OPTOGENETICS: AN ETHICAL PERSPECTIVE

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INTRODUCTION: ETHICS AND US

While we, as people, pretend to make decisions without subjective interference and with strictly logic, we, as humans, act according to a sometimes-dormant code of values known as ethics. Without even realizing, our ethics drive us to do essentially everything that we do. Ethics help us to differentiate what we view as ‘wrong’ and ‘right’: distinctions entirely unique to each being. Our ethics are why we either donate our change to the homeless person on the street corner or avoid eye contact and continue on our route. Ingrained in our mainframe, ethics keep us out of, but also get us into, later regretful scenarios. At the same time, our ethics are the source of this regret. This moral code roots itself in a variety of forms. Some of us are driven by the tradition that our loved ones have distilled into us. Others develop their values over experience in the cliché journey to find their position in the often-intimidating world. Though we typically see ethics as a subject limited to our personal lives, these characteristics fluidly translate into the professional field as well.

Ethics Meets Optogenetics

In an effort to promote stability, many professions, including engineers, release guidelines known as “codes of ethics” to give their careers a moral backing when approaching important decisions. As supported by a case study of engineering students conducted by IEEE Transactions on Education, engineers face ethical dilemmas ranging from “white lie” issues to major issues that impact society in general” [1]. Biomedical engineering in particular, a field that involves the study and manipulation of medical and cellular technology, leaves obvious room for ethical ambiguity, leading the Biomedical Engineering Society (BMES) to draft a code of ethics of their own [2]. While all engineers make decisions that affect human lives in some capacity, no concentration is nearly as direct as direct as bioengineering. Biomedical engineers work to optimize current medical technologies and find new methods of treatments for various disabilities and diseases. Despite recent surges, ethical questions surrounding biomedical innovation is no new concept. According to “Case Study 5: The XYZ Controversy” discussed by the National Academy of Engineering, after the 1961 discovery of males born with two Y-chromosomes, private researchers began to perform tests on newborn XYY males [3]. This received harsh criticism from human rights organizations that saw the subjected children as forever “stigmatized,” leading to the forced stop of the research. Engineering human biology in this fashion sounds like something of science fiction and, with progress, that is indeed a point we could reach. In a more modern example, a budding technology known as optogenetics allows researchers to study the activation of the brain’s neurons through the application of light. While results have been promising in cases of mental illness, many argue that the unrestrained growth of the field could be dangerous. If a major advancement were to occur in the field, the research has the potential to be exploited. As described in an article by Karl Deisseroth of Scientific American, “all aspects of our personalities, priorities, capabilities, emotions and memories arise from electrical and biochemical events within...neurons,” like those involved in optogenetics [4]. The brain is a powerful organ that controls our nearly every aspect, so its manipulation understandably causes much worry. Thus, bioengineers may face a decision on whether or not to release their results based on what they feel is best for society. Combining my own personal code of ethics and formal codes of ethics already in practice, I will arrive at a decision upon how to handle a groundbreaking, yet potentially threatening discovery in optogenetics.

EVALUATING OPTOGENETICS

While still a developing field in neuroscience, optogenetics has begun to revolutionize medical research with its precise and quick results inside the brain. As described by an article in the journal Nature Neuroscience, optogenetic research begins by probing an organism’s brain with a protein typically contained in algae known as an opsin [5]. Opsins are distinct in their ability to release charged ions under the presence of light, explaining how algae nourishes itself in water. In an article posted on the website Wiring of the Brain, Kevin Mitchell explains how researchers then insert the genome of the species into that species’ neurons [6]. By doing so, the opsin is “linked” to the subject, allowing the protein to open its ion channel once projected with the appropriate frequency of light. These released ions create a current within the synapses, or ‘wires,’ that connect the neurons. From which, the targeted areas of the brain can be activated in a matter of milliseconds, making optogenetics far more efficient when compared to traditional methods of neurological research. With this current, researchers can study the response different neurons have on the body to gain a greater understanding of interactions between synapses and the body. Although a complex process, applying the technology to live specimens unlocks reassuring results.
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Optogenetics So Far

