

Beyond Broca's area: why undergraduate neuroscience education matters

Andrew M. Novick¹, David A. Ross²

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ABSTRACT: Patients with psychiatric illness often present a unique challenge to medical students: in contrast to some medical conditions, in which patients may seem to be *stricken by* a disease, patients with certain psychiatric illnesses may seem *complicit with* the illness. Questions of free will, choice, and the role of the physician can quickly become overwhelming. This may result in students feeling helpless, disinterested, or even resentful. Here we argue that integrating a modern neuroscience perspective into medical education allows students to conceptualize psychiatric

patients in a way that promotes empathy and enhances patient care. Specifically, a strong grasp of neuroscience prevents the future physician from falling into dualistic thinking in which the psychosocial aspects of a patient's presentation are considered beyond the realm of medicine. The value of incorporating neuroscience into a full, biopsychosocial formulation is demonstrated with the case example of a "difficult patient."

Keywords: Broca area; Students, medical; Education, medical, undergraduate; Neurosciences.

The Dilemma of the "Difficult Patient"

As medical students make the transition from their pre-clinical to clinical years, they are often eager and excited to apply knowledge gained in the classroom to patient care. Thus, it is a particularly disturbing phenomenon that young, idealistic physicians often experience a decrease in empathy throughout medical training¹. While the reasons for this are likely multifactorial, one mechanism might be through interactions with particularly challenging and complex patients and observing the ways their superiors handle the negative emotions such patients can engender.

Take for instance, Mr. A, a 39-year-old gentleman with a history of intravenous heroin use, admitted to the internal medicine service for the treatment of infective endocarditis. Mr. A is well known to the residents and attendings on the service due to his frequent admissions, demands for pain medication, verbal outbursts, and tendency to leave against medical advice prior to completing his course of intravenous antibiotics. Physicians describe Mr. A's complaints of radiating neck pain,

attributed an old motor vehicle accident, as "lacking identifiable organic source. His uncooperative attitude is frequently documented as "manipulative" or "indicative of a pathological temperament". Not surprisingly, the medical staff feels frustrated and helpless with their inability to help Mr. A, to the point where they often question the amount of resources that have been dedicated to someone who continues to make such self-destructive choices.

The third-year medical student will have prepared a mini-presentation about the pathology and immunology of Mr. A's infective endocarditis. Previous pharmacology coursework will allow the student to participate in the selection of appropriate antibiotic treatment. Yet despite classes in interview skills and bedside manner, Mr. A's uncooperative attitude combined with problems that seem to lack "identifiable organic source" will likely become daunting obstacles to the student if they cannot relate it to their training.

Haunted by Descartes' Ghost

Comorbid substance use disorders are not easily treatable, a fact that surely contributes to the frustration

1. Department of Psychiatry and Human Behavior, Alpert Medical School of Brown University, Providence, RI, USA. ORCID: <https://orcid.org/0000-0002-0995-5060>. Email: andrew.m.novik@ucdenver.edu.

2. Department of Psychiatry, Yale School of Medicine, New Haven, CT, USA. ORCID: <https://orcid.org/0000-0001-7426-9561>. Email: david.ross@yale.edu.

Correspondence: Andrew M Novick, MD PhD. University of Colorado Anschutz Medical Campus. Department of Psychiatry, Fitzsimmons Building 13001 E 17th Place, Aurora, CO 80045. USA. Email: andrew.m.novik@ucdenver.edu.

that patients like Mr. A elicit in their providers. But they are hardly the only challenging cases. Physicians frequently encounter patients with chronic, treatment-refractory illnesses and may even find great satisfaction in working with such patients. Perhaps one difference between Mr. A and someone with congestive heart failure or a chronic autoimmune illness is the tendency to see Mr. A's symptoms as beyond the realm of conventional medicine – this type of case may feel different from what the student learned as part of the core curriculum in medical school.

In order to answer why something like a substance use disorder and its associated symptoms are so easily relegated to “lacking identifiable organic source”, it is helpful to look back to 17th century philosophy and, specifically, to the work of Rene Descartes. Descartes promoted the idea that mind and body were separate entities and that mental activity arose from a substance distinct from the substance of the body². This idea is now referred to as “Cartesian Dualism”. While Descartes had his contemporary detractors, his broad influence as it applied to medicine would go largely unchallenged for the next 250 years.

