The Brain in Your Hands

by Luiza Ghazaryan

In mid-November of 2022, I attended an NYU event where I was given a palm-sized, brain-shaped stress ball. This was around the time when I decided to change my major from chemistry to neuroscience. I had always loved chemistry, and refused to give up on it, but my attraction to neuroscience was growing. So for my future research plans, I decided to integrate these two disciplines by studying the chemistry of the brain. My question was how.

When people think of the tools in a neuroscience laboratory, they might envision brain scans, colorful chemicals in Erlenmeyer flasks, petri dish cell cultures, or in more advanced laboratories, tiny animal brains. These are all fascinating experimental tools, but they didn't satisfy me: how could I see the effect of chemicals on the brain without one in front of me? As I understood it, scans only show brain activity, and in animals you can only observe behavioral responses. Holding the brain-shaped stress ball made me see I needed something more, something that could provide me with more information about the intricacies of the brain's functions and responses. "Lab-grown mini-brains!" I fantasized. Imagine having a real brain to work with, and not needing to hurt any animals. Now imagine the satisfaction of finding out such a fantastic thing exists.

Lab-grown mini-brains—properly referred to as cerebral organoids—exist. But they are not what we may imagine. An organoid is a tissue "with a collection of stem and organ-specific cell types derived from stem cells or organ progenitors to simulate the architecture and functionality of the native organ to some extent" (Sun et al.). Such tissue may sound terrifying, if we rely on the image we've inherited from science fiction: a golf-ball-sized brain in a jar, ready to be put in a body and work as normal. Media coverage of cerebral organoids is often negative, scaring the public into believing that scientists are trying to create fully functioning human brains. But, scientists say, "We have no evidence that human brain organoids are conscious—we have no evidence of markers of sentience or evidence of conscious awareness" (Goddard et al.). Organoids function similarly to human tissue, but cannot feel, think or accomplish vital human tasks on their own. Talking about cerebral organoids as if they were miniature brains may have significant effects both within and outside the scientific community.

In their article "The Importance of Accurate Representation of Human Brain Organoid Research," Masanori Kataoka et al. point out that "media discussions of human brain organoids tend to drift away from the research itself." The authors argue that scientists

themselves exaggerate the reality of cerebral organoids, pointing to miscommunicating headlines like this one in the peer-reviewed scientific journal *Nature*: "Neanderthal-like 'mini-brains' created in lab with CRISPR." This title may make one think that the scientists were able to recreate the brains of a Neanderthal, but these were hardly organs and only contained a gene variant from Neanderthals. Moreover, the diction of 'mini-brains' is dangerous and confusing because it implies that scientists have created miniatures of full human brains (Kataoka et al.). Another study was published in *New Scientist* under the headline "Tiny human brain grown in lab has eye-like structures that 'see' light." Kataoka et al. observe that the word 'tiny' again implies a real brain at a smaller scale. More importantly, the word 'see' gives the impression that the organoids have developed sight and consciousness to perceive the world around them, even though responding to light does not mean that these cells have sight (Kataoka et al.). For example, many silver salts are sensitive to light and can undergo a reaction when it is present, but that does not necessarily indicate that silver salts have consciousness or can see. Kataoka et al. argue that such misleading portrayals of cerebral organoids amount to miscommunication that could result in public distrust in the research, detracting from its beneficial applications, generating antipathy and even resulting in strict regulation.

As distinct from these misconceptions, the applications of cerebral organoids in neuroscience and medicine are quite exciting. A cerebral organoid can model neurological or mental disorders, and this can help a scientist design a medication with regard for the chemical composition specific to that brain (i.e. lack of neurotransmitters). One could argue that animal brains can be used to explore psychiatric disorders, but if a less cruel method exists, one that doesn't require harming a living organism, why shouldn't scientists advance it? In addition, brain organoids can be more effective in studying human mental disorders than rodent brains, as Thomas Anthony Dixon and Alysson R. Muotri write in their article "Advancing preclinical models of psychiatric disorders with human brain organoid cultures." Studying the foundational neurotransmitter dopamine in humans and mice, the authors found that "Dopaminergic neurons contain substantially higher levels of dopamine in human neurons compared to murine neurons" (Dixon and Muotri). This is a crucial observation: dopamine levels are interconnected with mood and brain activity, so if dopamine levels are low, a human is more likely to feel depressed. As rodent brains contain significantly lower levels of dopamine at baseline, they are less effective than organoids at modeling this aspect of the human brain. Even apart from the ethical advantages of avoiding testing on living animals, cerebral organoids can reflect the particular shapes and needs of human neurochemistry—or, put more accurately, neurochemistries.

Cerebral organoids can be a crucial tool for studying mental disorders and neuroplasticity, as well as their impact on human behavior. Neuroscience provides the basic research needed for the medical community to design more efficient and accurate

treatments for patients with neurological or mental disorders. However, as Dixon and Muorti argue, researchers' current understanding of the mechanisms underlying mental disorders such as schizophrenia, OCD, and depression are limited, given the current limitations of imaging and rodent models. The authors write that by developing cerebral organoids from models of patients who suffer from these disorders, researchers could more closely and accurately study these brain abnormalities. This approach offers the prospect of developing and testing better diagnostic tools and treatments, and better overall support for individuals with mental health issues.

Rather than frightening us with the specter of 'mini-brains,' cerebral organoids could actually help destigmatize mental illness, if they are talked about in the right way. Some people still believe that mental health-related conditions are less 'real' because they are less visible than physical ailments. Cerebral organoids are still early in their development, but they could go on to demonstrate the physiological reality of mental disorders by presenting a more precise illustration of their biological foundations, helping to disprove the stigma and stereotypes surrounding people with these conditions. But if misinformation about organoid functions continues, we will miss out on this opportunity and perhaps lose precious time to create effective treatments for people with neurological and psychiatric disorders. On the other hand, if the public understands the actual nature and function of cerebral organoids, we will see their greater impact outside the scientific community, potentially leading to increases in mental health awareness, as well as treatment.

Works Cited

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