to secure a role in the recent popular series *Sex and the City*.
Acceptable Risk (Cook)	A fictional thriller written by a medical doctor that provides an exciting backdrop for the discussion of the development of psychotropic drugs and the ethics of "personality designer drugs"; a second story line related to a theory of fungus-induced hallucinations in the "Salem Witches" is also very interesting for students.

Table 3. Representative popular books used in the *Clincial Neuroscience* course.

Relevant Books and Media

Several relevant books and movies are incorporated into the Clinical Neuroscience course to provide additional

points of view for the students. Typically, several movies (e.g., *A Beautiful Mind*, *Awakenings*) are identified and students choose four to five movies that interest them from the recommendations. After viewing the movies out of class, students complete a reaction paper at appropriate times throughout the course in which they discuss the relevant issues portrayed in the film—assessing the accuracy of information included. Further, students are asked to examine "real" research on the topic by locating two studies from the scientific literature that are related to the topic of interest and including a description and evaluation of these studies in the reaction paper. Finally, pairs of students are assigned an oral presentation of one of their movie reviews and related scientific literature, allowing all students to learn about the interesting studies identified by other students. Typically these oral presentations are professional PowerPoint presentations and greatly enhance the content of the course (see the appendix for specific details of this assignment). A list of several movies and their relevant content is provided in Table 2 (for a more complete list of relevant movies for neuroscience courses see Wiertelak, 2002).

CONCLUSION

The Clinical Neuroscience course provides an opportunity for instructors to address some of the "disconnects" in the field of mental health described earlier in this article. As relevant neuroscience information is introduced to the mental health discipline, the face of mental health research and therapy is changing. These changes need to be reflected in academic curricula so that our students are better prepared to make informed decisions concerning their career paths in this burgeoning field. Due to its interdisciplinary nature, the Clinical Neuroscience course fits easily into psychology, biology, or neuroscience curricula. My experience has been teaching the course as part of a psychology curriculum; specifically, this course is an upper-level elective that is recommended for students interested in mental health and mental illness (both neurobiological and clinical career trajectories). As discerned by observing the syllabus provided in the appendix, the course is demanding but, thus far, the students have never complained about the workload—on the contrary, their subjective reports have been positive about all the readings and activities. In the Randolph-Macon program, the Clinical Neuroscience course can be taken along with two other courses in the psychobiology category (e.g., Behavioral Neuroscience, Comparative Animal Behavior, Neurocognition) to comprise an "emphasis" in psychobiology. Because fundamental neurobiological information is included in the course, the Randolph-Macon College program does not require students to take the Behavioral Neuroscience course as a prerequisite, but that is certainly a possibility in other programs. After completing this course, initiated students are often interested in conducting relevant clinical neuroscience research projects as part of Randolph-Macon's Summer Undergraduate Research Fellowship (SURF) program or as a senior project. Typically, these research projects involve the development and validation of animal models to investigate symptoms and responses frequently observed in various mental illnesses. Now that the course has become a permanent component of the Randolph-Macon curriculum, systematic assessment of the students and their entrance into graduate schools and professional careers is necessary to determine the value of the course in the education of pre-professionals in disciplines related to mental health.

REFERENCES

Bennett EL, Diamond ML, Krech D, Rosenzweig MR (1964) Chemical and anatomical plasticity of brain. Science 206:649-654.

Black MD, Selk DE, Hitchcock JM, Wettstein JG, Sorensen SM (1999) On the effect of neotatal oxide synthase inhibition in rats: A potential neurodevelopmental model of schizophrenia. Neuropharmacology 38: 1299-1306.

Cavigelli SA, McClintock MK (2003) Fear of novelty in infant rats predicts adult corticosterone dynamics and an early death. Proc Natl Acad Sci USA 100:16131-16136.

Cook R (1994) Acceptable risk. New York, NY: GP Putnam's Sons.

Farwell L (2000) Interview with Mike Wallace on Highlights of CBS 60 Minutes featuring brain fingerprinting. Retrieved January 8, 2004, from: www.brainwavesxcience.com/Highlights60Minutes.htm

Draganski B, Gaser C, Busch V, Schuierer G, Bogdahn U, May A (2004). Neuroplasticity: changes in grey matter induced by training. Nature 427:311-312.

Finger S (2000) Minds behind the brain. New York, NY: Oxford University Press.

George MS, Nahas Z, Kozel RA, Goldman J, Molloy M, Oliver N (1999) Improvement of depression following transcranial magnetic stimulation. Curr Psychiatry Rep 1:114-124.

