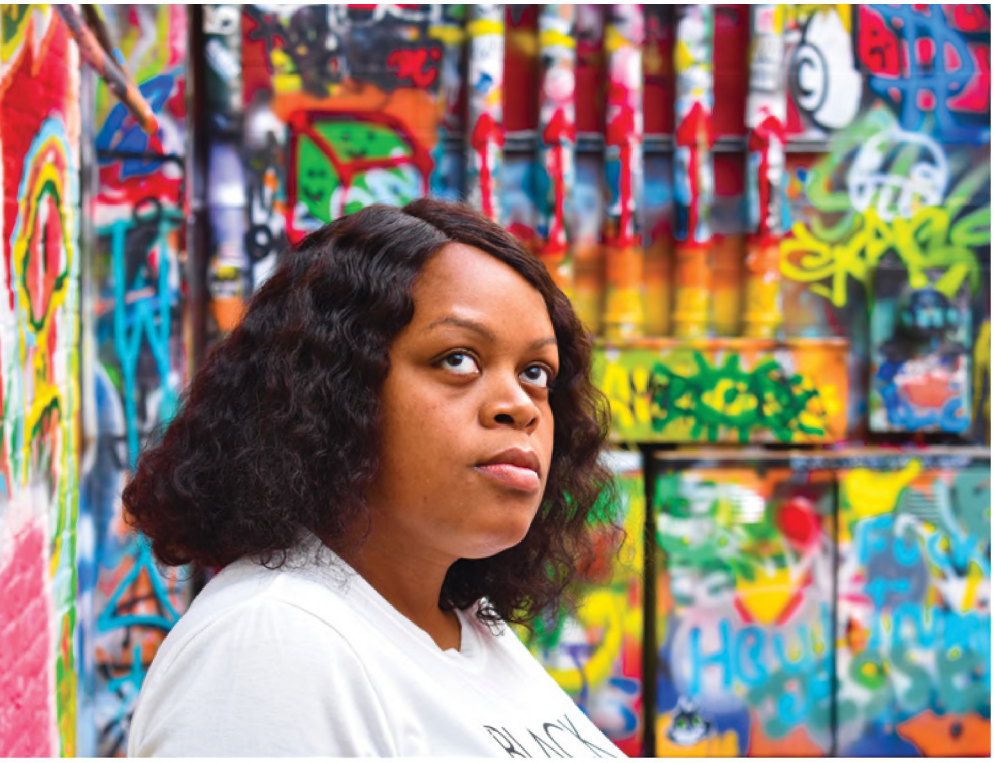
Laridae

SALISBURY UNIVERSITY

Undergraduate Academic Journal



Volume 2 – Fall 2020

Salisbury University
Office of Undergraduate Research and Creative Activity (OURCA)

Enough Is Enough

Eric Johnson Jr.

(Featured on the Cover)

ABSTRACT

Racism has led to continuous conflict between people since the beginning of time, and it is time for this evil to end – *enough is enough*. Since the beginning of 2020, we have lost many lives due to COVID-19 and police brutality as the whole world watched. Police brutality is the use of excessive force by an officer, which can be legally defined as a civil rights violation. Over the years, we have lost many of our citizens and justice was not served. Eric Garner, George Floyd, Breonna Taylor, Ahmaud Arbrey … and so many more. The fact that I can fill at least two pages with victims is sickening – *enough is enough*!

The brutality against African Americans this year has spiked to a recent all-time high. The videos of police killings have filled the news and internet – *enough is enough*. The death of George Floyd was heartbreaking. I personally couldn't even finish watching because the video was just so gruesome. All the lives that we have lost this year are heartbreaking – *enough is enough*. In this moment, the time we are in now, we do not need division. Instead, we need to come together in unity.

The purpose of these photos is to show that *enough is enough*. I believe that one day we will all see the light at the end of this dark tunnel, but we have a long way still to go in order to come together. Our journey will not end today, or tomorrow, or the next day, but eventually we will get there together. ALL LIVES WON'T MATTER, UNTIL BLACK LIVES MATTER.

ACKNOWLEDGMENTS

The artist thanks his family, the Johnsons, for their support and for their willingness to be photographed for this project, and Jeanne Anderton, who served as the faculty mentor for this project.

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Contents

Letter from the Founder

Welcome to our second edition of the *Laridae* undergraduate research journal. Last fall, our team of faculty and undergraduate researchers at the Office of Undergraduate Research and Creative Activity worked exceptionally hard to present the inaugural edition of this journal in November 2019. It featured 12 outstanding academic papers that explored topics in areas including, but not limited to, psychology, literature, education, biology, and chemistry, as well as original artwork from one of our fellow Sea Gulls. It was an exciting experience for everyone involved, and we yearned to feature more students in our next edition. Thanks to the combined efforts of everyone at *Laridae*, OURCA, and your classmates, we bring to you the second edition of the *Laridae*, SU's undergraduate research journal. We invite you to read, view, and enjoy the many excellent works in this edition.

These works demonstrate amazing creative thinking and embody the spirit of collaboration and undergraduate research on which Salisbury University prides itself and from which many students, including myself, have greatly benefitted. The mission of this journal is to reflect the brilliant work that SU students undertake within their respective areas of study. *Laridae* hones the academic diversity on our campus to showcase the many possibilities that our university strives to create with every opportunity. I hope that as you read the papers and view the works of art, you will be inspired to write, own your creativity, and make the most of your opportunities and your education.

Abiodun Adeoye
Founder

Letter from the Editor-in-Chief

Despite COVID-19, Salisbury University still holds strong. All around SU, students are finding ways to stay engaged in research by dedicating time to labs across campus, diligently attending Zoom meetings, and creating amazing works of art. Inside the journal, you will see works from majors housed in Salisbury's many colleges and schools and relevant creative works that reflect today's important events such as the Black Lives Matter movement. From meticulous, detailed analyses, to the aesthetic works of the visual arts and the literary beauties found in creative writing, *Laridae* represents the best and brightest minds at Salisbury University. We are proud to present the second edition.

Laridae strives to provide a platform for undergraduate students to showcase their brilliant creative and academic works. As a leading institution in undergraduate research, SU offers students opportunities to explore and engage with competing ideas from diverse fields.

The Office of Undergraduate Research and Creative Activity (OURCA), along with the faculty and staff at SU, provide the momentum behind our rich research environment. Without their support, most of the students would not have the resources to start these projects and *Laridae* itself would not have become reality.

Since our first edition of *Laridae* that debuted November 2019, we have worked tirelessly to uphold the highest standards. Recently, we've improved our application process by incorporating more faculty in the review phase. Over the course of the 2020 cycle, we received 32 submissions and accepted 14 manuscripts and seven creative works, which included two poems, three paintings and two photography collages. None of this would have been possible without Drs. Jessica Clark and Chrys Egan, former co-directors of OURCA; Dr. Rhyannon Bemis, the current OURCA director; and our dedicated editorial staff and *Laridae* alumni.

I invite you to discover something novel, challenge conventions, inspire those around you, and explore for the purpose of advancing our understanding of reality. That is the *Laridae*'s legacy. What will you do to continue it?

Margaret Giggey
Student Editor-in-Chief

Letter from the Inaugural Editor-in-Chief

Today, our devices and platforms trap us in our personalized versions of reality. Originally, these devices and platforms were designed to generate a shared public square, but now they serve a different purpose – unrestrained personalization. Under this new mission, these tools form the thick veneer that obfuscates and distorts reality. Compounded by our media industry's endless fornication with the methods of the entertainment industry, the information that circulates our so-called "public square" has never been so politicized nor trivialized.

In response to this formidable challenge, a group of trailblazing students, armed with collective will and youthful optimism, sought to dismantle the veneer. For the latter half of 2018 and the entire year of 2019, these students met frequently until they conceived what is now known as *Laridae*. The intentions of the *Laridae* were clear: provide Salisbury University with a platform for students to showcase diverse and confronting ideas to combat the veneer that prevents people from building a shared reality.

As the journal's first editor-in-chief, I am proud to admit that this year's printing of *Laridae* manifests our mission with greater clarity and precision than in its first edition. I hope you – the reader – enjoy the content and utilize it to continue our campaign against our world's most pressing problem.

Harrison Leon
Inaugural Editor-in-Chief
Sapere aude

YEARNING FOR CHANGE

Jirah Ross

ABSTRACT
"Yearning for Change" is a poem to honor the many African Americans who lost their lives to racial violence. This is for the little boys and girls who suffer as a result of gentrification and racism, the teenagers who are on the wrong path and need someone to hear their cries, and the mothers who have had to face the life cycle in reverse. Victims of racism, gentrification, and violence must know that their cries are heard and that their pain is felt.

Tick
  tock
Tick
  tock
The sound of my life clock.
Time keeps going even though I beg for it to stop
Through frustration, stress, anger, complete and utter shock
I have to keep it pushing

Keep pushing for the children
for the children that go down the wrong path
The ones that try to run the block
with illegal glocks cocked
trying to make hood rock
on woodstock all because they heard that Tupac did it
Next thing you know out the blue they shot
In a puddle of red they drop
Now there's a mother crying
Because she has to bury her son
  in a wooden box

Tick
  tock
Tick
  tock
The sound of my life clock
Time keeps going even though I beg for it to stop
Through frustration, stress, anger, complete and utter shock
I have to keep it pushing

Keep pushing for the children
For the children that want to learn
Let me slow it down
Break it down
And hand you some facts
cause' our children don't have Macs

Our children can't get a decent education
Due to gentrification
babies are forced to go to schools
not meeting our expectations
Then once they are in the building
Due to discrimination and our lack of assimilation
kids are suspended for wearing dreadlocks and braids
that have been passed down to us from generation to generation

Now back to gentrification
That sh** got me pissed
As Porsha O. said
"The rich is robbin' hoods
So Robin Hood wasn't a myth"

I am looking up to the sky like "God what is this?"
Babies dying before having a real chance at life
Strife is the American Negro story
If Rosa sat
  so Martin could march
    so Obama could run
Then why does it feel like, we in the Color Purple,
  as Sophia saying
"all our lives we had to fight"
I've been in battle fighting for life
what am I supposed to do now
I can't quit and sit down and just say aight'

But ...
Tick
  tock
Tick
  tock

The sound of my life clock
I am not trying to spend the rest of my life stuck on lock
Just give me a door of opportunity to make a change
I'll knock if you will unlock
We
are at a standstill
a roadblock
I can't see another person I love die
I can't sit up another night and cry
myself to sleep, not another goodbye
not another deep sigh,
Let me be the change that can unify
US before time flies by

Tick
  tock
Tick
  tock
The sound of my life clock

The Wizarding World of Oncology:

Harry Potter, Cancer Initiating Stem

Cells, and the Tumor Microenvironment

Madison MacDougall

Illustrated by Marrissa Izykowicz

ABSTRACT

Cancer is an aggressive, debilitating disease that affects millions worldwide. Cancer-initiating stem cells (CICs), a subtype of cancer cell with exponential self-renewal, lead to all the differentiated cells that make up malignant tumors. Understanding how these cells resist chemotherapeutics and contribute to metastasis is of critical importance to scientists and oncologists, as these cells possess a resilience with the same intensity as a patient's will to survive. This paper seeks to explain the impact CICs have on the immune system and their ability to hi-jack normal cellular functions to fit their own needs, altering the tumor microenvironment and increasing therapeutic resistance. Structural components of CIC microenvironment are also explored and related to drug resistance and metastasis. Told through analogies from Harry Potter, this outlook on cancer survival aims to engage not only scientific readers, but the general public as well. The goal is to intrigue even the most unlikely of audiences to see the magic of the human body and understand the central theme of survival, whether from the perspective of the patient or the cancer itself.

