Creating A Device To Examine The Impact Stretch Has On Cell Signaling

(Technical Report)

Examining the Politicization of Science for Monetization, Power, and Control

(STS Research Paper)

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On my honor as a student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Technical Topic: Creating A Device To Examine The Impact Stretch Has On Cell Signaling

Physical signals are happening constantly that impact cell behaviors. Muscles in the human body are constantly being stretched or compressed with an example being in breathing and heartbeat. When cells are going through mechanical stretching there are physical changes that produce "a set of biochemical and biomechanical responses that reprogram cell changing cellular processes, such as motility and lineage differentiation, thus critically impacting human (patho)physiology" (Constantinou & Bastounis, 2023). The issue is there are currently no drugs that target physical cues for cells. According to Dr. Barker, "continuing to target traditional biochemical signals that have consistently demonstrated a lack of disease specificity while biophysical cues are completely linked to actual disease phenotypes and thus are inherently disease-specific" (Barker, n.d.). Understanding cellular mechanotransduction (how cells sense and adapt to stress) can unlock and improve numerous therapeutic treatments potentially improving the lives of countless people. There is a critical need for devices to test the impact mechanical factors have on cells as diseases such as cardiomyopathies, cancer, and muscular dystrophies have all been shown to be impacted by defects in mechanotransduction (Jaalouk & Lammerding, 2009).

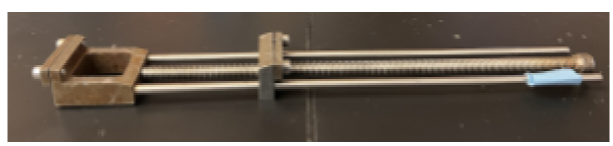
Figure 1: First Iteration of Strain Scout

The pharmaceutical market needs a device that can both stretch and culture cells, while also having imaging capabilities. Current devices in the market that are made for testing cellular mechanotransduction cannot meet all of these requirements, choosing to focus either on culturing or imaging cells (Constantinou & Bastounis, 2023). In Dr. Barker's lab, multiple prototypes have been designed, however, they are all deficient in some regard. His first model (Figure 1) was effective in stretching the cell membrane and culturing cells, although it was too large for the microscope, and as a result it was nearly impossible to image. The second iteration of Dr. Barker's design (Figure 2) can be imaged using a microscope. Moreover, cells can be cultured using the device but it is not designed to be used in a pharmaceutical setting. It is inefficient and requires manual stretching of the membrane with it only having two settings (stretched and unstretched). Additionally, the device is slightly raised where the microscope and cell membrane meet making it difficult to image properly. In a pharmaceutical setting where thousands of drug samples must be tested, it requires reproducibility and an autonomous design. With Dr. Barker's current model designs, this is impossible.

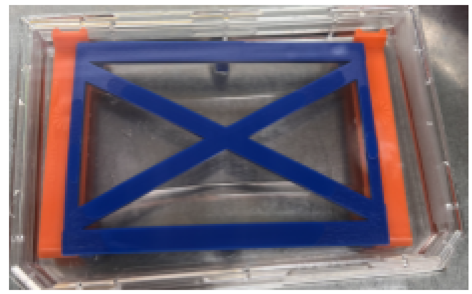

Figure 2: Current Strain Scout Design (Membrane is Stretched)

The technical project seeks to create an autonomous device (named Strain Scout) to stretch a cell membrane for imaging and cell culture growth. This will be achieved through three project aims. The first aim is to create a prototype to bring the membrane closer to the microscope lens. The prototype will stretch the membrane with minimal human intervention. Additionally, the prototype will measure how much the membrane has been stretched and there will be an interface where the user inputs a desired membrane length. Prototypes will be developed using Fusion 360 (Figure 3) and designs will be 3D printed using polylactic acid as it is durable and cost-effective. After the electrical components have been

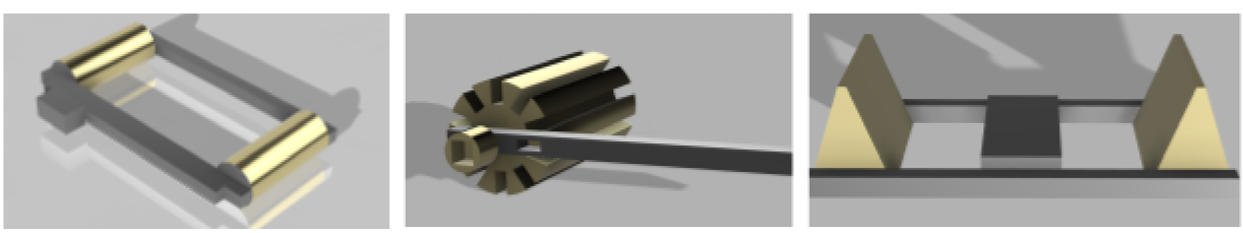

Figure 3: Prototypes of Strain Scout modeled in Fusion 360

added to the device, it will be tested for reliability. Another issue with the current design of Strain Scout is that only one experiment can be conducted at a time. The second aim is to create a cell membrane with wells where multiple experiments can occur at once for the high input testing required for the device to have market value. The cell membrane must have an even strain distribution throughout for it to be an effective research tool. The third aim is to test the functionality of the Strain Scout by culturing different cell types and conducting experiments on the effectiveness of the device to research mechanotransduction.

