Designing an Updated System for Time Lapse Microscopy to Study *Toxoplasma Gondii* Invasion in Intestinal Epithelial Cells
(Technical Paper)

Depictions of Social Media Using the Social Construction of Technology Concept
(STS Paper)

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Alexa Guittari
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Technical Project Team Members
Carolyn Graham
Danielle Heckert
Sydney McMahon

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

Signature  Date November 2020
Alexa Guittari

Approved _____ Date _____
Brian Helmke, Department of Biomedical Engineering

Approved _____ Date _____
Hannah Rogers, Department of Engineering and Society

Introduction

The phrase “crazy cat lady” is applied to when one becomes infected with a parasite called *Toxoplasma gondii* (Skloot, 2007). This saying emerged when scientists infected rats with the parasite, the rats, surprisingly, did not fear the cat. Instead, the rats showed signs of attraction towards the cat (Turban, n.d.). Besides rodents, one-third of the human population in the world is currently infected with *Toxoplasma gondii*. While most healthy people are asymptomatic when infected, this parasite is fatal for people who are immunocompromised or pregnant (KATO, 2018). Within this field of research, the way this parasite initially invades the host cell is unclear. Specifically, the question remains if people who have diseased host cells from gut motility disorders are more susceptible to the parasitic invasion. Thus, current therapeutics are not at their optimal potential since they do not have a specific blocking mechanism to block the parasite when it infects humans. The lack of specificity within therapeutics brings into question if the parasite utilizes the same mechanism of force to invade healthy versus unhealthy cells. This is important because there is very limited treatment available if one becomes fatally infected (e.g. there only three drugs available). Not only could there be more precise treatment options that focus on blocking specific parts of the invasion mechanism among different cell types, but the parasite has the ability to impact human brains by creating dopamine, a neurotransmitter (Turban, n.d.). In turn, being infected can cause human altering behavior, a phenomenon which is also demonstrated with the use of technology.

Comparable to the biological tactics *Toxoplasma gondii* uses to increase dopamine levels, technology firms use methods that trigger users to receive endless supplies of dopamine (*Social Media Addiction*, n.d.). These tactics are acknowledged by the machine learning algorithms that generate such an engaging feed. The algorithm behind social media and *T.gondii* are examples of

external factors that manipulate human behavior. This prospectus will encompass two proposals; the first will describe the Capstone component which is to study the initial interactions of *T.gondii* on host cells that mimic gut motility disorders. The second, the Science, Technology, and Society (STS) component will describe the sociotechnical relationship between social media and its impact on human behavior.

Technical Topic

More than six million people suffer from inflammatory bowel disease (IBD), which is associated with gastrointestinal motor disorders; it impacts muscular contractions of the intestine which is commonly referred to as peristalsis (Alatab et al., 2020; Fakhoury et al., 2014). Infectious parasites, such as *Toxoplasma gondii*, have been seen as a complex relationship with respect to altering one's gastrointestinal motility (Halliez & Buret, 2015). Within the research field, the invasion of host cells by *T.gondii* has been classified into four parts: attachment, penetration, force generation, and encapsulation within a vacuole. However, the biomechanical mechanisms of invasion in stretch-adapted cells remain poorly understood. Currently, it is unclear whether *T. gondii* invades by pulling itself into the cell, or if host intracellular mechanisms are permissive to the invasion. While it is known that diseased cells have a distinct cobblestone-like appearance that is unlike the normal columnal phenotype of gut epithelial cells, it is unknown how this contributes to the susceptibility of *T. gondii* invasion (Booth, 1970). Current methods for studying *T. gondii* invasion rely on cytoskeleton inhibitors, but such approaches do not accurately simulate the *in-vivo* environment of the cells. A mechanobiology-focused approach is required to determine whether *T. gondii* invasion is a consequence of the non-stretch adapted epithelial cells associated with the disease state, or whether *T.gondii* invasion produces the diseased cell state.Live cell Microscopy is an important imaging technique

used to study *T. gondii* invasion. *T. gondii* invasion rates, epithelial cell responses, and structural dynamics will all be analyzed with this imaging technique. However, such techniques require an environmental chamber that mimics physiological conditions so that one is able to analyze the invasion mechanism under a microscope which is outside of the incubator for long periods of time. Therefore, the primary goal of this technical project is to design an environmental chamber in which the relationship between *T. gondii* invasion and the health of epithelial cells will be observed. The research team will design a 3D printed enclosed chamber using AutoCAD that will serve as a mountable microscope incubator. Specifications, such as maintaining incubator conditions (e.g. 37 degrees Celsius, five percent carbon dioxide concentration, and 100 percent humidity) and protecting the microscope, will be incorporated into the design and will allow the team to conduct accurate experiments in an efficient manner that produces consistent data. Once an environmental chamber is produced, cells will be plated, infected with *T. gondii*, and stretched based on mimicking diseased or healthy cells. Invasion mechanisms will be observed, and effective research will be done to understand the relationship between *Toxoplasma gondii* and gut diseases, like IBD. These results will help gain a better understanding from the mechanobiology perspective that can help improve treatment options for people who are infected with *T. gondii* as well as seek a finer grasp of the different characteristics of cells that are displayed in different microenvironments, such as IBD.