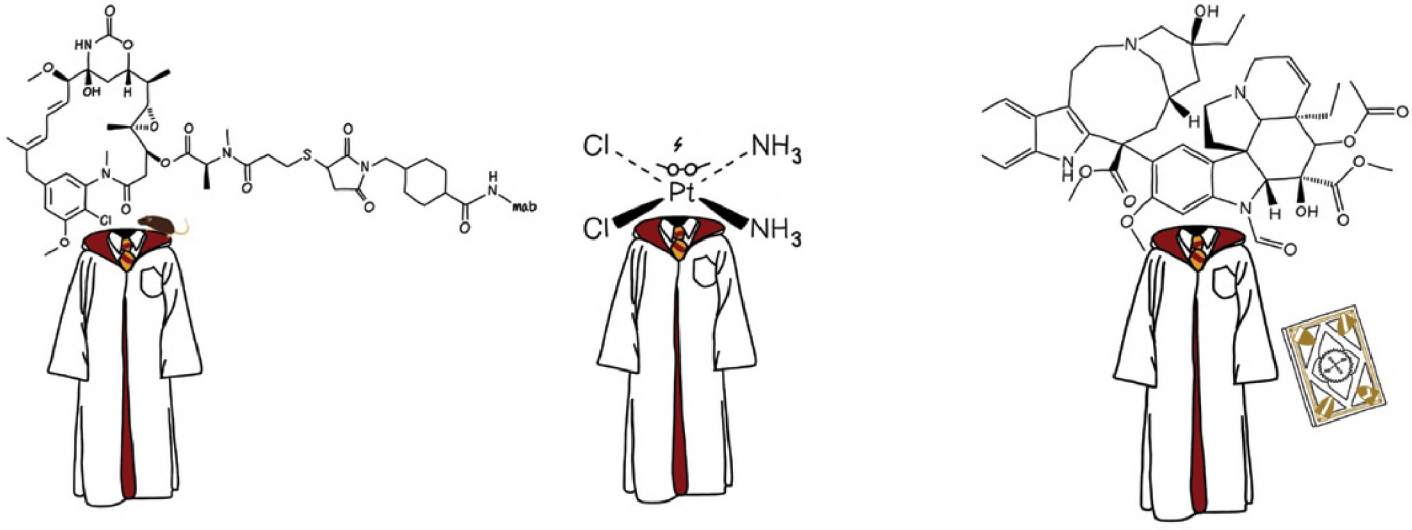

Figure 1: Ron, Harry, and Hermione depicted as the chemotherapeutic drugs Trastuzumab, Cisplatin, and Vincristine, respectively

INTRODUCTION

After 11 years of hiding, He Who Must Not Be Named returned, dispersing hundreds of his Death Eaters into the wizarding universe to convert good wizards and witches into following his dark ways. His goal: Overtaking Hogwarts, the very body of the Wizarding World, once and for all in order to ensure his immortality. While the protagonists Harry, Hermione, and Ron were able to defeat Voldemort and restore Hogwarts to its full glory and vivacity[1], many people are not so lucky in their battle against a certain two syllable, six letter word: Cancer. Sometimes lying dormant for many years, cancer often appears in the battle for the body, sending its own army of Death Eating metastatic cells to kill or mutate the opposing healthy cells that stand in the way of cancerous proliferation. While patients fight as hard as our classic story book heroes to overcome the villain threatening their wellbeing, often undergoing their own kind of magic in the form of chemotherapy and radiation (Fig.1), good does not always prevail in the battle against cancer. Approximately 1,762,450 lives were impacted by cancer in 2019 in the United States alone, resulting in 606,880 deaths[2]. This colossal number poses the important question of *why?*

Why, despite scientific innovation and increased understanding of cancer progression have we not found a cure? How do cancerous cells evade chemotherapy and continue proliferating in the face of these toxic chemicals? Part of the answer lies in cancer-initiating stem cells (CICs) as well as tumor microenvironment. As patients fight for survival, cancer cells fight to stay alive and resist the effects of these drugs, eluding chemotherapy to persist in the internal battle between medicine and cancer. By manipulating fibroblasts and macrophages, utilizing the physical protection of the extracellular matrix (ECM), and altering their physical appearance, CICs are ultimately able to increase tumor development and therapeutic resistance.

PART ONE: CANCER-INITIATING STEM CELLS AND THE IMPERIUS CURSE

Defining cancer-initiating stem cells and the tumor microenvironment

In the last novel of the Harry Potter series, Harry, Hermione, and Ron search for and destroy magical artifacts known as horcruxes, which hold parts of Voldemort's soul[1]. One of the last horcruxes to be found is a golden cup hidden in the Gringotts bank vault of Voldemort's most trusted Death Eater, Bellatrix Lestrange[1]. Other goblets in the vault are charmed with the Gemino curse, otherwise known as the doubling charm, in order to prevent intruders from reaching the horcrux[1]. Upon touching, the golden goblets rapidly proliferate, popping off into new cups two at a time until the entire vault is filled to the ceiling with replicas of the original[1].

The rapid proliferation of the chalices is the perfect analogy for exponential growth, a key component of CIC behavior. CICs are a subtype of cancer cell with exponential self-renewal that lead to all the differentiated cells that make up malignant tumors[3]. Unlike normal cells that halt division when they come in contact with other cells, CICs grow in a way that mimics the division of these chalices, differentiating into numerous different types of cancerous cells that layer on top of each other until they fill their "vault," or body cavity, in the form a tumor[3]. The rapid growth pace of CICs makes cancer an aggressive disease that is difficult to treat, as well as increases the likelihood that these cells will break out of their "vault" and spread to other areas in the body, in a process known as metastasis[3].

CICs are also surrounded by an ECM composed of collagen fibers and proteins, which provide structural support for the cells[4]. The ECM, as well as healthy cells in the proximity of the cancerous tumor, are considered the tumor microenvironment because they compose the environment the malignant tumor is located in[4]. CICs interact with the tumor microenvironment in many ways in order to aid tumor progression and therapeutic resistance. One method involves the recruitment and manipulation of the microenvironment's healthy cells, such as fibroblasts and macrophages, to protect them. In the absence of CICs, fibroblasts assist in epithelial cell growth regulation, meaning they regulate the cells found in the linings of most organs and body cavities, including the skin[3]. Macrophages degrade foreign substances to increase the effectiveness of the immune system[4,5]. Similar to the effect of a scientific spell, CICs trigger fibroblasts and macrophages

Figure 2: A Dementor sucking the energy out of a cancer patient, leaving behind CICs to continue proliferating, metastasizing, and transforming healthy cells into their ab counterparts.

to abandon their predetermined functions and act in ways that are in opposition to their original roles[4,6]. CICs appear to cast an Imperius Curse on healthy members of the tumor microenvironment, manipulating their functions from immune protection to immune hindrance and facilitating cancer progression[4,6].

From fibroblasts to Cancer-Associated Fibroblasts

The Imperius Curse, one of the Unforgivable Curses in the Wizarding World of Harry Potter, allows the caster to manipulate the actions of the victim, controlling them completely and forcing them to do things they would not normally do[7]. Essentially, a wizard's actions are unrecognizable from their normal lives under the influence of this spell. Just as wizards and witches were manipulated by the Imperius Curse to transform from normal members of Hogsmeade into cruel Death Eaters, fibroblasts in the presence of CICs transform from normal components of the ECM into Cancer-Associated Fibroblasts (CAFs), the complete opposite of their normal counterpart[4]. Normal fibroblasts make up the connective tissue of the ECM, controlling inflammation and regulating epithelial cell growth to prevent excess development[4]. However, when fibroblasts come in direct contact with CICs, their functions change and result in an overexpression of proteolytic enzymes[4]. These enzymes serve to break down proteins and contribute to the degradation of the ECM, promoting metastasis[4]. Additional matrix modifying enzymes secreted by CAFs include urokinase-type plasminogen activator (uPA) and the matrix metallopeptidases MMP-9 and MMP-2, all of which degrade the ECM and intensify metastatic potential[6].

To understand the significance of an ECM alteration, imagine thousands of Death Eaters trapped behind bars in Azkaban prison. When the bars burst open, the dangerous Death Eaters explode out of the prison in black clouds of smoke, free to go anywhere in the Wizarding World and wreak havoc. The progression of events following ECM degradation is strikingly similar. No longer trapped inside a layer of tissue, cancerous cells including CICs in tumors freely roam throughout the body, metastasizing to new tissue, forming new tumors, and wreaking havoc on normal cells. This has the potential to start the cycle all over again, as CICs may encounter additional fibroblasts and transform them into CAFs[4]. The degradation phenotype of CAFs is thus the antithesis of the normal fibroblast phenotype, showing how cancer is able to transform healthy cells into supporting its spread in what appears to be a cancerous Imperius Curse. Continuous transformations from healthy to abnormal cells is harsh on the body, painting cancer as the energy draining equivalent to soul sucking Dementors (Fig.2).

Other functional transformations in CAFs involve cell growth and inflammation control[4,6]. For example, instead of regulating cell growth like healthy fibroblasts, CAFs aid in cell proliferation, further spreading the

cancer[4]. This is largely due to a mutation the *TP53* gene[6], which is the most commonly mutated gene in human cancer[8]. *TP53* codes for the tumor suppressor protein p53[9]. Tumor suppressor proteins like p53 act as cell growth regulators that halt cell proliferation when DNA errors, such as those that lead to cancer, are detected[9]. Damaged DNA can then be repaired or the cell can self-destruct in a process known as apoptosis[9]. The mutation in the *TP53* gene, found in CAFs but not in healthy fibroblasts, shows a distinct transformation taking place in the presence of CICs. Without functioning p53 proteins, cell cycle checkpoints are decreased or absent, allowing an accumulation of DNA mistakes and an increased likelihood for malignant tumor development[9]. This is similar to preventing Hermione Granger from checking her work on an exam before turning it in for a grade. Not correcting a multiple-choice answer from A to C may result in Hermione missing a few points on her exam. However, not correcting a nucleotide error from Adenine to Cytosine may have dire consequences for the body, including the proliferation of cancerous cells.

Lastly, CAFs overexpress inflammatory cytokines, increasing inflammation of the cancer stroma[6]. Increased inflammation from the cytokines attracts more cancer cells to the growing tumor through chemotaxis, a process in which cells are drawn toward chemical signals[4]. Cytokines are the biological equivalent of the Mirror of Erised in the *Sorcerer's Stone*. Erised is desire spelled backwards. This name is fitting as the mirror shows onlookers their deepest desires, often luring them to sit in front of it for hours[10]. Harry is attracted to the mirror due to its compelling nature that draws him closer and closer[10]. The compelling nature of cytokines draw cancerous cells toward the malignant tumor, allowing the accumulation of more cells, increasing tumor size, and making the tumor more difficult to treat.

From macrophages to Tumor-Associated Macrophages

The transformation from fibroblasts to CAFs is not the only cellular manipulation that occurs due to contact with CICs. Another cancerous Imperius Curse occurs when macrophages encounter CICs and transform from normal immune protecting cells to immune hindering Tumor-Associated Macrophages (TAMs). Normal macrophages are responsible for phagocytosis of cellular debris, apoptotic material, and foreign substances like microbes[5]. They may also play a role in recognizing and destroying tumorigenic target cells[5]. This can be understood by imagining the Goblet of Fire as a macrophage. Hogwarts students submit their names into the Goblet to enter the Triwizard Tournament, a dangerous competition of magical abilities and wit[7]. Because of the dangers of competing, tournament entries have an age requirement of 17 years and slips of paper containing the names of wizards under the age limit are ripped to shreds and spit back out of the Goblet[7]. Macrophages degrade and expel foreign substances to protect the body's immunity during phagocytosis, mimicking the Goblet's role of protecting the students of Hogwarts by breaking down and spitting out entries that should not be there. Unlike normal macrophages, however, TAMs have been shown to increase tumor progression, metastasis, chemoresistance, as well as immunosuppression[6]. Part of this transformation is due to increased inflammation from CICs, which stimulate TAMs to release specific molecules that damage healthy tissue and increase the likelihood of DNA mutations and tumorigenesis[7]. TAMs also excrete vascular endothelial growth factors in the presence of CICs[11]. These growth factors contribute to angiogenesis, which is the formation of new blood vessels surrounding and infiltrating the tumor[11]. An increase in number of mutations, healthy tissue damage, and blood vessel formation expedites tumor development and makes a patient's cancer more aggressive[11]. Ultimately, macrophages no longer fulfill their immune protection role in the presence of CICs, similar to how the Goblet of Fire was charmed into accepting, rather than rejecting, Harry's entry to the Triwizard Tournament[7]. The resulting phenotype switch further shows the role CICs play in hijacking the immune system to fit their own needs, ultimately increasing their survival and proliferation.