Handler E (1996) Time on fire: My comedy of terrors. New York, NY: Little, Brown and Company.

Heim C, Newport DJ, Bonsall R, Miller AH, Nemeroff CB (2001) Altered pituitary-adrenal axis responses to provocative challenge tests in adult survivors of childhood abuse. Am J Psychiatry 158:575-581.

Hill RD, Storandt M, Malley M (1993) The impact of long-term exercise on training on psychological function in older adults. J Gerontol 48:12-17.

Holsboer F (2000) The corticosteroid receptor hypothesis of depression. Neuropsychopharmacology 23:477-501.

Jamison KR (1996) An unquiet mind. New York, NY: Vintage Books.

Kalman BA, Grahn RE (2004) Measuring salivary cortisol in the behavioral neuroscience laboratory. J Undergrad Neurosci Edu 2:A41-A49.

Kempermann G, Kuhn HG, Gage FH (1997) More hippocampal neurons in adult mice living in an enriched environment. Nature 386:493-495.

Kleinman A, Cohen A (1997). Psychiatry's global challenge. Sci Am 276:86-89.

Krystal AD, West M, Prado R, Greenside H, Zoldi S, Weiner RD (2000) EEG effects of ECT: Implications for rTMS. Depression and Anxiety, 12:157-165.

Lambert KG, Kinsley, CH (2005) Clinical neuroscience: The neurobiological foundations of mental health. New York, NY: Worth.

Madsen TM, Treschow A, Bengzon J, Bolwig, TG, Lindvall O, Tingstrom A (2000) Increased neurogenesis in a model of electroconvulsive therapy. Biol Psychiatry 47:1043-1049.

McEwen BS, Lashley EA (2002) The end of stress as we know it. Washington, DC: Joseph Henry Press.

Meaney MJ, Aitken DH, Sapolsky RM (1991) Postnatal handling attenuates certain neuroendocrine, anatomical, and cognitive dysfunctions associated with aging in female rats. Neurobiol Aging 12:31-38.

Nemeroff CB (1998) The neurobiology of depression. Sci Am 278:28-35.

Paylor R, Crawley JN (1997) Inbred strain differences in prepulse inhibition of the mouse startle response. Psychopharmacology 132:169-180.

Ressler KJ, Nemeroff CB (2000) Role of serotonergic and noradrenergic systems in the pathophysiology of depression and anxiety disorders. Depress Anxiety 12:2-19.

Russo-Neustadt AA, Beard RC, Huang YM, Cotman CW (2000) Physical activity and antidepressant treatment potentiate the expression of specific brain-derived neurotrophic factor transcripts in the rat hippocampus. Neuroscience 101:305-312.

Russo-Neustadt AA, Ha T, Ramirez R, Kesslak JP (2001) Physical activity-antidepressant treatment combination: Impact on brain-derived neurotrophic factor and behavior in an animal model. Behav Brain Res 120:87-95.

Sanders AR, Detera-Wadleigh SD, Gershon ES (1999) Molecular genetics of mood disorders. In Neurobiology of mental illness (Charney DS, Nestler EJ, Bunney BS, eds) pp 299-316. New York, NY: Oxford University Press.

Sapolsky RM (1998) Why zebras don't get ulcers. New York, NY: Freeman.

Schulkin J (2003) Rethinking homeostasis: Allostatic regulation in physiology and pathophysiology. Cambridge, MA: MIT Press.

Schwartz JM, Beyette B (1996). Brain lock: Free yourself from obsessive-compulsive behavior. New York, NY: HarperCollins.

Schwartz JM, Stoessel PW, Baxter LR, Martin KM, Phelps ME (1996) Systematic changes in cerebral glucose metabolic rate after successful behavior modification treatment of obsessive-compulsive disorder. Arch Gen Psychiatry 53:109-113.

Seligman MEP, Weiss JM (1980) Coping behavior: Learned helplessness, physiological change and learned inactivity. Behav Res Ther 18:459-512.

Sloman L, Gilbert P (2000) Subordination and defeat: An evolutionary approach to mood disorders and their therapy. Mahwah, NJ: Erlbaum.

Snowden D (2001) Aging with grace. New York, NY: Bantam Books.

Soldatos CR, Bergiannaki JD (1999) Sleep in depression and the effects of antidepressants on sleep. In: Pharmacotherapy for mood, anxiety, and cognitive disorders (Halbreich U, Montgomery SA, eds) pp 255-272. Washington, DC: American Psychiatric Press.