In the 19th century, new ideas about natural selection and conservation of energy often seemed incompatible with Cartesian Dualism. This inspired a new generation of researchers to try to bridge the mind-body divide³. One such individual was the young neurologist, Sigmund Freud. With training in both neuroanatomy and neurophysiology, Freud seemed to be in a perfect position to integrate the biological with the psychological⁴. But when the scientific tools of his day proved inadequate for such an undertaking, Freud's work shifted to exploring psychological models in greater depth⁵. Ironically, for someone who set out to integrate the field, he may inadvertently exacerbated the severe dualism that became cemented in psychiatry for another hundred years. Elements of dualism continue to exist even within well respected departments of psychiatry in the United States. For example, at the first author's institution, trainees and faculty from the fields of psychology, psychiatry, neurology, and neuroscience come together on an annual basis to present their research in an event called “Mind Brain Research Day”. The inherent dualism in this name did not go unnoticed by the director of the National Institute of Mental Health, who in his recent keynote address, suggested that it be changed to “Brain Research Day”.

In medicine as a whole, Cartesian dualism has continued to survive despite our attempts to embrace and teach ideas that refute it. One of the most influential contrasting approaches is Engel's biopsychosocial model⁶ that emphasized “psychobiological unity” and the physician's role in integrating biological, psychological, and social elements of a patient. The biopsychosocial model is taught to most medical students even if it is not named as such. Most medical school curricula emphasize the importance of viewing the patient holistically, and

appreciating reciprocal relationships between a patient's illness, their social situation, and their behavior. Yet the mechanisms by which these elements interact can rarely be seen with common diagnostic techniques. So even if there's face value to the idea that Mr. A's infection would affect his emotions, or that his social isolation might make him more vulnerable to infection, these concepts are likely to remain abstract, distant, and “soft”. Without understanding the mechanistic details, the illusion of separateness may persist.

Modern neuroscience is increasingly providing the crucial data to bridge this divide and to demonstrate the nuanced ways in which bio-, psycho-, and social processes are all mediated through the brain. For example, a large body of literature has demonstrated the ability of psychotherapy to alter brain activity in a way that promotes improved emotional regulation⁷. Early social experiences, such as a history of abuse and/or neglect, can blunt the brain's response to rewards in the environment (such as money or social praise), while increasing sensitivity to drugs of abuse^{8,9}. A burgeoning literature is illustrating that one key mechanism through which experiences influence brain function is through alterations in gene expression, otherwise known as epigenetics. This was elegantly demonstrated by Michael Meaney's research group, who showed that variations in maternal care in rodents altered methylation of key genes related to the stress response and anxiety-like behavior¹⁰. As concluded by Eric Kandel, winner of the 2000 Nobel Prize in Medicine and Physiology for describing how learning is dependent on changes in gene expression in neurons, “all of ‘nurture’ is ultimately expressed as ‘nature’”¹¹.

The Modern Enlightenment

The Age of Enlightenment was thought to begin with Descartes. It is ironic, then, that one of his most influential ideas has pervaded medicine in a way that prevents us from understanding patients in a scientific manner. The true challenge for clinicians today is to be able to thoughtfully integrate a patient's experience beyond vital signs and crude diagnostic tests. For example, coming back to the case of Mr. A it would be interesting to learn more about his family and early life experiences. Heritability of substance use disorders can be as high as 70%¹². As described above, a history of childhood adversity is associated with brain changes that can increase vulnerability to addiction. These findings challenge our instinctive tendency to view addiction as a choice. Careful investigation into his pain might reveal that Mr. A's previous injury led to long-term plasticity in his nervous system that has resulted in chronic pain¹³. Mr. A's use of exogenous opioids may have also created a state of opioid-induced hyperalgesia via increased release of excitatory neurotransmitters. The ability of opioids to directly suppress the immune system may also contribute to his current infection¹⁴. By utilizing principles and research in neuroscience, we are better able

to view Mr. A through a biopsychosocial lens. Increased understanding has the tendency to invite empathy, to promote continued inquiry and discourse, and to leave less room for helplessness and resentment.