While the exact mechanism of the fibroblast and macrophage "switch" from normal to abnormal is not fully understood, one can easily see that CICs play a large role in their transformation. A cancerous Imperius Curse is most certainly at play inside the human body, poaching cells from Team Human Body and forcing them to play on Team Metastasis. While the elucidation of pathways involved in these seemingly scientific spells is of interest to scientists and oncologists, other microenvironment characteristics play a large role in chemotherapeutic resistance, including the ECM itself.

PART TWO: THE EXTRACELLULAR MATRIX AND THE HOGWARTS CASTLE

The extracellular matrix as castle walls

A new analogy to describe the ECM is needed for CICs' defense strategy rather than their offensive approach. Rather than escaping the prison bars of Azkaban, CICs retreat to their version of Hogwarts Castle in the presence of chemotherapy. The walls of Hogwarts' Castle provide physical protection to those inside. Mirroring this supportive function, the ECM provides physical protection to CICs against therapeutic intervention, acting as a physical barrier between healthy tissue and CICs[12]. CICs are able to adhere to the ECM, holding the tumor steady in

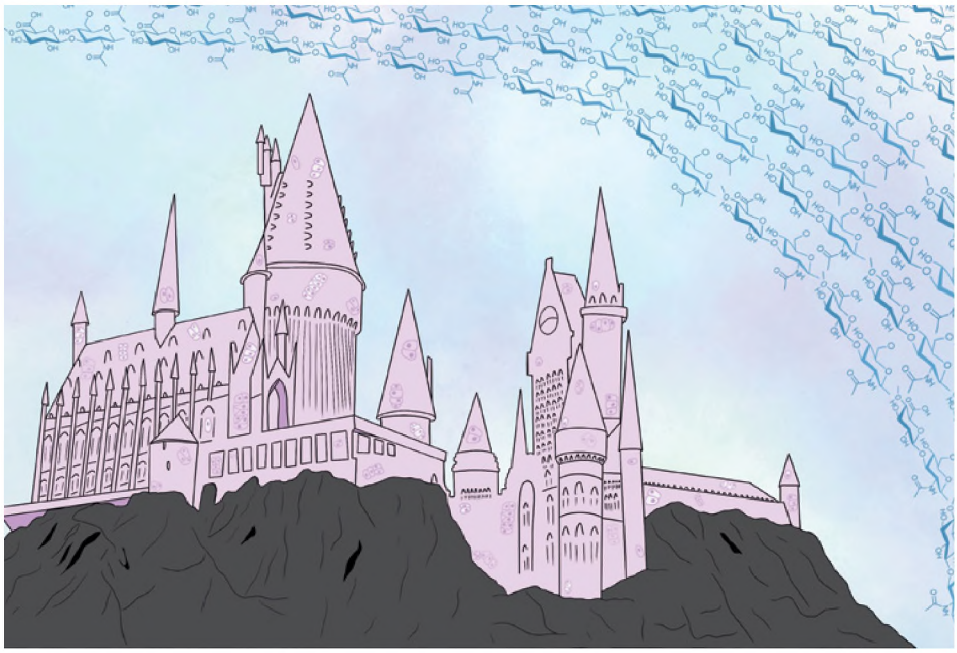

Figure 3: Hogwarts Castle acting as the ECM providing protection from chemotherapeutic with strong walls of cartilage and hyaluronan shield charms.

the face of trauma[12]. The ECM also has the ability to interact with CIC receptors, enabling the malignant cells to gain elasticity, as well as tensile and compressive strength[12]. Other times, the ECM overproduces collagen, resulting in excess collagen crosslinking and an even stronger barrier between anticancer drugs and the cancerous cells, much like Hogwarts' thick stone walls that resist penetration[13]. All of these factors contribute to a tumor's overall rigidity, making it stiffer than other tissue and resistant to therapeutics[12].

Hyaluronan as a shield charm

Another contributor to the strengthening of the ECM's castle walls is hyaluronan (HA)[14]. HA occupies a large volume of the ECM and acts as a semipermeable barrier, allowing the diffusion of small molecules but blocking large compounds from getting through to the cells underneath[14]. Thus, the molecular size of effective chemotherapy drugs for cancers expressing high levels of HA is limited. HA is an extra layer of protection surrounding the already strong ECM castle walls. Imagine the shield charms cast by Hogwarts professors that created a protective enhancement shield around their already fortified castle during the Battle of Hogwarts[1]. This glowing barrier acted as an additional protective layer, forcing the Death Eaters to get through it first before they could begin their attack on the castle[1]. This is exactly like the role of HA against anticancer agents: An additional resistance layer to anticancer drugs before they can reach the already strong ECM (Fig. 3).

ATP-binding cassettes as Hogwarts' chimneys

Lastly, Hogwarts' chimneys that pump smoke and ash from fireplaces out of the castle mimic the extracellular transport proteins possessed by CICs. These proteins are called ATP-binding cassettes (ABCs) and serve to pump chemotherapeutics out of the CIC[6]. ABCs have the ability to transport drugs made of numerous components such as proteins, amino acids, inorganic ions, vitamins, and polysaccharides, labelling them as multi-drug-resistant proteins (MDRs)[6]. The ability to recognize and expel numerous toxins shows another element of CICs' defense strategies against chemotherapy, adding an additional weapon to their Hogwarts' arsenal for protection and survival.

PART THREE: POLYJUICE POTION AS AN ESCAPE FROM T-CELLS

T-cells as the sword and fang

T-cells are an important component of the body's adaptive immunity[15]. Adaptive immunity is developed over time, unlike innate immunity, which is present from birth. Each type of T-cell is able to recognize a specific antigen, or protein structure, on a specific type of foreign material to attack and destroy it[15]. This can be understood by comparing the Sword of Godric Gryffindor and the basilisk fang to T-cells. These magical tools were the only things Harry and his friends could use to destroy Voldemort's horcruxes because they interacted with the deadly artifacts in a way that nothing else would[4,16]. T-cells have a specificity for one type of antigen, like the sword and fang have specificity toward the horcruxes. For example, tumor-associated antigen (TAA)-specific T-cells target TAAs on the cell surface of tumor cells[3]. Unfortunately, T-cells are readily fooled despite their unique recognition abilities. Much like those who fall for the shapeshifting effects of the Polyjuice Potion, T-cells are unable to recognize CICs when their appearance is that of a normal cell.

Lack of Tumor-Associated Antigens as a Polyjuice potion of protection

Classified as one of the most advanced concoctions in the Wizarding World, Polyjuice Potion enables the drinker's appearance to morph into another's, enabling one to pretend to be someone they are not[16]. While disgusting to drink, it has convincing results. Harry and Ron used it to infiltrate the Slytherin common room, pretending to be Crabbe and Goyle[16]. Hermione, Ron, and Harry effectively employed it to sneak into the Ministry of Magic, pretending to be employees[1]. Most notably, however, this potion enabled members of the Order of the Phoenix to transform into Harry one by one, drawing the Death Eater's attention away from the real Harry during an attack and allowing his survival[1]. The central themes of disguise and survival brought on by the Polyjuice Potion are not new to the cancer world. CICs are masters of disguise, pretending to be normal cells by manipulating their appearance, much like Harry and his friends. Just as the Polyjuice Potion enables witches and wizards an escape from recognition, CICs can escape recognition by T-cells because they lack specific antigens on their cell surface[3] (Fig. 4). Unlike non-stem cancerous cells that possess a large amount of TAAs, CICs lack or present with very few TAAs, tricking T-cells into thinking they are normal cells and avoiding destruction[3].

Vaccines have been able to target TAA-specific immune responses in patients with cancerous tumors, although these

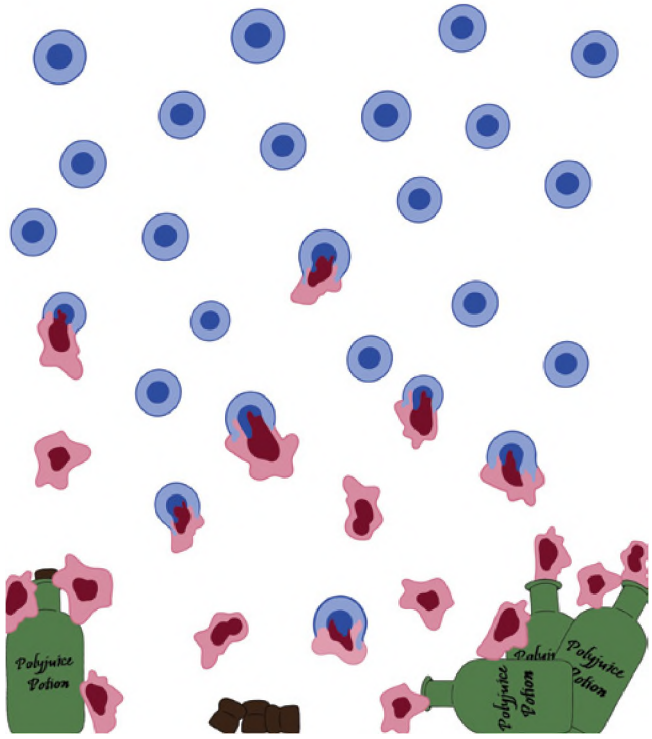

Figure 4: Cancerous cells using Polyjuice Potion to the avoid being targeted by the immune system.

vaccines have not worked against CICs[3]. This is because many CICs have defects in their HLA class I antigen processing machinery (APM), which is responsible for TAA production[3]. With few or no TAAs on their cell membrane, CICs are less likely to be detected by TAA-specific T-cells, allowing them to escape destruction by the immune system[3]. By tricking T-cells into thinking they are something they are not, CICs thus act in a way similar to drinkers of Polyjuice Potion, ensuring their safety and survival when faced with an outside threat such as therapeutic vaccines.

CONCLUSION

Cancer is a debilitating disease that affects millions every year, dismantling the lives of patients and their families alike. This disease continues to evade therapeutic attempts and simultaneously baffles the minds of scientists and oncologists searching for a cure. As determined as patients are to survive their diagnosis, cancer is just as determined to survive. Voldemort's sole desire was immortality, and he did anything in his power to gain the upper hand over his opponents in order to keep it. Natural selection works both ways, adapting the patient and cancerous cells alike. Just as Voldemort fought for immortality, so do CICs, continually adapting to new environmental stresses that doctors throw at them, including anticancer drugs. CICs hijack normal cellular functions through a cancerous Imperius Curse and use the ECM component of their microenvironment as protection like castle walls. The lack of TAAs also acts as a Polyjuice Potion of protection, decreasing T-cell recognition and destruction. As common as this disease is, most cancer literature includes heavy jargon and complex statistics tailored specifically for scientists and doctors, not patients. As the ones bearing the disease, patients deserve an explanation of their suffering in terms they can understand, including analogies to common stories. The utilization of Harry Potter will hopefully encourage readers to be interested in the complex underpinnings of cancer, proving that anything can be broken down in simpler terms. It is of utmost importance to recognize the deadly adversary of cancer in its own fight for survival in the magical and mysterious force of atoms we call the human body.