STS Topic

On average, a user in the United States touches their own smart device 2,600 times per day ("Dopamine, Smartphones & You," 2018). The true "workers" behind this addictive feature are used by the big technology companies' artificial intelligence (AI) machine learning algorithms. Machine learning algorithms are ways for AI to automatically improve from their

own experiences without being reprogrammed (Team, 2020). These AI programs produce such an engaging, personalized user experience that the user spends countless hours staring at these free social media platforms. The impact of these free platforms with such powerful AI is that it makes social media so addictive, resulting in negative impacts to one's health by hurting one's self esteem. Large technology companies want users to be more engaged, and therefore they create their algorithms to utilize variable reward schedules to do so.

Variable reward schedules are similar to the techniques used in casinos, which can amplify one's gambling addiction. In other words, the purpose of using a variable reward schedule is that when a user is aware of a reward, such as new notifications being presented with little effort, the user will check for the reward. The user will then begin to check for their "reward" (e.g. notifications) habitually which is the ultimate goal of these powerful technology companies ("Dopamine, Smartphones & You," 2018). Technology companies also make the users form habits as every time one hears their phone buzz to a notification ringtone, it feeds into one's addictive habits (Forstmann, 2019). The habits that form in the brain reinforce the connection between action and reward, triggering the release of dopamine. Dopamine is a hormone that functions as a neurotransmitter and is in charge of regulating the "reward and motivation" behavior ("The Dark Side of AI," 2019). Dopamine is not only present when habits are forming, but the secretion of dopamine is seen when someone "likes" a user's post. The liking makes the user "feel good" as it releases this neurotransmitter (Osman, n.d.). These connections between the change in a user's behavior and machine learning algorithms can be further demonstrated in the movie, *The Social Dilemma*, in which users' confidence levels undertake a downhill spiral when using social media platforms (Prendergast, n.d.). This can be partially acknowledged by the creators of social media who did not see the potential

consequence(s). For example, the creator of the Facebook Like button, had no intention of making the Like button a self-esteem destroyer and had no idea that the intention that these machine learning algorithms would trigger conspiracy theories (Morgenstern, n.d.). People using these free social media platforms are dictating the function and purpose of technology, which can be applied to the Social Construction of Technology (SCOT) concept. The SCOT concept derived from social constructivists supports the notion that human action shapes technology (*SCOT | STS Infrastructures*, n.d.). Although critics have indicated that SCOT does not adequately explain the roles of structural influences (e.g. social class), people have access to these social media platforms regardless of their class because these platforms can be reached through multiple different devices (e.g. phone, tablet, or computer) and are free of charge (Prell, 2009).

Research Question and Methods

The research question that will be analyzed is: what is the sociotechnical relationship between machine learning algorithms on social media and human behavior. By utilizing the social construction of technology framework, one will be able to examine how human activity has influenced technology, which in this case is examining the outcome of how people portray machine learning algorithms on social media. The methods to conduct this analysis include documentary research methods and discourse analysis. Documentary research methods will include articles such as "The Psychology of Social Media: Why We Like, Comment, and Share Online" by C. Seiter and "How to Rise Above Social Media Algorithms" B. Barnhart. This research will help address the consequences of how social media algorithms are behavior altering from a psychological and scientific perspective. Furthermore, the discourse analysis will be discussed through use of the documentary, *The Social Dilemma,* as it mentions the implications

of what technology companies have posed on its users due to its complex machine learning algorithms. The discourse analysis will help establish this sociotechnical relationship which will be analyzed with research publications from the documentary research method sources. The use of these two different research analyses methods will allow for further examination of how humans depict social media and machine learning algorithms. Furthermore, this will shed light on some of the limitations and outcomes (both good and bad) that are seen in technologies. The mentioned sources have keywords such as machine learning algorithms, behavioral changes (e.g. the fluctuations of dopamine levels), and large technology companies (e.g. Instagram, Facebook, and Twitter) which will allow the proposed research question to be analyzed. Lastly, this information will be presented in a chronological manner; there will be a discussion regarding social media algorithms which are used by the large technology companies and the psychological impact on society.

Conclusion

Notably, *Toxoplasma gondii* is a fairly common infection that many people do not even realize they have, and secondly, people do not always have control of the machine learning algorithms' way of programming. Both mechanisms are seen as situations in which one cannot control or regulate dopamine. The outcome of the Capstone proposal will be to determine if there are any significant differences in the mechanism of invasion when *Toxoplasma gondii* invades healthy cells versus diseased cells using time lapse microscopy. The STS component's outcome will be to look at how people in society depict social media and the presence of machine learning algorithms by focusing on the associations that can be drawn between documentary research and discourse analysis research methods.

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