The Onion (2003). Pfizer launches "Zoloft for Everything" ad campaign (Parady). Retrieved January 8, 2004, from http://www.healthyskepticism.org/reports.2003/0514.htm.

Valenstein ES (1998) Blaming the brain: The truth about drugs and mental health. New York, NY: Free Press.

Wiertelak EP (2002) And the winner is: Inviting Hollywood into the neuroscience classroom. J Undergrad Neurosci Edu 1:A4-A17.

Whitaker R (2002) Mad in America. Cambridge, MA: Perseus Books

APPENDIX

Syllabus: Clinical Neuroscience (Psych 335)

Men ought to know that from nothing else but the brain come joys, delights, laughter and sports, and sorrows, grief, despondency, and lamentations. And by this, in an especial manner, we acquire wisdom and knowledge, and see and hear and know what are foul and what are fair, what are bad and what are good, what are sweet and what are unsavory....And by the same organ we become mad and delirious, and fears and terrors assail us...All these things we endure from the brain when it is not healthy...In these ways I am of the opinion that the brain exercises the greatest power in the man.

Hippocrates, *On the Sacred Disease* (Fourth century, B.C.)

Introduction

The emphasis of this class is a generally new area known as *Clinical Neuroscience*—which is simply an exploration of the neurobiological foundations of mental health and mental illness. We'll focus mostly on empirical work—avoiding some of the psychobabble that you may see on *Dr. Phil* or hear on *Dr. Laura*. The "scientific literature" will be our guide as we explore the most likely causes and most effective treatments of the many mental disorders that haunt our society. With the new developments in genetics and brain imaging, these are exciting times to be interested in clinical neuroscience. I'll rely on videos, lectures, readings, and class discussions to introduce you to the world of clinical neuroscience this semester.

Texts

Lambert KG, Kinsley CH (2005) *Clinical Neuroscience: Neurobiological Foundations of Mental Health*.

Jamison KR (1995) *An Unquiet Mind: A Memoir of Moods and Madness.*

Whitaker R (2002) *Mad in America: Bad Science, Bad Medicine, and the Enduring Mistreatment of the Mentally Ill.*

Grading

Three in-class exams……55%
Four Movie Reviews……..……...10%
Independent Paper and Oral Presentation……..10%
Stressography……..……5%
Integrative Final Exam……..……15%
Class Participation……5%

Movie Reviews

Because there are so many movies related to topics that will be discussed in class, I thought they would be an effective springboard for thinking about some of the relevant issues in a more applied way. Seven movies are listed in the tentative syllabus and will be held on reserve in the library; you are required to write reviews for FOUR of these movies (hopefully you'll watch all of them). Each review should be typed (no more than five pages) and consist of the following components:

1. General description of relevant topic in movie.
2. An evaluation of the way the relevant "neuro/health-related science" was presented in the film.
3. A description of two references/articles that empirically evaluated a research question related to this topic (PubMed is a wonderful resource to use). A copy of these articles should be attached to your paper. As you probably know, it takes about a week

to get items from interlibrary loan if we don't have it in the library.

4. Your views of the relevance of this particular topic in the field of mental health.

Small groups of students will be assigned to one of the recommended movies and will subsequently be expected to make an oral presentation of each movie at appropriate times throughout the course; this presentation will contribute to your class participation grade. These presentations should last no longer than 15 minutes and should address the relevant questions mentioned above. It is fine to show a few short clips of key scenes of the movie if it adds to your presentation.

Stressographies

As we learn about the stress response and the importance of coping strategies, you will be asked to keep a daily journal describing the nature of the stressors you encounter in your life (e.g., acute, chronic, mild, intense, physical, psychological) and your subsequent responses (e.g., passive, active). Also, as we learn about effective coping strategies, you will be asked to examine your own coping responses to determine a "coping profile" (e.g., passive, active, flexible) and propose ways to modify these strategies and introduce "maintenance coping" (e.g., increased exercise, increased social support) to provide a buffer against the toxicity of the chronic stress response. More details about how to describe the stressors and subsequent responses will be made available at the time of the assignment. Your journal is yours to keep but you will be expected to write a reaction type of paper using information in your journal later in the semester. This assignment will force you to become more aware of your day-to-day coping strategies so that modifications can be made to enhance your neurobiological health.