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AHOMÉ

Gloria Atamekl̀o

ABSTRACT

Ahomé, the Ewe word for home, was the first thing to come to mind upon landing in Togo. One step into the capital city of Lomé or beach town Aného, and one could easily see life thriving under the hot sun. This small collage of photographs represent the colorfulness and vibrancy seen everyday along Togo's coast. Even in a place where life may at times seem bleak, beauty can be found no matter the location or activity, but always in a place one considers ahomé.

LOMÉ

ANÉHO

ANÉHO

AGBODRAFO

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Putting a Check in All the Boxes:

The Case for the National Voter Registration App

Brittany Grubb

ABSTRACT

The voter registration process can be complicated and overwhelming, especially for youth individuals. Voting is incredibly important for ensuring that the views of all U.S. citizens are represented equitably under the laws. This research identifies the best method for increasing voter registration while being efficient and economically practical. It may be the case that a voter registration app will be more effective than civic learning and engagement through school systems, the National Voter Registration Act, and a national voter pre-registration law. An app would be widely accessible because 95% of the people born between 1996-2010 (Generation Z) have a smartphone that is capable of downloading an app (Center for Generational Kinetics, 2018). Apps also can be designed for people who have language barriers and difficulties with mobility. This could be useful for those who need extra assistance with registration. The cost of developing an app is much less than a voter registration drive and will reach more people in return. A voter registration app is the best method to fix the inefficiencies of the registration process because it is widely accessible, user friendly, and financially feasible. This study shows that in order to fix the youth voting crisis, the government should create and promote the voter registration app.

INTRODUCTION

The youth of the United States are not voting because the voter registration and polling system is inept and has been neglected for too long. Many inefficiencies within the youth voter registration process make the process difficult for adolescent individuals to register and vote in state and federal elections. The Center for Information and Research on Civic Learning and Engagement (2011) stated that only 21.3% of the eligible youth voter population actually voted in the 2008 presidential election. Many of the young voters who viewed this process for the first time found it to be confusing and overwhelming. There has been a decline in youth voting because the youth generations are unable to register (or preregister to vote). Scholars, such as Callahan (2010), Cherry (2012), Galston (2003), Muller (2010), and Schiller (2010), unanimously agree that youth individuals are confused about how to register to vote because the requirements are different in each state and the allocation of resources are inequivalent. There has been a contentious disagreement among political scholars about what methods are the most practical and efficient for youth voter registration.

Ensuring that the youth of today understands how to register to vote is imperative to equal representation in politics and lawmaking. Equitable representation in politics comes when there is equal opportunity to vote. The youth who do not vote become underrepresented in politics. Older citizens have delegates and senators in their age group to represent their beliefs. The younger generations must vote to ensure their spot in their democracy. The first step in establishing higher voter participation and turnout at the polls is increasing voter registration. Many methods have been proposed to help youth voter preregistration, but the methods currently being used have proven to be ineffective. One method proposed by Callahan, Muller, and Schiller is an increase of civic learning and engagement throughout school curriculums. There is also the National Voter PreRegistration Act (1993), as well as the enactment of a national voter preregistration law to eliminate the differences in each state's law. Although there are many methods currently in place to improve the inadequacies of the youth voter registration process, the utilization of a smart phone app is the best solution. An app designed for voter registration will be widely accessible, user-friendly, and financially feasible.

YOUTH VOTER REGISTRATION INEFFICIENCIES

It is important to define youth to maintain continuity because each scholarly source defines youth differently. Youth, according to the *University of Michigan Journal of Law Reform*, is defined as anyone between the ages of 18 and 24 (Cherry, 2012). The Center for Information and Research on Civic Learning and Engagement defines youth as the ages 18-29 (CIRCLE, 2011). Some institutions do not provide a definition or age range as to who youth constitutes. Most scholars, such as Cherry and the Center for Information and Research on Civic Learning and Engagement, agree on the fact that when put in the context of voting, youth begins at 18. Scholars and research institutions disagree as to what age youth ends and adulthood begins. In this article, youth is defined as people aged 18-29, unless otherwise noted for statistics and data purposes.

It is statistically shown that youth individuals do not vote at the same rates as other age cohorts. If Americans under 30 voted at the same percentage as voters over 30 did, then an additional seven million citizens would have cast ballots in the 2008 election (Cherry, 2012). Many young people do not vote due to work, lack of resources, and feeling like their vote is inadequate – 33.5% of young people did not vote due to being too busy or conflicting work schedules (Youth Service America, 2010). This means that even if a young person is registered to vote they may be unable to. There are many reasons why so many young people do not vote, and one way to combat this is to assist those who are unregistered. The lack of registration further perpetuates the under-representation of youth concerns and interests. Each state has different requirements on voting age eligibility, election schedule, registration on the day of an election, and where citizens can register to vote (usa.gov, 2018). In Florida, citizens can register on or after their 16th birthday; whereas, California is 17, Georgia is 17 ½, and Alabama is 18

before or on election day (usa.gov, 2019).

The difficulties in registering to vote decreases the number of youth registered to vote, and, therefore, youth turnout at the polls. In some states, the voter registration age is determined by the election schedule. This means the citizen must be one age to vote in a local election but a different age to vote in a national election. The youth may be uninformed about the local or national election schedule. Consequently, many voters may miss the first election they can vote in because they do not know when to register. Missing a registration date results in votes not being casted and their political influence being unrepresented.

Youth voters may also be confused about the process because of the inequivalent distribution of resources. Voter registration drives are also disproportionally distributed based on socioeconomic status (Cherry, 2012). Areas in higher socioeconomic brackets receive more campaigning and financial resources, compared to those with a low socioeconomic status (Cherry, 2012). Those who live in poorer communities do not receive equal opportunities to be involved in politics as those in wealthy neighborhoods. Not only are those areas ignored by voter registration drives, but also they are forgotten by political campaigns on a local and national scale. This means that citizens do not receive equal opportunities to learn about politicians and their policies first-hand. This divide in communities shows that something new and equitable needs to be put in place. This creates a divide in youth voter registration even though the youth has already been detached from older age brackets in terms of voter registration. Although there are methods in place to help fix the voter registration process, there are many inefficiencies and problems that still need to be addressed and amended.

CURRENT METHODS

One of the methods to fix the problems in the youth voter registration process is civic learning and engagement through the public school system. One type of civic learning and engagement puts pressure on school systems to have effective social studies departments to teach students about politics and how to register to vote (Callahan, Muller, & Schiller 2010). Civic learning and engagement include voter registration, student debates, assisting in internships, etc. Teachers have the ability to distribute the paper voter registration form to their students or can assist them in registering online. Teachers are able to walk the students through the process and act as a resource. While this is a good solution to help increase voter registration, it is not accomplishing enough. The problem with civic learning and engagement through school systems is that the curriculum is outdated and ineffective. Students may be given the paper to register to vote, but they may not feel confident in their ability to interact with their political system or to vote. School-based civic education programs have been in decline over the past three decades (Galston, 2003). In the 1960s, it was common to have three social studies courses in high school, as compared to only one that is mandated today. Students have less access to civic learning than before. Schools that have more funding and more resources offer more courses compared to their counterparts in lower socioeconomic areas (Callahan, Muller, Schiller, 2010). The students of today are not being given the same opportunities as previous generations, which is causing the unprecedentedly low number of youth voters. Although civic learning and engagement appear to be a great idea to get youth registered to vote, outdated and dwindling social studies curriculums are not enough to increase modern voter turnout.

Another method that assists youth in the registration process is the National Voter Registration Act of 1993. Passed by Bill Clinton, the National Voter Registration Act affirms that all states offer voter registration opportunities at state Motor Vehicle Agencies. This act increased access to voter registration and awareness about registering to vote. The National Voter Registration Act helped to streamline and facilitate the registration process in an attempt to increase voter participation. When young drivers obtain their licenses, they are asked if they want to register to vote. The law states that the opportunity must be available at every MVA, not that everyone must be asked. When getting their license, many youths are not asked to vote. This may be because of time constraints at the MVA or employees forget to ask. Many people do not know that the MVA will register people to vote. Another problem is that the age requirements to vote in each state may not align with age requirements to obtain a license. For example, in Maryland, someone can get a learner permit at 15 years and 9 months, but they are not able to register to vote for months until they are 16 years old. This means that if a youth individual obtains their learners permit and is asked about registering to vote, they are unable to due to age qualifications. Although this legislation does help with increasing opportunities for voter registration, it was passed 26 years ago. This process is outdated and does not offer the same opportunities to modern youth as it has done for previous generations. As previously stated, only 21.3% of the eligible population voted (CIRCLE, 2011), so modernized and equitable solution needs to be implemented.

An additional method to fix the youth voter registration process is a voter pre-registration act. An author from the *University of Michigan Journal of Law Reform* proposed a national voter pre-registration act to eliminate the discrepancies in the state laws regarding voter registration age and establish a uniform national standard (Cherry, 2012). For example, every American citizen is able to register to vote on their 16th birthday. This uniform voter registration age would reduce the confusion around the age requirements and election schedules that have been previously stated. This appears to be a great idea to increase youth voter participation. While this sounds promising, this law will be struck down and will not be enacted by Congress. In the event that this national voter pre-registration act was passed by Congress, it would ultimately be declared unconstitutional by the Supreme Court. Democracy in the United States is established on the basis that states have individual liberties not directly incorporated into the Constitution. To make a uniform voter registration age, an amendment would have to be made to the Constitution. The national voter pre-registration act takes away from the power of the states. This act was proposed in 2012 and has gained no political traction or support due to its controversial nature. While the act would decrease confusion based on state discrepancies, something else needs to be put in place, due to the legal hurdles that the proposed legislation faces in many states.

AN APP

A voter registration app is the best way to increase youth voter registration. An app could clearly describe the steps to go through the voter registration process and allow citizens to register directly from their phones, computers, laptops, or tablets. The name of the app would be simple: National Voter Registration. Keeping the name of the app simple helps to ensure that its purpose is understood. An app would not be used to vote in either national or local elections, it would simply be for someone to register to vote. A voter registration app would be connected to the current online registration process. No data would be stored on the app; all data and records would go online. The National Voter Registration app will not require a login or account, the process to register will be fast and efficient. This app will keep everything simple, which helps

to eliminate the inefficiencies in the voter registration process.

The voter registration app will prompt a user through the following questions in order to ensure all information is received. The first question on the app will be a drop-down menu containing each state and Washington, D.C. This information is asked because each state has a slightly different set of requirements and age restrictions when registering to vote. The next question asks for citizenship status and if someone is living within the United States. This question will be a multiple-choice question. The variety of question types will be implemented to ensure user-friendliness. The next section requires more information and is collected with a blank section asking for name, date of birth, and social security number. In states such as Maryland, in order to verify the information, a person must next enter their license or identification card number to be checked for accuracy against the MVA records. Each state may have a different requirement for a license or identification card based off of the current online system. After a current address and mailing address are entered, users are able to select a political party or remain unaffiliated. This app is non-partisan and will contain no information regarding the benefits of any political party compared to that of another. Additional contact information such as a phone number or email address are needed in case there are any questions about the application. The user is then prompted with a multiple-choice question that inquires whether they have registered to vote before and if they would need assistance at the polls during voting. The user is then asked if they require an absentee ballot or if they would be voting near their home address. In the end, a user must sign an oath to ensure that the information is correct. After submitting all of the information a voter card will be sent to their mailing address.

THE BENEFITS OF THE NATIONAL VOTER REGISTRATION APP

Younger people spend an unprecedented amount of time on their phones. The Center for Generational Kinetics has stated that 95% of Generation Z, the youth of today, own a smartphone, and many had one before the age of 10 (Watson, 2018). With youth on their phones more than ever, an app for voter registration is simply bringing needed information to the most used platform. This app would be much more accessible compared to an in-person registration process. A smartphone app has the opportunity to change languages and therefore be able to reach more people than a traditional paper registration. An app is more conducive to schedules for those who are in school or work. Many cannot register to vote because they cannot get to the MVA when it is open, given the assumption that they are aware of the MVA registration option. An app will maintain the most accurate and up-to-date information in a platform that is familiar to today's youth.

