Is addiction a brain disease?

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> *If we take in our hand any volume; of divinity or school metaphysics, for instance; let us ask, Does it contain any abstract reasoning concerning quantity or number? "No. Does it contain any experimental reasoning concerning matter of fact and existence?" No. Commit it then to the flames: for it can contain nothing but sophistry and illusion (Hume, 1748, p. 165) [1].*

After reading a draft of a paper, physicist Wolfgang Pauli purportedly exclaimed, "Es ist nicht einmal falsch!" ("It is not even wrong!") [2]. Pauli's quip reminds us that some scientific assertions are so nebulous that they do not have the virtue of being refutable, even in principle. Following the lead of Sir Karl Popper [3], many philosophers of science would concur that claims that could never be falsified given any conceivable set of data are unscientific. Philosopher David Hume made a similar point in our opening quotation: A proposition that does not generate measurable predictions is scientifically meaningless: It should be committed to the flames.

In this commentary, we advance a heretical position: The proposition that addictions are brain diseases is fundamentally unscientific. In the words of Pauli, it is not even wrong. To be more precise, some aspects of the brain disease claim are unfalsifiable whereas others are falsifiable; and those aspects that are falsifiable have now been falsified.

The familiar meme that addictions are brain diseases took hold in the mid-1990s, coinciding with the advent of modern brain imaging techniques, especially positron emission tomography (PET) and functional magnetic resonance imaging (fMRI). In 1997 Alan Leshner, then head of the National Institute on Drug Abuse (NIDA), authored an influential article in the prestigious journal *Science* entitled "Addiction is a Brain Disease, and It Matters" [4]. Leshner staked out a bold position on addiction, describing it as "a chronic, relapsing brain disorder characterized by compulsive drug seeking" (p. 45). He argued that chronic use of psychoactive substances often damages brain circuitry to the extent that the capacity to resist drug use is severely impaired. Likening addiction to Alzheimer's disease, Leshner contended that the addicted require medical treatment. Many prominent figures and public officials, including Nora Volkow, current head of NIDA, and former

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Surgeon General Vivek Murthy, have since embraced and promoted the brain disease framework of addiction [5−7] as have scores of addiction treatment centers. Many brain imaging investigators now unabashedly invoke this model as a justification for their research.

Several key tenets of the brain disease model of addiction are vague, rendering them challenging, if not impossible, to test. Nevertheless, this model appears to comprise three key assertions: (1) addictions are traceable to dysfunctions in brain circuitry; (2) addictions are chronic and relapsing conditions; and (3) addicts' brains are sufficiently compromised that they have largely lost the capacity to refrain from pathological use. Let's examine each of these propositions in turn.

The NIDA website asserts that addiction is "a brain disease because drugs change the brain; they change its structure and how it works" [8]. The finding that chronic substance use changes the brain has been supported by brain imaging studies. Data show that the brains of addicted individuals tend to display diminished activity in regions linked to inhibitory control, such as the orbitofrontal cortex and cingulate gyrus [9]. Nevertheless, such findings are in no way specific to addiction. For example, brain imaging studies demonstrate that reading alters brain activity, and that extended juggling alters brain structure [10,11]. In fact, the finding that prolonged substance use alters brain activity as revealed by PET and fMRI scanning is entirely unsurprising, even trivial, from a neuroscientific standpoint. Given that all behaviors are mediated by brain functioning, the finding that chronic substance use affects the brain is barely more than a self-evident scientific truism [12].

Indeed, it is hard to envision precisely what kind of neuroscientific findings could even be invoked to falsify the assertion that addictions are rooted in brain functioning. For example, plentiful data demonstrate that psychosocial variables, such as life stressors, peer influences, neighborhood factors, and availability of substances, play key roles in addiction risk, suggesting that a primary or even exclusive focus on a disordered brain as the principal culprit in addiction is misplaced [13]. In response, some brain disease enthusiasts have argued that the roles of social and psychological factors are actually consistent with the brain disease model, because these variables ultimately exert their influence via the brain.

