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Ethics in Bioinformatics

13 November 2025

# Ethics of Organoid Intelligence

## Ethical Dilemma

Organoid intelligence is the emerging field of research that uses human brain organoids for computation. Research on these human brain organoids has been ongoing since the first ones were created in 2013 (Lancaster et al., 2013). This research has the potential to model diseases or toxins within human neurons, derive individualized patient treatments, and allow lab grown neurons to be used in the treatment of traumatic brain injuries or other neurological conditions. More recently, researchers have started using these organoids for computational tasks, opening up a whole new world of possibilities in biocomputing, brain-computer interfaces, and robotics (Hartung et al., 2024). This opens a can of ethical questions that are still unanswered. The ethical dilemmas span the topics of consciousness, human-animal chimaeras, human-robot integration, research oversight, informed consent standards for cell donors, cell donor data privacy, and commercialization with equitable access.

## Background

Research on brain-machine interfaces started about 50 years ago (Smirnova et al., 2023), but the first human brain organoid was developed in 2013 by Madeline Lancaster and Juergen Knoblich (Lancaster et al., 2013). This was made possible by the development of human induced pluripotent stem cells in 2007 (Takahashi et al., 2007) and further work by Lancaster and Knoblich. Since then these brain organoids have grown from monolayers into organized clumps of cells with differential brain regions and various cell types. With these advances, researchers have been able to incorporate these organoids into computational interfaces, animals, and robots (Smirnova et al., 2023).

The tools, materials, and techniques developed over the last decade have provided a growth in the size and complexity of these human brain organoids. Multiple brain regions, glial cells, myelination, and the inclusion of biosensors (primitive eyes) have made these organoids useful in a computational role. Microelectrode arrays embedded in these organoids allow us to control and monitor the neuronal activity (Smirnova et al., 2023). A Swiss startup founded in 2023, called FinalSpark, utilizes these methods and offers cloud compute resources that run on human brain organoids. They have thousands of them at their disposal and you can watch some of them live at finalspark.com/live/ (FinalSpark, 2023).

One of the major issues facing brain organoids is feeding them. As of 2023, they are fed through a substrate bath that only permeates 300μm, limiting the size of these organoids to a that radius. To fix this, researchers have been working on microfluidic perfusion systems (Smirnova et al., 2023), although a vascular system would be better. Currently, the easiest way to provide a vascular system to these organoids is to implant them into a living creature with a working vascular system (rats). It has been shown that these human organoids integrate with the rats' brains, repairing partial sight in one study (Jgamadze et al., 2023). Robots have also had the chance to try out some new human brain matter. "Muotri's team connected a brain organoid to a spider-shaped robot, allowing the organoid's electrical activity to control the robot's movements" (Hartung et al., 2024). These types of integrations start to get ethically complicated as the organoids grow in size and complexity and once they're included in non-human primates.

**Current Policies and Proposed Changes**

There are many nuances to the ethical concerns surrounding these human brain organoids. What is their moral status? At what point do they become conscious or sentient? How can a cell donor consent to future research they are unaware of? How is a cell donors' biological data being protected? How do we define these human-robot / human-animal hybrids

and what are their moral statuses? Some researchers propose taking an embedded ethics approach while others dismiss these concerns entirely (specifically consciousness) (Hartung et al., 2024). Though some laws exist, there are currently no overarching standards or guidelines regarding these questions.

Governance around these brain organoids varies by country, but overall it is very sparse. “In the United States, NIH guidelines restrict federal funding of human-animal chimeric research, but few formal policies otherwise exist. The UK similarly lacks specific regulation, instead relying on general governance frameworks for medical research and human tissues” (Hartung et al., 2023). Germany has a much stricter history of ethics, putting “constraints on research deemed contrary to human dignity”, but it is still unclear how it relates to these organoids (Hartung et al., 2023). There is an immediate need for international consensus and guidelines regarding these organoids, ideally coming from the World Health Organization’s Ethics Review Committee and the United Nations Intergovernmental Bioethics Committee.

The Baltimore declaration was the outcome of the First Organoid Intelligence Workshop in February 2022. This workshop was a gathering of researchers across many fields including neuroscience, AI, engineering, and ethics. They coined the term “organoid intelligence”, promoted further research in the field, and proposed taking an embedded ethics approach (Hartung et al., 2023). Embedded ethics is the idea of incorporating an ethics team with the research team to analyze ethical issues as they arise. The downside to an embedded ethics approach is that it lacks public input. Overall, I believe this is a safe approach, but I don’t think it goes far enough.

Instead of an embedded ethics approach, I propose the world takes a proactive ethics approach using fictional literature as a basis for what’s to come. Books, movies, television, and video games like Black Mirror, Planet of the Apes, Halo, or The Matrix already portray the future possibilities of this research. Using these stories as potential outcomes of our future will steer

the conversation towards what kind of future we want and what problems we should anticipate. Putting this into the ethical framework, continuing this research would benefit the **common good**, but we need to make sure it is done in a **utilitarian** way. Personalized medicine will initially be subject to high prices, leaving out lower income individuals, but as long as the research continues and doesn't go behind closed doors, it will eventually benefit everyone. Laws may need to be enacted to guide this toward a **just** utilitarian outcome. Laws will definitely need to be enacted to protect the **rights** and privacy of cell donors. How someone can consent to future research they can't even imagine yet is still an open question, but one that needs to be answered. The question of consciousness is the elephant in the room for this field, but with more research, I believe we can proceed in a **virtuous** way. Taking this approach would not currently affect stakeholders as this proposal leaves the current system in place but anticipates ethical concerns ten years down the road. This would motivate stakeholders by providing more guidance than what is currently given.

In addition to using a proactive ethics approach through fictional literature, I would also propose the NIH ends its ban on funding human-animal chimeras. That reality is already here and shows promise in helping cure neurological diseases and developing personalized medicine. This ban on federal funding just puts us behind the rest of the world as we currently see with stem cell research.

## Conclusion

The field of organoid intelligence is still in its infancy, but it will change the world as we know it. Human-robots and human-animal hybrids will no longer be the stuff of science fiction; our compute power will continue to grow exponentially; and diseases thought once untreatable will find cures. An embedded ethics approach is the standard for these growing interdisciplinary fields, but with the potential impact organoid intelligence offers, I fear it's not enough. We have already seen the potential this technology possesses and there is no reason to wait until it is

here to start discussing the ethics and developing standards. I implore the World Health Organization and United Nations to take a proactive ethics approach in the next two years. Our future has many possibilities and with ethical guidance, we have the potential to create a world that is utilitarian, virtuous, and just and protects everyone's rights for the common good.

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