Regardless of what type of smartphone a person owns, a voter registration app will be more user friendly compared to the tradition application. A smartphone app does not replace the current online voter registration websites; it increases accessibility to decrease the barriers that many citizens face. The most common programming language is Java for Android apps, and the most common programming language for iOS (Apple) apps is Swift (Chebbi, 2019). A programming language is used by the creator of the app to create the features that are needed for the app. Although there are different programming languages that are used for each type of phone, they share common features such as print size, language translations, and bright/dark mode. With a mobile app, users can adjust font size and zoom in. This is much more accessible to people who have impaired eyesight, compared to that of an on-paper registration. An app is also accessible to people who speak a different language. Through both Java and Swift programming systems, the language can be translated to eliminate any language barriers that may exist. Regardless of the type of phone or feature needed by the user, it can be coded and programmed creating a voter registration app that is the most effective way to get youth to register to vote. A voter registration app is more than just convenient, it is solving problems and assisting citizens with disabilities.

This app can be used by anyone, but it is designed to reach the unregistered youth population because younger generations are using technology significantly more than previous generations. Multimedia and internet services can create the most youth-friendly spaces. Youth individuals are more inclined to interact and be excited about something using technology compared to physically writing. New sources of technology can help to get this demographic interested and feeling more involved in politics (Lombardo, Skinner & Zakus, 2002). Bennet and Xenos (2005) stated that political websites are becoming increasingly aware of their youth engagement, but many do not offer links to voter registration sites. A voter registration app will rectify this by increasing accessibility to unregistered youths. Technology can be used to combat the ignorance of the political world (Applewhite & Taylor, 2010). The first step in becoming a civically engaged citizen is registering to vote.

An app is much more financially feasible when compared to other methods of voter registration. Estimates for app designing put the price between $40,000 (adc calculator, 2019) and $100,000 based on the complexity of the app (ZI digital studio, 2019). This may seem like an expensive figure for a single app, but this would be a one-time cost, with very minor changes needed to be made in the future. This is a modest cost to finance if the outcome is the registration of several million youth voters who are profoundly underrepresented. While this app is catered toward young people, it is also accessible to anyone regardless of their age. The United States Census Bureau stated that 61.3% of all Americans are registered to vote, while only 45.7% of youth (18-24) are registered to vote (United States Census Bureau, 2019). An app will help to increase voter registration for citizens of all ages, but especially those who are in the 18-29 age range. With anyone being able to register to vote, the price becomes much more manageable. A voter registration drive can be costly; in the 2008 election, the state of Oregon spent 8.8 million dollars on voter registration (Pew Charitable Trust, 2010); 8.8 million dollars on voter registration drive that only reaches one state is an astronomical price. An app has an upfront one-time startup cost, but it is far less expensive compared to voter registration drives and can register hundreds of thousands of people to vote. Due to the fact that the app would be free to download, it would be financially friendly to its users; the profit being made is all of the people now registered to vote.

SECURITY

Although many people are concerned about putting personal information such as their social security number online, there is a security method that can be used for personal data and information that is entered into an app. Some states have an online voter registration page where personal information is documented; because it is done through the state government, it is regarded as secure. The national voter registration app has to be as secure as the current online process to ensure the security of personal information. Any data that is entered into the app can be encrypted to decrease the probability of leaks. Coding and encryption guarantee increased security of personal information (IBM). Encrypting data means that any personal information, including passwords, social security numbers, and addresses, that are

entered will be scrambled (IBM). The numbers and letters are moved around so they no longer resemble the original input. This means that in the event that the data is stolen, the data would appear unreadable until unencrypted; a hacker would have no access to the encryption key, therefore rendering the stolen data useless. Encryption of private data and information is the same security method that NASA, Apple, and the FBI use to secure highly confidential information. This app will not contain a login or password because it is secure without one. A voter registration app is the safest and best method for citizens to register to vote.

SOCIOECONOMICS

The creation of this app would not replace the current voter registration methods. This app only increases the accessibility of voter registration to communities that are underrepresented in political affairs. In areas with low socioeconomic statuses, an app may not be possible due to the fact that some people in a low-income bracket cannot afford smartphones. There are programs, such as the Lifeline Program, in place for those citizens to receive smart phones through government assistance (Federal Communications Commission, 2020). This app may not be accessible to everyone in this demographic, but there are still other methods in place to help them, such as the National Voter Registration Act (1993). Anyone can go to the MVA to vote; while the National Voter Registration Act is not effective at promoting youth voter registrations, it can be effective for other populations. Also, due to the fact that there is currently an online voter registration process it can be accessed for free through any computer, such as those at a public library. An app is far less expensive compared to voter registration drives. This app does not require an app login or personal information to be saved, so the user does not have to own a phone; they can borrow someone else's to register. By charging money for the app, it would decrease accessibility, which is the opposite of the original intent. Keeping the app free will ensure that people of all socioeconomic classes will have equal access regardless of income. A voter registration app may not help people of all socioeconomic statuses, but it will increase accessibility to many.

MARKETING

In order for a voter registration app to be practical, citizens of the United States must know of its existence. Many of the inefficiencies in previous youth voter registration outreach programs was the fact that many citizens were unaware of the resources that were available. An app can be promoted through a QR code, a barcode that contains information (QR Code Generator), meaning anyone who has a smartphone can scan access it. These codes can be attached to a link on how to download the voter registration app, after scanning that code, any citizen can register to vote immediately. Another marketing strategy is online campaigns. It has already been shown that adolescent individuals respond best to information on a technological platform. Ads can be made and shared through a variety of websites such as social media sites or any site that offers commercialized ad spaces. By having an ad of an app on the platforms that youth use the most, they will be most likely to use it and register to vote. Creating ads that inform youth individuals about this voter registration app on social media platforms would substantially increase the marketing awareness. A third marketing strategy to increase usage of a voter registration app is through colleges. Many college students fall into the 18-29-year-old category. This is the demographic that is trying to be reached through marketing strategies. Some of the strategies include putting up posters in dorm buildings. Messages and advertisements could be placed in campus bulletins or on campus television stations. Many colleges partake in a club fair involving tables set up for each club and campus organization. A table can be set up to distribute flyers and information while reaching the largest number of involved students. There could also be visiting representatives visiting classrooms in the business or political science classes. College students are also able to spread information and interest about the app by talking to their peers as well as their family members.

WHY MARYLAND IS THE BEST PLACE FOR IMPLEMENTATION

Maryland is the best place to implement the voter registration app due to the fact that it is "America in miniature." Maryland as a state it is incredibly diverse and is home to people from all walks of life. There are a variety of jobs that Marylanders have, including public services 82%, manufacturing 9%, construction 7%, and agriculture 2% (Maryland Office of Tourism Development, 2020). With this amount of diversity, Maryland's implementation of this app could increase voter registration from people with various ethnical backgrounds, thus, resulting in a vast range of represented views. The promotion of the voter registration app in Maryland could be used as an example for a national version of the app. Maryland is the best place to see how all demographics will respond to the app. Based on preliminary data, it can be shown where new developments could be made in marketing or in the software of the app itself.

Maryland is home to world-renowned colleges and universities. This is perfect for the voter registration app because it is directed at youth aged 18-29 years old. In 2012, "79% of college students were aged 18-24" (Marketing Charts, 2013). The universities in Maryland create a perfect environment for youth voter registration. College is where many intellectual conversations happen and people begin to form their political views; a voter registration app is the best way to increase youth voting so they can make sure their views are heard by the elected officials. Maryland colleges have very diverse programs that help to produce well-rounded members of society. With many academically exceptional colleges and universities, Maryland is the perfect place to implement an app designed to appeal to intelligent youth individuals.

CONCLUSION AND FUTURE STUDIES

There is a youth voting crisis that is affecting the ambitions and necessities of many young citizens. The inefficiencies in the youth voter registration process further the social injustices of those who are not privileged. If a large population of the country does not vote, then their views will be disproportionately represented. The current methods that are attempting to rectify this crisis have failed to produce the effective results. An app increases accessibility to voter registration and provides a starting point for political involvement. There is only one way to fix the voting crisis. Everyone should have access to voter registration. Ensuring that the youth of today is able to register to vote has become imperative for fostering equitable representation. Another step in this study is making a prototype of the app and presenting at an entrepreneurial conference. An app could later be expanded to include a section to find local delegates, ways to contact politicians, and a map of the legislative districts. The government needs to develop and support a voter registration app in order to reach the youth of today and ensure that everyone has the opportunity to register to vote. The year 2020 is the start of a new decade in which we must move forward with new technology and new opportunities for all.

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The Definition of Grammar in the Writing Center: A Research Study

Allison Guy

ABSTRACT

In the context of a writing center, "grammar" can mean many different things. This project focused on what grammar means specifically to writing center consultants and students who use the Salisbury University Writing Center. This study looked at questions such as: When students come into the writing center to work on grammar, do they actually want to work on grammar? If not, what would be a better way to define what they want to work on? A 10-question survey was designed for both Salisbury University Writing Center consultants and students who visit the writing center to assess other terms they associate with grammar and what students who want to work on grammar end up working on during writing center sessions. This study found that both consultants and student writers associate especially the term "clarity" with grammar, but also associate the terms "flow" and "organization" with grammar. The results of this study reveal that writing center consultants should continue to think of grammar as a flexible topic in tutor training and in conversations with student writers who visit the writing center.

INTRODUCTION

A writing center is a place where student writers can meet with trained consultants to discuss their writing. Students primarily attend writing center sessions in order to improve their writing. During these sessions, there are a number of aspects of writing that students and writing center consultants work on, including content, organization, and tone/voice/style. Grammar is one of the main reasons students state for coming to writing centers, but writing center consultants aren't sure that students all mean the same thing when they indicate this, since grammar is a familiar term that can be interpreted broadly. So, what does the concept of grammar mean to students who use writing centers?

Composition research has primarily focused on whether grammar instruction helps or harms students' writing. According to Richard Braddock, Richard Lloyd-Jones, and Lowell Schoer, "the teaching of formal grammar has a negligible or, because it usually displaces some instruction and practice in composition, even a harmful effect on improvement in writing" (qtd. in Hartwell 105). In other words, composition instructors should not teach grammar if they want to improve students' writing. Braddock et al.'s sentiment is echoed in Rei R. Noguchi's *Grammar and the Teaching of Writing*, in which Noguchi analyzes and questions the results of existing literature on the topic of grammar and writing improvement: "Assuming that such studies are valid and reliable, why does formal instruction in grammar fail to produce any significant improvement in writing quality?" (3). While some research studies show that grammar instruction fails to improve students' writing, some composition instructors advocate for grammar instruction in the writing classroom. One such instructor is Gail Lewis Tubbs, who argues that "People who write should know their tools ... None of this knowledge inhibits their creativity or dampens their responsiveness to intuition; rather it provides the discipline to support and enrich the art" (3). People such as Tubbs are labeled "grammarians," while composition instructors who are against teaching grammar for the improvement of writing are "anti-grammarians." Despite Patrick Hartwell's call that "it is time that we, as researchers, move on to more interesting areas of inquiry" other than grammar and its influence on writing instruction, the debate over the importance of grammar remains strong (127).

Some anti-grammarians have downplayed the role of grammar when it comes to good writing and instead believe that other facets of writing, such as content and structure, are more important than grammar. According to John Bean and Maryellen Weimer, it is more beneficial for students when their teachers give revision-oriented feedback than editing-oriented feedback (82). Revision-oriented feedback "largely ignores sentence errors and concentrates on ideas and structure ...," while error-oriented feedback occurs when "the teacher identifies and circles errors, often with few comments (or none) about ideas or structure" (Bean and Weimer 82). This view decreases the role of proper grammar and mechanics and instead places emphasis on ideas. Others, such as writing center tutor Jennifer Beattie, have stated that grammar is only part of the equation when it comes to effective writing: "I still believe that good grammar is a key to good writing; it provides clarity and understanding for the reader. However, I now know that it is only one of many keys" (11). Beattie's claim goes against the view that many students have been taught: that good grammar is the most important element of good writing. Thus, with the importance proper grammar has been given, it is no surprise that many students come into writing center sessions with the intention of working on grammar. With the limited scope that these researchers have given grammar, referring to it as the structure of the English language and rules for usage, how do students define grammar?