Traditional medical school curricula have emphasized the importance of neuroscience education in localizing brain lesions and in diagnosing and treating neurological conditions such as Parkinson's and Multiple Sclerosis. A modern neuroscience curriculum needs to take things a step further: it is time to stop pretending that that our emotions, behaviors, and thoughts are somehow

distinct from the rest of our biology. It is time to embrace a fully integrated biopsychosocial model.

Approaching Mr. A's case from this perspective will not necessarily cure his addiction or prevent him from leaving the hospital against medical advice. However, it will allow students to: 1) appreciate that his illness is a medical condition that is within their scope of practice; 2) appreciate how the psychosocial interventions they provide such as empathic listening and supportive engagement can have biological consequences; and 3) reassure patients like Mr. A that while their symptoms may be "in their head", it is a head that houses the body's most complex organ.

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REFERENCES

- Hojat M, Vergare MJ, Maxwell K, Brainard G, Herrine SK, Isenberg GA, Gonnella JS. The devil is in the third year: a longitudinal study of erosion of empathy in medical school. *Acad Med.* 2009;84(9):1182-191. <https://doi.org/10.1097/ACM.0b013e3181b17e55>.
- Descartes R (1641). *Meditations on first philosophy*. Available from: <http://selfpace.uconn.edu/class/percep/DescartesMeditations.pdf>.
- Smith DL. From philosophy to psychoanalysis: a classic Freudian move. In: *Aeon Essays*. Retrieved May 2, 2019. Available from: <https://aeon.co/essays/from-philosophy-to-psychoanalysis-a-classic-freudian-move>.
- Freud S. Project for a scientific psychology. In: Bonaparte M, Freud A, Kris E, editors; Mosbacher E, Strachey J, Mosbacher E, Strachey J, trans. *The origins of psycho-analysis: letters to Wilhelm Fliess, drafts and notes: 1887-1902*. New York: Basic Books; 1954. p.347-445. <https://doi.org/10.1037/11538-013>.
- Northoff G. Psychoanalysis and the brain – Why did Freud abandon neuroscience? *Front Psychol.* 2012;3:71. <https://doi.org/10.3389/fpsyg.2012.00071>.
- Engel GL. The need for a new medical model: a challenge for biomedicine. *Science.* 1977;196(4286):129-36. doi: 10.1126/science.847460.
- Sankar A, Melin A, Lorenzetti V, Horton P, Costafreda SG, Fu CHY. A systematic review and meta-analysis of the neural correlates of psychological therapies in major depression. *Psychiatry Res Neuroimaging.* 2018;279:31-9. doi: 10.1016/j.psychresns.2018.07.002.
- Novick AM, Levandowski ML, Laumann LE, Philip NS, Price LH, Tyrka AR. The effects of early life stress on reward processing. *J Psychiatr Res.* 2018;101:80-103. <https://doi.org/10.1016/j.jpsychires.2018.02.002>.
- Oswald LM, Wand GS, Kuwabara H, Wong DF, Zhu S, Brasic JR. History of childhood adversity is positively associated with ventral striatal dopamine responses to amphetamine. *Psychopharmacology.* 2014;231(12):2417-33. <https://doi.org/10.1007/s00213-013-3407-z>.
- Weaver ICG, Cervoni N, Champagne FA, D'Alessio AC, Sharma S, Seckl JR, Meaney MJ. Epigenetic programming by maternal behavior. *Nat Neurosci.* 2004;7(8):847-54. <https://doi.org/10.1038/nn1276>.
- Kandel ER. A new intellectual framework for psychiatry. *Am J Psychiatry.* 1998;155(4):457-69. <https://doi.org/10.1176/ajp.155.4.457>.
- Bevilacqua L, Goldman D. Genes and addictions. *Clin Pharmacol Ther.* 2009;85(4):359-61. <https://doi.org/10.1038/clpt.2009.6>
- Baller EB, Ross DA. Your system has been hijacked. The neurobiology of chronic pain. *Biol Psychiatry.* 2017;82(8):e61-e63. <https://doi.org/10.1016/j.biopsych.2017.08.009>.
- Plein LM, Rittner HL. Opioids and the immune system – friend or foe. *Br J Pharmacol.* 2018;175(14):2717-25. <https://doi.org/10.1111/bph.13750>.

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