Introduction

“If thought corrupts language, language can also corrupt thought. A bad usage can spread by tradition and imitation even among people who should and do know better.” (Orwell, 2013). Science is not concerned with morality, it is a tool used to answer questions about the natural world. It is neither good nor bad, with an example being the discovery of fission in 1938. Fission can be controlled using a nuclear reactor to generate electricity. Coincidentally, the chain reaction created by fission was used to create the first atomic bomb (December 1938, n.d.). The knowledge gained from a scientific discovery must be given meaning by society. The issue is after a discovery has been made as it can be exploited to fit certain political agendas. These agendas are often hidden under pretenses. Additionally, scientific findings can be manipulated to support specific ideologies.

This STS prospectus will analyze the impact social factors have on science, and how science can be exploited to promote certain political agendas for financial gain, power, and control. This will be achieved through the analysis of eugenics, the link between cancer and tobacco, and the COVID-19 pandemic.

STS Framework: Sociology of Scientific Knowledge

The sociology of scientific knowledge (SSK) framework best fits into the analysis of the politicization of science. The SSK framework is the relationship between social influence and knowledge. The SSK framework presents an objective view of why one theory will prevail where uncertainty exists as a result of social influences (Sociology of Scientific Knowledge - an Overview | ScienceDirect Topics, n.d.). This fits well with the politicization of science as certain agendas can shape knowledge more than empirical evidence. By examining the link between cancer and tobacco, eugenics, and COVID-19 policy, the SSK framework will aid in helping to explain how social factors were able to shape science and public opinion.

Background and Context from Three Case Studies

The World Health Organization states, “Smoking is the leading cause of preventable death. Worldwide, tobacco use causes more than 7 million deaths per year” (Diseases and Death, 2023). It is now widely known that tobacco causes cancer, however, this was not always the case. Lung cancer was rare before the 20th century accounting for nearly 10% of all cancers (Ruegg, 2015). Smoking became more popular during the 1900s due to commercialization. In WWI and WWII, cigarettes were supplied to soldiers and smoking started to gain more widespread popularity. According to the American Cancer Society, “Per capita cigarette consumption soared from 54 per year in 1900, to 4,345 per year in 1963. And, lung cancer went from rarity to more commonplace – by the early 1950s it became ‘the most common cancer diagnosed in American men’” (The Study That Helped Spur the U.S. Stop-Smoking Movement, n.d.). Before the 1950s there had been various studies drawing a connection between cancer and tobacco, although there was a struggle to give clear evidence proving smoking definitively causes cancer. This all changed in 1953 when the American Cancer Society published a study linking death and cancer to smoking through 188,000 participants (The Study That Helped Spur the U.S. Stop-Smoking Movement, n.d.). However, through multiple study's scientific uncertainty, the tobacco industry was able to still dispute the connection that smoking leads to cancer. The tobacco industry would intentionally confuse and cast doubt on prior research through its funding of scientific discovery, "It would be crucial to identify scientists who expressed skepticism about the link between cigarettes and cancer, those critical of statistical methods, and especially those who had offered alternative hypotheses for the causes of cancer" (Brandt, 2012). The sales of cigarettes grew considerably with these new tactics. The tobacco industry showed how easy it was to exploit scientific research for financial gain. The very system that makes research possible was shown that it could be manipulated when answers were not certain. The issue is certainty in science is impossible. Uncertainty in knowledge is a necessary part of the scientific process as it gives way to refinement. Additionally, language is a powerful tool in educating the public on scientific discoveries. It is nearly impossible to give an objective view of data, however, the tobacco industry was able to manipulate and warp scientific language to highlight or cloud specific information. This malicious tactic proved just how malleable knowledge and public discourse can be.

The distortion of scientific facts and language lay at the heart of eugenics, which is the belief that there can be a superior race of humans through selective breeding. The process of eugenics is to limit the gene pool by excluding groups deemed inferior. Charles Darwin's theory of natural selection was a large inspiration for the eugenics movement within the United States and Germany. The dark truth of this practice is that it is extremely susceptible to abuse by those who determine what superior traits are. To limit certain groups of people from reproducing, forced sterilization of people would take the place of minority groups, people with developmental disabilities, and criminals (Eugenics, n.d.). The largest example of this abuse is the Nazis who used eugenics as justification for the genocide of minority groups they did not deem fit. Eugenics laws in Germany eventually lead to euthanasia, “its aim was to exterminate the mentally ill and the handicapped, thus ‘cleansing’ the ‘Aryan’ race of persons considered genetically defective and a financial burden to society” (Nazi Persecution of the Mentally & Physically Disabled, n.d.). It is estimated that between 200,000 and 250,000 people were killed as a result of euthanasia while nearly 400,000 people were sterilized by eugenics laws in Nazi Germany (Nazi Persecution of the Mentally & Physically Disabled, n.d.). The Nazis were able to hide their ideology under the veil of science, using manipulation and scientific language for justification of genocide. Additionally, prejudice played a pivotal role in the widespread adoption of eugenics. The issue is as scientific philosophy becomes more popular it fuels more research, giving validity to questionable theories. The Nazis showed how science could be used as a tool to further promote a deeply flawed ideology.

In the full analysis, I will take what is shown from these two cases to explore how beliefs, not scientific data influenced COVID-19 policy during the pandemic.

Conclusion

Examining the politicization of science through the SSK framework aids in objectively seeing how social influence impacts knowledge. Science has no morality. It is ultimately society's job to determine how its knowledge will be used. By examining eugenics, the link between cancer and tobacco, and the COVID-19 pandemic, it becomes clear how science can be exploited for certain agendas. It is crucial to apply ethics to science as history has shown the abuse and corruption that can come from knowledge and ideas as a result of moral ambiguity.

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