One potential solution to this question lies in the connection between grammar and style. Some researchers have pointed out the intersection between these two concepts. Noguchi hypothesizes that "Although students make many kinds of errors in writing (e.g. errors in content, organization, and style), grammar, as it is presently conceived and practiced, can aid most in remediating errors pertaining to style" (32-33). Benjamin Dreyer points out the close intersection between matters of grammar and matters of style: "And that's how I learned to copyedit ... by taking note of the sorts of flaws, ranging from more or less inarguable errors of grammar to more or less arguable missteps of style and taste, and how copy editors addressed them" (XV). Even Joseph M. Williams and Joseph Bizup's *Style*, which is aimed at improving writers' sense of clarity and style, acknowledges the intersection between these ideas and grammar, asking that before writers read the book, they be familiar with grammatical terms such as "subject," "verb," and "noun" (vi). Perhaps students view grammar as a concept that is closely related to style.

Other researchers have focused on how grammar is or should be taught in the writing center or classroom. There is a disconnect between how grammar

should be taught in the classroom and how it is actually being taught. Because of this disconnect for teachers, there is also a disconnect for students. Students often misuse the term "grammar" because teachers are also confused on what they should be focused on when they are instructed to teach grammar. Because of this, we as researchers need to more closely examine and possibly rework the language surrounding grammar in the context of the writing center, a place where change can occur through one-on-one interaction. English teacher educator Leah A. Zuidema suggests that teachers expand the language contexts in which grammar instruction is taught: "Furthermore, as composers of everything from academic papers to YouTube videos, social text messages, workplace emails, and tweets calling for civic change, young writers benefit from having a more conscious command of their words" (63). Peter Smagorinsky, Amy Alexandra Wilson, and Cynthia Moore call for those who train teachers to give them more pedagogical preparation in the areas of writing and grammar (289-290). Still other studies, such as Ellen Schendel's "We Don't Proofread, So What Do We Do? A Report on Survey Results," find that "tutors' confidence level in working with writers on grammar and mechanics rules influences how frequently and in what ways they help writers with grammar and mechanics" (2).

However, the existing research fails to address the key question of how writers and consultants view the term "grammar" in the context of the writing center. For instance, when students come into the writing center to work on grammar, do they actually want to work on grammar? If not, what would be a better way to define what they want to work on? When consultants meet with students in the writing center who want to work on grammar, what do the students and consultants actually end up working on? And, finally, how can writing center consultants best assist writers who come into writing centers wanting to work on grammar (i.e. subject-verb agreement, parts of speech, punctuation, etc.)?

The rest of this study is divided into three sections: Methods, Results and Analysis, and Conclusion. In Methods, background information on the place of research and the survey questions used to collect data are given. Results and Analysis focuses on the feedback from the survey questions and the author's analysis of that data. Finally, the conclusion explains how the results of this study inform writing center studies as a whole.

METHODS

Two groups of people filled out a survey: writing center consultants and student writers who used the Salisbury University Writing Center, or UWC. The UWC makes writing assistance available to all students at Salisbury University. Most sessions consist of one consultant and one student, though groups of students can make appointments with a consultant. At the time this study was written, the UWC had 17consultants, including 13 peer consultants and four professional consultants. Before they can begin working at the UWC, newly hired consultants must take a class that trains them on how to tutor.

Surveys focused on participants' academic and linguistic background, how long consultants and students had been working or attending sessions at the UWC, respectively, how they viewed themselves as writers, and how they viewed the concept of grammar during their sessions. Surveys were created using the Qualtrics platform and were distributed via email from the middle of April to the beginning of May 2020. The consultant survey link was emailed to the author's coworkers at the UWC, and the student writer survey was emailed to every writer who had attended a UWC appointment over the span of approximately three weeks[1].

The first five questions were demographic questions, while Questions 6 and 7 used a Likert scale to indicate to what degree those being surveyed agreed with statements about writing. Questions 8 through 10 asked about consultants' and students' perceptions of grammar. Bold formatting was used to differentiate the survey questions, since they are similar in scope, so respondents would be clear that one question was asking about perceptions (what writers wanted to work on), and one question was asking about the actual session focus (what ended up being worked on during the session). Below is the survey for consultants and then the survey for student writers. Differences between the two surveys are shown in italics.

Figure 1: Survey given to writing center consultants.

UWC Grammar Survey - Consultants

1. What is your *academic year/classification*?
   - Freshman
   - Sophomore
   - Junior
   - Senior
   - Graduate Student
   - *Professional Consultant*
2. What is your major, or *what is your most recent degree in*?
3. How long have you been *working at the University Writing Center*?
   - 1 semester
   - 2 semesters
   - 3 semesters
   - 4 semesters
   - 5+ semesters
4. Is English your first or home language?
   - Yes
   - No
5. What additional languages do you speak or write, if any ?
6. I write often.
   - Strongly Agree
   - Agree
   - Neutral
   - Disagree
   - Strongly Disagree
7. I consider myself to be a good writer.
   - Strongly Agree
   - Agree
   - Neutral
   - Disagree
   - Strongly Disagree
8. When *students* come into the UWC wanting to work on grammar, are there any other words that describe this same concept that *they* **want to work on**?
   - Clarity
   - Flow
   - Tone/Voice/Style
   - Organization
   - No other term
   - Other
9. Of all the *students* who come into the UWC wanting to work on grammar, for what percentage (%) of them, in your estimation, is there another word to describe what *they* **want to work on**?
10. When *students* come into the UWC wanting to work on grammar, are there any other words that describe what you both **end up working on** ?
    - Clarity
    - Flow
    - Tone/Voice/Style
    - Organization
    - Other

Figure 2: Survey given to student writers.

UWC Grammar Survey

1. What is your *academic year*?
   - Freshman
   - Sophomore
   - Junior
   - Senior
   - Graduate Student
2. What is your major *or area of study*?

   [ ]
3. How many times have you *come to the University Writing Center*?
   - 1 time
   - 2 times
   - 3 times
   - 4 times
   - 5+ times
4. Is English your first or home language?
   - Yes
   - No
5. What additional languages do you speak or write, if any?

   [ ]
6. I write often.
   - Strongly Agree
   - Agree
   - Neutral
   - Disagree
   - Strongly Disagree
7. I consider myself to be a good writer.
   - Strongly Agree
   - Agree
   - Neutral
   - Disagree
   - Strongly Disagree
8. When *you* come into the University Writing Center wanting to work on grammar, are there any other words that describe this same concept that *you* **want to work on**? (Check all that apply)
   - Clarity
   - Flow
   - Tone/Voice/Style
   - Organization
   - No other term
   - D on't work on grammar in UWC
   - Other

   [ ]
9. Of all the times *you* have come into the UWC wanting to work on grammar, in what percentage of these visits, in your estimation, is there another word to **describe what *you* want to work on**? (See number 8)
   - % [ ]
   - N /A (I never come into the UWC wanting to work on grammar)
10. When *you* come into the UWC wanting to work on grammar, are there any other words that describe what you and the consultant both **end up working on**? (Check all that apply)

    Clarity
    Flow
    Tone/Voice/Style
    Organization
    Other

    [ ]

In terms of year, there was a representative sample of consultants – at least one from almost every seniority level[2] (sophomore, junior, senior, graduate student, and professional consultant). There was a representative sample of class years in not only the consultant survey but in the student writer survey as well. Of the 12 respondents, there was at least one for each year (freshman, sophomore, junior, senior, and graduate student).

RESULTS AND ANALYSIS

Once data collection was complete, the response rates for the consultant and student surveys were 35% (six out of 17) and 17% (12 out of 72), respectively. Microsoft Excel spreadsheets and the Qualtrics platform were used to analyze the data. The first round of analyses involved discerning popular answers to each of the survey questions. The second round of analyses involved analyzing whether certain categories, such as speaking a foreign language, caused survey respondents to answer in ways that were different from the rest of their peers.

Consultant Survey Analysis

When going through the survey results, the consultant survey was analyzed first. All respondents indicated that their major or most recent degree was in English, communication, education, or rhetoric and composition. The majority of respondents were English students. Additionally, the data indicate that there was a very even divide between how long consultants have been working at the UWC. Half of the respondents had been working for two semesters, while the other half had been working for five or more semesters.

Despite the differences between consultant responses, there were some similarities. All said English was their first or home language, though three consultants indicated that they knew a foreign language, either Spanish or American Sign Language. All respondents indicated "Agree" or "Strongly Agree" to Question 6, "I write often." Additionally, all respondents indicated "Neutral," "Agree," or "Strongly Agree" to Question 7, "I consider myself to be a good writer." Half of the respondents selected "Strongly Agree." Another similarity can be found in the results of Question 8, which asks, "When students come into the UWC wanting to work on grammar, are there any other words that describe this same concept that they **want to work on**? (Check all that apply)." Two-thirds of the respondents selected "Clarity," while half selected "Flow." However, these two terms were not the only responses. Respondents also selected "Tone/Voice/Style," "Organization," and "No other term."

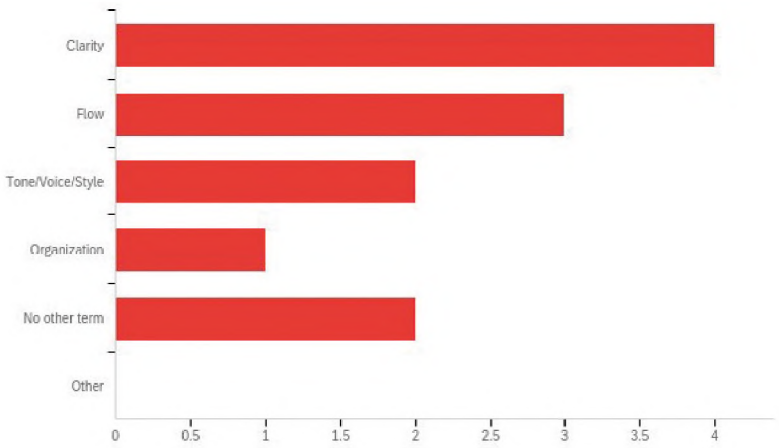

Figure 3: Consultant responses to Question 8, "When students come into the UWC wanting to work on grammar, are there any other words that describe this same concept that they **want to work on**?"

Responses varied for Question 9, "Of all the students who come into the UWC wanting to work on grammar, for what percentage (%) of them, in your estimation, is there another word to describe what they want to work on?" The consultants typed in a numerical

percentage for this question, and their responses ranged from 0% to 80%. Interestingly, two-thirds of the responses ranged between 70% and 80%. The answers to Question 10, "When students come into the UWC wanting to work on grammar, are there any other words that describe what you both end up working on? (Check all that apply)" showed a greater degree of similarity. Eighty-three percent of consultants chose "Clarity" and "Organization." "Flow" was another popular category, with two-thirds of consultants choosing that as well. One-third of consultants chose "Other," and their responses were "Diction" and "Thesis/Argument."

There were differences in survey responses depending on how the consultants responded to the demographic questions. For instance, those who had been tutoring for five or more semesters, two of whom were the graduate student and professional consultant, all indicated "Clarity" for their answers to Questions 8 and 10, which dealt with what students mean when they come into the UWC wanting to work on grammar and what students and consultants actually end up working on in these scenarios, respectively. Additionally, the only people who answered "no other term" for Question 8 were undergraduate consultants who had been tutoring for two semesters. However, interestingly, for Question 10, they answered, respectively, "Clarity," "Flow," "Tone/Voice/Style," "Organization," and "Flow," "Organization," "Other," writing in "Thesis/Argument." This shows that even consultants who view students that want to work on grammar as just wanting to work on grammar acknowledge that they as consultants end up working on more than just grammar with these students.