This rhetorical ploy essentially renders the brain disease model unfalsifiable, because all psychological factors, including basic learning processes, necessarily affect the brain at some level [14]. Moreover, this tactic sidesteps the point that the brain is merely one lens of analysis among many for explaining addiction, and not necessarily the most important for intervention or prevention. Finally, extending this analysis to its (il)logical conclusion, one could just as legitimately contend that these findings are consistent with an "atomic model" of addiction given that all psychosocial variables influence the brain's atoms. (But why stop there? We could also entertain a quark model of addiction, for instance).

Seeking to account for complex phenomena in terms of their lower-order constituents—an approach that philosophers term *explanatory reductionism* (see Chapter 14)—is not always a helpful scientific strategy [15]. Imagine that jumbo jets kept blowing up in midair during the summer because the airlines routinely left them sitting on tarmacs in scorching heat for hours prior to take-off. An analysis of each

plane's 3 million-plus parts in an effort to detect the cause of the explosions would be fruitless, because the plane's design and construction are not at fault. It would be equally misleading to conceptualize the cause of the explosions as "an airplane parts problem" on the grounds that the excessive heat interacts with the plane's subcomponents.

Unquestionably, addictions are brain diseases from the perspective of *one* lens of analysis, namely, neuroimaging and neuroscience more generally. But addictions are every bit as much motivational diseases, personality diseases, social diseases, cultural diseases, and so on. There is, thus, scant scientific or logical justification for privileging one lens of analysis, such as the lens of neuroimaging, above all others [16]. A full understanding of the causes, treatment, and prevention of addiction will require improved knowledge of its brain-based causes, and neuroimaging will almost surely assist us in this endeavor. But it will also require better knowledge of other contributors, including learning history, motivation, personality traits, and the social and cultural setting of addiction. Notably, in his 1997 article, Leshner acknowledged that "Addiction is not just a brain disease... It is a brain disease for which the social contexts in which it has both developed and is expressed are critically important" (p. 46). Regrettably, this caveat appears to have been largely ignored by scholars.

What, now, about the assertion that addictions are chronic, relapsing conditions? Here, the data are unequivocal. In controlled studies, many or most addicts manage to quit on their own, without formal treatment [17,18]. In our experience, many addiction practitioners and researchers are skeptical of these data. We suspect they have fallen prey to the *clinician's illusion*, the tendency to overestimate the persistence of psychological conditions over time. After all, practitioners routinely encounter patients who fail to improve and rarely encounter patients who improve on their own. This is no surprise, as people who recover rarely need treatment or volunteer as addiction research participants [19].

A final cornerstone of the brain disease model is that addicts' brains are so badly damaged that their owners have lost the capacity to refrain from use. Here the model possesses a kernel of truth insofar as brain imaging studies indicate that prolonged substance use sometimes damages brain regions mediating impulse control. As a consequence, addicts often find it difficult to refrain from use. Still, there is clear evidence that most or all people with long-standing substance addictions retain the capacity to curtail use in the presence of external incentives.

For example, during the Vietnam War, between 10% and 25% of American GI's were addicted to high-grade heroin. Yet, once they returned home, heroin apparently lost its appeal, and most recovered. Heroin helped soldiers endure war-time's alternating bouts of boredom and terror, but stateside, where use was a crime and civilian life took precedence, its allure faded [20].

Let's further consider the commonly invoked comparison of addictions with neurological diseases, such as Alzheimer's disease. If one held a gun to the head of a person addicted to alcohol and threatened to shoot her if she consumed another drink, she could comply with this demand—and the odds are high that she would. In contrast, pointing a gun to the head of a patient with Alzheimer's disease and

threatening to shoot her unless her memory improved would be futile. The analogy between addictions and classic neurological illnesses fails [12].