Student Paper/Presentations

Each student will select a topic that is not covered extensively in class but related to the clinical neuroscience subject matter (see list below) and write a paper (appx. 12 pages) on the topic. I expect you to include about 10 references in this paper—at least seven should be empirical articles whereas up to three may be more popular readings or reputable web sites. Please use APA format when referencing your articles. Topics should be submitted to me by the deadline in the syllabus. Only one student can work on a particular topic. During the last week of class, student presentations are scheduled—each student will make a 10-15 minute presentation (preferably a PowerPoint presentation) of his/her topic. An outline of the talk should be distributed to the students at the time of the presentation. Possible topics include: autism, ADHD, Alzheimer's disease, Parkinson's disease, panic disorders, PTSD, Huntington's chorea, the role of behavioral therapy in mental illness, eye movement desensitization reprocessing (EMDR), repetitive transcranial magnetic stimulation (rTMS), contemporary utilization of psychosurgery, diet and mental health, estrogen and cognition, St. John's wort for depression therapy, neurobiology of sexual orientation, the placebo effect, neuroscience and forensics, cultural influences and mental illness, music and the brain, and plasticity of the human brain.

Exams

There will be three in-class exams that will count 55% toward your final grade. The nature of these exams will be quite eclectic with diverse types of questions ranging from fill-in-the-blank to essay format. If you know in advance that you will miss a scheduled test I will allow you to take it before the test day; however, if you miss an exam, you will have to take a *pre-final* exam during the last week of classes. The pre-final will cover the material missed by the students required to take the exam—hence, only one pre-final exam will be written. The nature of the final exam will be an essay take-home format enabling you to integrate the diverse aspects of the information covered during the semester.

Schedule

Introduction to the Brain and Clinical Neuroscience

Class 1	Introduction
Class 2	View and discuss video *Back from Madness* (HBO Productions)
Class 3	*CN: Ch 1: Clinical Neuroscience Emerges Reading: *Psychiatry's Downfall*—chapter from Hobson and Leonard's *Out of its mind: Psychiatry in crisis*; Video case of *Nadean Cool*, Multiple Personality Disorder (Dissociative Identity Disorder)
Class 4	Evolution of Clinical Neuroscience CN: Chp 2: Research, Treatment, and Points of View: Historical Perspectives

Fundamentals: Establishing Homeostasis

Class 5	CN: Ch 3: Macroanatomy and the Dynamic Brain
Class 6	CN: Ch 4: Microanatomy and Neurotransmission
Class 7	CN: Ch 5: Neurochemistry & Psychopharmacology Reading: Chapter 1 (Introduction) to Valenstein's *Blaming the Brain;* Movie Review: *Awakenings*
Class 8	Exam I
Class 9	CN: Chp 6: Neurodevelopment over the Lifespan; Video cases of hemispherectomy, brain plasticity; Movie Review *At First Sight*

Disruptions of Homeostasis: Representative Clinical Disorders

Class 10	CN: Ch 7: Disorders of Anxiety: Obsessive-Compulsive Disorder and Tourette's Syndrome; Video cases: *Dr. Mort Doran* (BBC Documentary) and *Arachnaphobia* (Scientific American Frontiers video series); Movie Review: *The Aviator*
Class 11,12	CN: Ch 8: Mood Disorders: Major Depression and Bipolar Disorder
Class 13	Roundtable Discussion of *An Unquiet Mind*
Class 14	CN: Chapter 9: Schizophrenia; Movie Review: *A Beautiful Mind*

Class 15 Schizophrenia, Cont; CN: Chp 10: Drug Addiction
Class 16 Continue Addiction; Video: *The Hijacked Brain* (PBS Series: Moyers on Addiction)
Class 17 Exam II

Maintaining Homeostasis
Class 18 CN: Ch 11: Coping with Stress; Movie Review: *Life is Beautiful*; Discussion of "Spit Happens" Cortisol/Coping Activity
Class 19,20 CN: Ch 12: Psychoneuroimmunology;
Class 21 Movie Review: *Osmosis Jones;* Stressography Assignment Due
Class 22 CN: Ch 13: Eating Regulation and Associated Disorders; Movie Review: *Supersize Me*

Ethical and Professional Issues
Class 23 CN: Epilogue: Ethical Issues and the Future of Clinical Neuroscience
Class 24 Discussion/Presentation of *Mad in America* (Each student/s will be assigned a chapter to present to the class); Movie Review: *Gattaca*
Class 25 Exam III
Class 26,27 Individual Presentations; Distribution of Take-home final exam
*CN=*Clinical Neuroscience* (Lambert & Kinsley)

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