The data also indicate that speaking a foreign language had an influence on how consultants answered the survey. The only significant area of difference between consultants who spoke a foreign language and those who didn't was found in the answer to Question 10. Of the consultants who spoke a foreign language, all answered at least "Clarity" and "Organization" to Question 10, "When students come into the UWC wanting to work on grammar, are there any other words that describe what you both **end up working on**?" Two of the three answered "Clarity," "Flow," "Tone/Voice/Style," and "Organization." Perhaps consultants who speak a foreign language end up working on more than just grammar with student writers who come into the writing center wanting to work on grammar because they view language in more flexible ways than their only-English-speaking consultants.

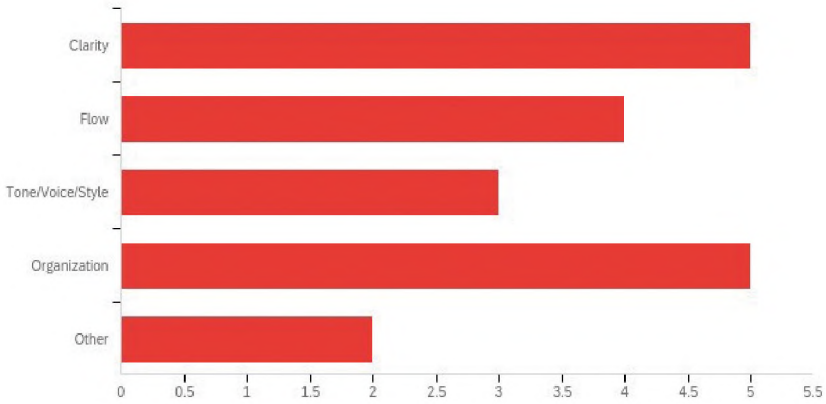

Figure 4: Consultant responses to Question 10, "When students come into the UWC wanting to work on grammar, are there any other words that describe what you both **end up working on**?"

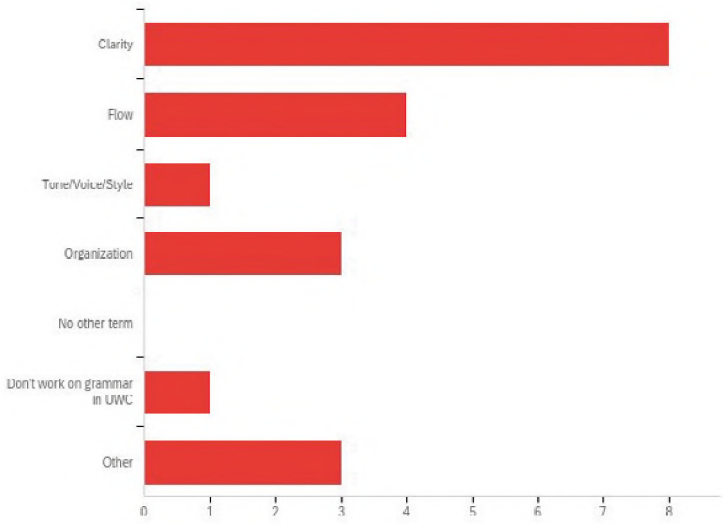

Figure 5: Student writer responses to Question 8, "When you come into the University Writing Center wanting to work on grammar, are there any other words that describe this same concept that you **want to work on**?"

Student Writer Survey Analysis

The respondents' majors/areas of study were highly diverse, ranging from elementary education to biology to communication. The number of times writers had come to the writing center also ranged greatly, with five respondents indicating that they had come to the University Writing Center just one time, three respondents indicating that they had come to the UWC more than five times, and the rest of respondents falling somewhere in between those extremes. Finally, student writers also reported a moderately high level of language diversity. Although English was the home language for all but one of the respondents, half of the respondents (six out of 12) indicated that they spoke another language. These languages included Spanish, French, Swahili, and Kikuyu.

Despite these differences, the next three questions revealed commonalities across student writers. For Question 6, "I write often," 50% of students responded "Strongly Agree," while the other 50% responded "Agree." Question 7 echoed this similarity. The question read, "I consider myself to be a good writer." All the respondents answered "Neutral," "Agree," or "Strongly Agree," with a majority of respondents (seven out of 12) selecting "Agree." Finally, Question 8, "When you come into the University Writing Center wanting to work on grammar, are there any other words that describe this same concept that you **want to work on**? (Check all that apply)" revealed a surprising level of similarity between

respondents. Two-thirds of student writers indicated "Clarity" as their response to this question, although for some respondents, their answer included other terms, such as "Flow," "Tone/Voice/Style," and "Organization." Surprisingly, no respondents selected "No other term" as their answer. Of those students who selected "Other," their responses indicated wanting to work on sources and format.

Responses for the next questions varied. Question 9 read, "Of all the times you have come into the UWC wanting to work on grammar, in what percentage of these visits, in your estimation, is there another word to **describe what you want to work on**? (See number 8)." Of the seven out of eight students[3] who indicated that they have visited the writing center wanting to work on grammar, responses ranged from 50% to 100%. Responses varied for Question 10, "When you come into the UWC wanting to work on grammar, are there any other words that describe what you and the consultant both **end up working on**? (Check all that apply)," as well. Of the answer options, "Clarity," "Flow," "Tone/Voice/Style," "Organization," and "Other," there was at least one respondent who selected each of the options. "Clarity" was a popular category, with two-thirds of respondents indicating that during writing center sessions where they want to work on grammar, they and the consultant work on clarity. The second-most popular option was "Flow." Half of respondents chose this option.

Although the findings from the student writer survey were interesting, there were not any specific patterns that could be analyzed in the same way as with the consultant survey, except that for the most part, students self-identified as good writers. All students answered "Neutral," "Agree," or "Strongly Agree" to Question 7, with ten of 12 respondents answering "Agree" or "Strongly Agree." This dispels the myth that students who feel they are poor writers use writing centers the most. These results also potentially show that it is not a lack of confidence that leads to writers asking consultants for help on grammar.

One of the differences between the two surveys was the level of language diversity that respondents showed. The student writers who visited the University Writing Center exhibited a greater level of language diversity than did the consultants who answered the survey. Additionally, while there were two consultants who indicated that students who wanted to work on grammar in the UWC don't intend to work on any other facet of writing, the students themselves disagreed. No student writers selected "No other term" to Question 8, "When you come into the University Writing Center wanting to work on grammar, are there any other words that describe this same concept that you want to work on?" Another difference between the two surveys can be found in the answer to Question 10, which asked what consultants and writers actually end up working on during sessions where writers want to work on grammar. Five out of six of the consultants said that during these sessions, they end up working with students on organization. This response differed from the student writer survey, in which only one-third of respondents indicated that during these sessions, they work with the consultant on organization. This shows a differing perception between consultants and writers on how often and in what contexts they work on organization.

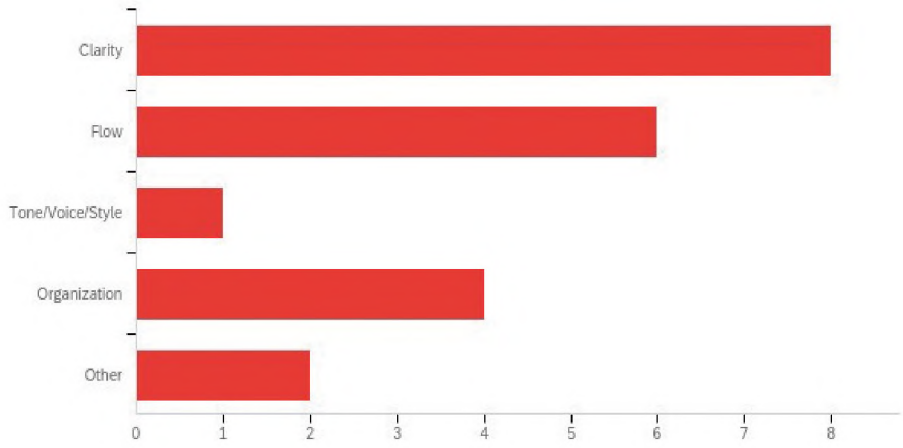

Figure 6: Student writer responses to Question 10, "When you come into the UWC wanting to work on grammar, are there any other words that describe what you and the consultant both **end up working on**? (Check all that apply)."

Consultants feel that more areas are covered. Perhaps this is because they have a more nuanced understanding of writing-centered terminology than writers do. Or, alternatively, maybe student writers come into writing centers with certain goals in mind and feel that these goals are met post-session without considering other aspects of writing that they may have also worked on during their sessions.

Despite their differences, the consultant survey and the student writer survey shed light on some similarities between those who tutor in the writing center and those who visit it to gain writing help. For instance, for the vast majority of respondents, English was the language spoken at home. Only one of 18 total respondents answered "No" for Question 4, which asked, "Is English your first or home language?" Additionally, all of the survey respondents answered either "Agree" or "Strongly Agree" for Question 6, "I write often." This pattern was echoed in Question 7, "I consider myself to be a good writer." The entirety of survey respondents answered either "Neutral," "Agree," or "Strongly Agree" to this question. Finally, both consultants and student writers frequently indicated that students wanted to work on clarity during sessions where they also wanted to work on grammar. Not surprisingly, during these sessions, they actually ended up working on clarity as well.

The most notable result is that both consultants and student writers indicated that the concept of grammar is closely tied with the concept of clarity. "Flow" and "Organization" were other popular terms among both groups used to describe what students want to work on and what consultants and students actually end up working on. This is interesting because grammar is often thought of as being rule-driven, but clarity can be more connected to context or genre. For instance, a clear argumentative essay written for a general audience would be much different from a clear lab report written for an audience of scientists. Flow and organization are similarly universal terms that often depend on audience and genre.

CONCLUSION

The results show that the traditional conceptual boundaries between grammar and other areas of writing are perhaps more porous and flexible than composition instructors and students realize. In a lot of students' and writing consultants' minds, grammar is not only grammar – it also encompasses, or it is closely related to, clarity, flow, and organization. This speaks to how students and consultants experience many aspects of language as being interlinked, affecting one another. It is hard to separate out grammar, for

instance, from clarity or flow.

This survey also hints at the need to revise language surrounding grammar instruction. These results indicate that many students come into writing centers wanting not only to work on grammar, but also wanting to work on organization, clarity, flow, or even tone/voice/style. If students were more aware of terms to describe writing other than grammar, perhaps they would come into the writing center with a clearer way to describe what they really want to work on during their sessions, whether they want to work on grammar and additional concepts or whether they find that grammar is not the best word to define what they want to work on.

Additionally, the results of this study suggest that writing center tutors could be trained differently and more effectively on the topic of grammar. Though "grammar" means different things to different people, it is traditionally taught to consist of prescriptive rules that include correct subject-verb agreement, verb tenses, and the like. However, this study implies that it would be helpful for tutors to be trained to think of grammar as a concept that, for many students, encompasses not only these prescriptive rules but also clarity, flow, and even organization. Tutors should also be encouraged to clarify with student writers on what exactly they want to work on when they come into a writing center wanting to work on grammar.

However, this study does have its limitations. For instance, only 18 people completed both surveys, even though the surveys were sent to 89 people in total. A more representative sample size may have changed the results. Also, this study only addresses what student writers who visited a college writing center associate with grammar. It does not address what student writers in general think of the concept of grammar and its relationship to other terms.

This study reveals that researchers and writing center consultants could ask even more questions on the topic of grammar through data-driven research. Some additional questions for future research are: Why do students so frequently come into the writing center wanting to work on grammar? Do students enjoy working on grammar? And, finally, what are the most effective practices for writing center consultants to use when working with writers on grammar? These questions could be addressed in a follow-up study in which student writers' attitudes toward grammar instruction are examined, either through a survey or interviews. Based on the results of this study, though, writing center consultants should continue to think of grammar as a porous, flexible topic in tutor training and in conversations with students who visit the writing center.