Optogenetics has already proven itself as a valid option in plotting the brain and its functionality. As of now, researchers have yet to implement clinical practice of optogenetics. Probing the proper neurons with proteins and then activating these proteins with an acceptable frequency of light inside a live brain continues to challenge modern engineers [5]. However, developments so far show notable promise. According to a report conducted by the International Journal of Neuroscience, when injecting mice with mental ailments such as Parkinson’s Disease and epilepsy, the stimulation of certain opsins in conjunction with electrical tools can work to counteract symptoms brought on by the illnesses [7]. Additionally, as noted in a research article by Ernst Bamberg, bioengineers have begun to test optogenetic technology on viruses that are susceptible to neural signals [8]. In fact, one opsin in particular has been accepted as a regular treatment to certain cases of vision loss. Though still in its preliminary phases, optogenetics gives neurologists a more concise idea of how the brain functions. Every neuron controls a certain aspect of life, whether it is linked with the diseases mentioned or other biological operations. This shows that it is entirely plausible that the application of optogenetic research could evolve into something far more powerful.

A QUESTION OF ETHICS: EXPLOITING OPTOGENETIC RESEARCH

Although an enticing and invigorating field, due to its controversy, optogenetics presents an ethical dilemma that I, as a future biomedical engineer, may face. For this scenario, I will play the role of an executive engineer of a medical technology company that works to oversee its neurological department. After studying the effectiveness of optogenetics, our business begins to centralize its research around the field in order to experiment with how subjects respond to different opsins. Once a distinct, new species of algae is found in polar waters, my team decides to invest in the exclusive right of harvesting the algae for medicinal purpose to capitalize on its distinct biology. By studying their structure, I have my team begin to recreate the opsins of the algae, which we simply name “Opsin X.” Knowing that rodents maintain a similar transmittance of light in their brains as that of humans, I probe a sample of mice with the opsins to uncover surprising results [7]. When testing neurons particularly associated with motor skills, my team and I find that the mice are responsive with an accuracy unrivalled by any other researched opsin at the company. Since, at this point, optogenetics has helped to map most of the brain’s neurons, we are able to guide the light to known sections of the mind and essentially control the mice’s actions as we wish. With a larger sample of the algae, we conclude that these direct results could provide insight into the treatment of debilitations, as all the tested neurons respond immediately to the light stimuli as intended. Data such as this excites the team at first, yet, upon further consideration, we realize that the results are almost radical in the field of neuroscience. If the opsin is as effective in the human mind as it is in the mice, we could have discovered a powerful tool in treating patients of mental illness and other conditions. However, we must also consider how people could implement this technology for purposes that are not solely medicinal and how this could be used to manipulate human behavior. In order to determine how this data will affect society at large and what to do with the results, we decide to utilize codes of ethics in place and our own judgment before taking subsequent action.

Applying Engineering Codes of Ethics and Case Studies

Considered one of the most centralized organizations in all of engineering, the National Society of Professional Engineers (NSPE) published a code of ethics that could reveal a solution to the scenario previously posed [9]. At the top of their “Fundamental Canons,” NSPE lists that one of an engineer’s primary objectives is to “hold paramount the safety, health, and welfare of the public.” Abiding by these guidelines, we must decide whether the release of this data will endanger these three pillars. While some may argue that the public revelation could lead to mass innovations in healthcare, the research is undeniably still young. Without any indication on how humans react to the opsin, there is no telling what Opsin X could be used for in criminal hands. This viewpoint that appears to argue against the reveal is later contradicted when document encourages engineers to “extend public knowledge of engineering and its achievements.” No known material has caused the level of direct response in rodent subjects as Opsin X has had so far. Censoring that information from public use could cause a level of distrust between the engineering community and society as a whole, even if it is done out of protection [4]. Opsin X could revolutionize how we study the brain, save lives with more research, and grant my team unprecedented wealth and respect inside the community. However, NSPE details how engineers will not allow their professional life be corrupted by “conflicting interests,” such as fame or money. In order for a decision to be reached ethically, we must leave our own personal gain separate from our final decision. This scenario is complicated once more when considering the BMES Code of Ethics, a piece designed for moral questions in the field of biology like those brought on by Opsin X, and other case studies pertaining to medical research [2]. Reiterating the primary point of the NSPE code, BMES explains how biomedical engineers are to use their skillsets to “enhance the safety, health, and welfare of the public.” By this logic, one must consider all the potential hazards that would arise if a new development, such as Opsin X, were to be released to the public without proper
protocol. For example, in a case study released by Stanford Biodesign known as “To Release, or not to Release: An Engineer’s Perspective,” a situation occurs where a company prematurely releases a low-risk medical product after an outsourced company takes over its design [10]. The protagonist of the scenario, a product development engineer at the original company, concludes that, even though the device is non-invasive and the product is behind market schedule, it is best that the device undergo further tests to ensure that the third-party group did not overlook a defect in the system’s functionality. With this in mind, it is important to note that medical innovations, whether they be physical products or intangible research, should be handled under careful discretion to avoid costly risks to the mass public. While these codes of ethics provide us with a professional and logical approach to engineering decisions, my personal ethics must have some weight in the scenario.