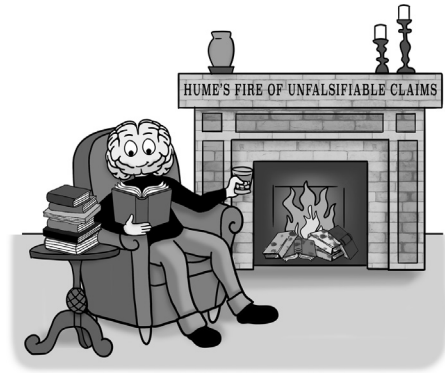
Further undercutting the notion that brain changes invariably lead to drug consumption is the extent to which users' expectation of the drug's pending effect influence their behavior. Research using *balanced placebo designs* suggests that among individuals with alcohol use disorder (formerly called alcoholism), the decision to drink is driven largely by beliefs about what they are consuming. In these designs, participants are randomly assigned to one of four conditions, in which they ingest (1) an alcoholic drink and are informed correctly that it contains alcohol, (2) a placebo drink (one that does not contain alcohol but is mixed to taste like alcohol) and are informed correctly that it does not contain alcohol, (3) an alcoholic drink but are informed incorrectly that it does not contain alcohol, or (4) a placebo drink but are informed incorrectly that it contains alcohol.

Data reveal that alcoholics assigned to condition (3) often refrain from drinking, but that those assigned to condition (4) frequently fail to do so [21]. At least with respect to alcohol, these results raise serious questions concerning the assumption that addicts' altered brain physiology renders them incapable of stopping use. The results also underscore the importance of examining lenses of analyses in addition to the brain, in this case a psychological perspective that incorporates addicts' expectations [22].

Lastly, people consume drugs and alcohol for psychological reasons. Addicted individuals variously describe the value of substances in quelling anxiety, feelings of emptiness, self-loathing, and boredom. They can give meaningful responses to the question: Why do you use drugs? An Alzheimer's patient, in contrast, would find the questions (assuming that she could understand them)—Why is your cognition failing? Why do you allow it to fail?—to be incoherent. To be sure, a neurobiologist could explain the processes associated with her brain degeneration, but she would never think to explain her condition in psychological terms.

So, even if the brain disease model is logically and scientifically indefensible, is it useful? In at least three ways, the answer appears to be no. First, this model has not pointed scientists toward beneficial interventions. The few modestly effective treatments for addiction, such as naloxone (which blocks the action of the brain's endogenous opioids), were developed long before the full-scale advent of modern brain imaging methods and the conceptualization of addiction as a brain affliction [23]. In addition, the brain disease model prioritizes medication over psychosocial interventions, which are essential to recovery. *Contingency management*, in which addicts receive tangible rewards for staying off drugs, has been found to be effective in many controlled studies [24,25]. Second, although advocates of the brain disease model often maintain that it reduces stigma, the evidence is mixed. Studies suggest that although informing alcoholics that their substance use is attributable to a brain disease may alleviate self-blame, it diminishes their belief that they can control their drinking [26]. Third the brain disease model does little to explain dramatic shifts in the societal prevalence of addictions. As we write this essay, the United States is in the midst of the most lethal opioid epidemic in its history. Yet, Americans' brains have not changed. Instead, what has changed is an increased

availability of diverted pain medications, combined with the despair and economic dislocation created by deindustrialization and a growing sense among many that the American Dream is no longer attainable [27,28].



In sum, the brain disease model of addiction is little more than a vague metaphor, despite concerted efforts to confirm it with neuroimaging. It is unhelpful at best and misleading at worst. The model hinges on a presupposition—that addictions are diseases of the brain—that is unfalsifiable and essentially devoid of scientific content. In this regard, it is not even wrong. Further, addicts' capacity for choice-making, albeit at times compromised, is by no means obliterated in the face of demonstrable brain changes. It is high time that we commit this model to the flames.

Additional readings

A brief and accessible review of the brain disease model of addiction, with a particular focus on the data on the effects of methamphetamine on the brain: Grifell M, Hart CL. Is drug addiction a brain disease? This popular claim lacks evidence and leads to poor policy. Am Sci 2018;106:160–7.

Good survey of the evidence for brain disease model, including its questionable track record for generating novel and effective interventions: Hall W, Carter A, Forlini C. The brain disease model of addiction: is it supported by the evidence and has it delivered on its promises? Lancet Psychiatr 2015;2:105–10.