Nature, Nurture, and Opsin X

Like most individuals, my ethics stem from both the influence of my peers and my own developed ideas, which I look towards during times of crucial decisions like the one described in the previous scenario. As the product of a late divorce and one of four siblings, I understand the value of being both independent and considerate. I rarely take the popularity of an action into account before I act upon it, which, for instance, has led me to an out-of-state university where I originally knew no one. At the same time however, I believe in evaluating all sides of the equation before reaching a fair verdict that does the most benefit for all parties involved. While unpopular, I knew that the University of Pittsburgh provided me with the strongest educational opportunities available and was still affordable for my generous parents. In addition, my late grandmother, a survivor of five bouts with cancer, taught me how to be selfless. She consistently put the happiness of others before herself and I strive to echo her in that regard daily. While some may argue that it is virtually impossible to reach a truly selfless decision, I find satisfaction in the happiness of others. Thus, it is difficult to look past the overreaching possibilities that a major advancement such as Opsin X hopes to provide. When my moral standards meet the ethics promoted in the established world of engineering, I can narrow in on a proper verdict on how to handle Opsin X.

CONCLUSION: REACHING AN ETHICAL DECISION

In this instance, I find the most ethical decision is to keep the discovery out of public domain for the time being. Although Karl Deisseroth claims that optogenetics would be “virtually impossible to use...on an unwitting or unwilling patient,” jumping to conclusions with technology that deals directly with something as fragile as human life is an undeniably precarious territory [4]. As a corporation, I would look into alternative options of experimentation other than the rodent subjects to confirm that human application is both feasible and safe. By doing so, I feel as if this is an ideal way of protecting the social welfare and safety that engineers hold “paramount.” If my team finds that Opsin X is indeed an effective and safe protein to be used in the human brain, we will then proceed to publish the data in order to encourage collaboration and discourage information censorship. Optogenetics is a notably complex process used to study and treat the mind, so the risk of twisting the field into a large-scale form of ‘mind control’ is extremely slim. Therefore, I believe Opsin X’s potential to save victims of illness far outweighs its risk of manipulation, but only if I have determined so amongst a team of skilled, experienced bioengineers.

To the Future Engineer

After considering professional engineering codes of ethics, case studies, and my own beliefs, I arrived at a decision regarding a dilemma on whether to reveal an exciting development in optogenetic technology. Ethics involve the reasoning behind every decision we make. As an aspiring engineer, I now realize the magnitude of the work conducted. By trade, engineers attempt to evolve how society operates for the better by introducing new technology and improving the current way of life overall. While sometimes tedious with official guidelines, engineering requires these formalities to avoid situations where casualties and/or cases of corruption could surface. For these reasons, it is imperative for engineers to have an ethical code that can be rigid at some points, but also flexible at others. Engineers face choices that are far from straightforward, so one must consider the consequences of each option and work towards a goal that results in the greatest social gain. In a sense, our ethics are who we are and professions like engineering ask us to translate that directly into what we do.

REFERENCES

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ADDITIONAL SOURCES


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