ENDNOTES

[1] Data collection occurred during a period when all of Salisbury University's classes and writing center sessions were online due to the COVID-19 pandemic. However, survey respondents were not limited to only discussing their online experiences.

[2] Although the Salisbury University Writing Center will hire students of any year, those who are hired as freshmen do not start working until they are sophomores.

[3] There were 12 total students who filled out the student writer survey, but only eight students responded to Question 9.

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The History, Lifecycle, and Importance of the Hawaiian Language: An Overview

Madison Baloy

ABSTRACT

The history and importance of language use in the Hawaiian Islands is often overlooked. This paper offers a literature review, compiling seven peer-reviewed publications in an effort to aid in recognition of the importance of the Hawaiian language. A brief overview is provided of Hawaii's national and linguistic history. The importance of minority language preservation is highlighted, along with the significance of Hawaiian language maintenance within classroom environments. Hawaii is proposed as a nation of relevance for linguistics as linguists push toward a deeper understanding of the lifecycle of a language, while the language discussed encompasses all aspects of a language's lifecycle. Further, this review recognizes and identifies the effects of colonization on the Hawaiian Islands and the debt still owed to the Hawaiian people. The history of the Hawaiian language is analyzed and offered as a necessary tool in curriculum, so as to recognize the importance of minority languages. As we define language as being a primary factor in identity formation, this review explores the importance and responsibility to ensure a prosperous future for the Hawaiian language.

INTRODUCTION

The implications of colonization of the Hawaiian Islands is an aspect of Hawaiian culture that often goes overlooked. When considering Hawaii, it is easy to envision a tropical paradise of beaches lined with coconut-studded palm trees. To a person with limited knowledge of the Hawaiian Islands, the history of acquiring Hawaii as the United States' 50th member may not be of any concern. Someone with a partial understanding of the Islands' backstory may be familiar with the American imperialism on the islands and the seizure of native land by white Americans. Even still, one key factor of Hawaiian culture still holds a history unknown to many: the extinction and revitalization of the Hawaiian language.

Language is an essential part of identity in all beings. Language is the meaning-making tool that we use to define ourselves, our peers, and all aspects of our world. Our language holds as the sole communicative piece that allows us to demonstrate who we are and what we believe in. Monolinguals are able to take pride in their singular model, while bi/multilinguals are able to foster a home within multiple tongues. Language acts, not only as a vehicle for communicating identity, but as a means for shaping identity as well (Bucholtz & Hall, 2005). In sociolinguistics and the related scholarship on language in society, it is understood that language lays hand in the construction and recognition of power or marginalization within a person (Mohanty, 2010). These patterns are observed often within the power dynamic. Take, for example, an American man who has become fluent in Chinese – this man may be thought of as a well-rounded business executive with international appeal. Take also, a Mexican American woman with Spanish as her first language whose bilingualism is not viewed with such notoriety. Power held within a language shifts the power-dynamic held within individuals and their communities as they construct their identity around language (Bourdieu, 1991). With this, the conclusion is drawn that language embodies key aspects of developing an image for oneself, whether that be personality construction or marginalization patterns. It is then easy to understand why the robbery and forced extinction of the Hawaiian language created such a rift within Hawaiian culture and people.

Following the Hawaiian annex of 1898, the Hawaiian language was outlawed. With a language death looming, we follow the lifecycle of a language, from extinction, into a renaissance, and into a resurgence as an integral part of the Hawaiian Islands. This observation follows the history of the Hawaiian language, commenting on different impacts of language loss and the importance of fostering bilingualism in native languages within a Hawaiian classroom. Separately, this literature review acts as acknowledgement for the culture-stripping and white washing of Hawaii's history, as readers examine the importance of Hawaiian bilingualism.

HISTORY OF HAWAII

The Hawaiian Islands were first established by Polynesian settlers as early as 400 CE (Smithsonian, 2007). Prior to 1778, the Hawaiian Islands remained untouched by European settlement. Islands were a flurry of picturesque landscapes, rich in culture and native life. Hawaii implemented a monarchy and held a long history of ruling via kings and queens. In 1778, James Cook landed on the island of Kuai, making him the first European to set foot on Hawaiian territory.

In *Captive Paradise*, James L. Haley details that Hawaii existed as a monarchy, and from 1791 to 1810, it was ruled by King Kamehameha (2015). This king unionized all of the islands under his rule to form one large, overarching ruling. The monarchial lineage continued into the reign of King Kamehameha III. During this ruling, Christian missionaries arrived on the islands. The imposition of Christian practices soon stripped away many native Hawaiian cultures and practices. Colonizers continued to arrive in support of James Cook, with efforts and intentions to back Cook's ideas of a sugar-based economy. At the time of Cook's arrival, the Hawaiian population was around 300,000 people. Following the spread of diseases accompanying colonization, by 1853, the native population dwindled at 70,000 Hawaiians.

During the ruling of King Kamehameha III, Hawaii converted into a Christian monarchy upon the signing of the 1840 Constitution. Missionaries remained active within the kingdom (Haley, 2015). Following Cook's visit to the Islands and his many publications detailing the beauty and idealism of the Islands, adventurers, traders, and European tourists were attracted to the

area. Visitation to the Islands resulted in a consistent decrease of Native Hawaiian population, due to disease, famine, and wars. In 1887, the Constitution of the Kingdom of Hawaii was signed, stripping the Hawaiian people of any ability to vote, as the Islands were now recognized as an American Republic. White Islanders were allowed to vote, leaving Native Asians disenfranchised. During the 1890s, Hawaii's last ruler, Queen Lili'uokalani, was imprisoned by American peoples and forced into abdication. The United States annexed Hawaii as a territory in 1898, signing it into statehood in 1959. In 1993, the United States released an official apology to the Hawaiian people for the illegal overthrow and seizure of the Hawaiian Islands (Haley, 2015). Understanding the history of Hawaii allows for one to have a better understanding of the Islands' linguistic timeline.

HAWAII'S LINGUISTICS HISTORY

The exile of the Hawaiian language was not proposed in malice, rather, it was presented through lenses of optimism. In 1895, the Bureau of Public Instruction of the Republic of Hawaii was released, stating: "The gradual extinction of a Polynesian dialect may be regretted for sentimental reasons, but it is certainly for the interest of the Hawaiians themselves," (Wilson & Kamanä, 2006). This proclamation was instated by the colonizers who overthrew Hawaii. The Hawaiian language, at least as a tool for educational purposes and instruction, was outlawed on the Hawaiian Islands. Learning, speaking, and sharing Hawaiian was completely outlawed on the Islands. That same year, a small group of Hawaiians established a secretive collection of schools, 'Aha P nana Leo (the language nest),' (Neason, 2016). By the early 1980s, less than 50 native people under the age of 18 spoke Hawaiian. Had it not been for its renaissance during the 1970s, Hawaiian may have gone completely extinct.

The Hawaiian Language Renaissance of the 1970s served as a second wave of Hawaiian vitalization. It acted as a surge amongst indigenous Hawaiian peoples in efforts against falling victim to Western colonization. This language renaissance served as a thrust toward also promoting a cultural renaissance within the same timeframe, encouraging the reinstatement of native Hawaiian practices. A new wave of Hawaiian chants, dances, and songs were celebrated around the islands – more importantly, a resurgence of Hawaiians taking interest in their native language emerged.

A constitutional amendment was not made until 1978, following a nearly 100-year-long language ban, reinstating Hawaiian as one of the state's two official languages, sharing the title with English. With numbers still low and cultural pride increasing, Hawaiians turned toward this new amendment in efforts to revitalize their language to its original popularity. Hawaii's first language immersion schools began to open in 1984 (Nakata, 2017). While state language still existed as primarily English, native Hawaiians were now integrating Hawaiian as part of their home language and encouraging their children to practice the Hawaiian language. Despite the excitement surrounding Hawaiian language integration, controversy was met within the new Hawaiian pedagogy. Despite the ability for Hawaiians to now enroll their children in immersion schools, a large concern emerged from the fear that their children would not be able to compete in an Americanized English-based job market.

With optimism, Hawaiian parents made the decision to continue enrollment in Hawaiian-medium classrooms. This learning style offers instruction in Hawaiian, allowing parents the ability to immerse themselves within the Hawaiian language and culture entirely. Today, the Hawaiian language has been brought back to life, serving as a primary example of a minority-language's lifecycle. Now, Hawaiian parents have the option of enrolling children in K-12 Hawaiian curriculum, and the University of Hawaii at Hilo offers several degrees taught in Hawaiian (Nakata, 2017). Despite the repairs the language has undergone within the last 40 years, Hawaiian still faces several challenges in solidifying itself as an official language in practice. Hawaiian is still not recognized in state or legal practices, and many ordinances on the Islands are only provided in English. The following sections of this literature review aim to highlight the importance of encouraging bilingualism in Hawaiian classrooms (Nakata, 2017).

IMPORTANCE OF MINORITY LANGUAGES

Language inequality is present when one language is viewed to be powerful, while another is considered 'weaker.' Further, diglossia is understood as when two languages are spoken under different conditions within a community, or when a single language is used in two varieties. These two options will often lead to the perception as a 'desirable' and 'undesirable,' or 'high' and 'low' language forms. When considering the concept of diglossia in linguistics, it is important to understand it from its starting point: inequality (Higgins, 2015). Hawaiian is currently holding the shared title of the state's official language, along with English. The combination of English and Hawaiian is known as Pidgin, Hawaii's Creole, or Hawaiian English, and it is seen to be worth much less than monolingual English in the eyes of many. It is important to highlight the understanding of mainland English versus Hawaiian English and the praise received by the former with its ties to punishing the latter. Higgins analyzes Hawaiian from a diaglossic standpoint as she makes her claims toward the mistreatment of the language (2015).

Many of the biases toward Hawaiian English come from the idea of Hawaiian being a minority language. A minority language may be thought of as a language with few speakers, or as a language not able to be used to produce a large amount of money. The idea of minority vs. majority languages is a racist and classist mentality, but because of the prevalence of the notions surrounding majority and minority languages, it is necessary to recognize the importance of minority languages. At the root of this, language is the essence of identity and the ability to hold on to identity. Even more, it is important to understand that protection of minority language equates to protection of human rights. Even outside of Hawaii, colonization has had major impacts on minority languages, leading to a past riddled with language extinction. Because of this, it is important to recognize the efforts toward language preservation and the necessities of language maintenance within Hawaiian and other minority languages.

IMPORTANCE OF HAWAIIAN LANGUAGE IN CLASSROOMS

As a link toward fostering a healthy identity for Hawaiian children and serving as a way to maintain the minority language of the Polynesian Islands, the importance of the Hawaiian language in a classroom setting cannot be overlooked (Warschauer, Donaghy, & Kuamoʻo 1997). The development of a student's first language facilitates entirely the acquisition of a second language. As the state has progressed in its cultural aspects, Hawaiian English is typically the main language used at home. As is the case for many native Hawaiian students, their first language is typically Hawaiian, and English is introduced societally. Native language instruction in a classroom is important for children as it encourages the students' over all well-being. Native language instruction emphasizes the importance of native languages and recognizes the value of minority languages, promoting confidence in the language's speakers.

In "For the Interest of Hawaiians Themselves," authors William H. Wilson and Kauanoe Kamanä (2017) pose the argument that a Hawaiian-medium education for children on the Polynesian islands holds more core-value than an English-based education. The authors of this study considered five different instances on the Hawaiian Islands within classrooms instructing in a native language. The authors found and argue that the immersion of Hawaiian in native language learning environments led to higher tests scores and literacy ratings amongst Hawaiian students. Likewise, they discovered that the replacement of Hawaiian-based education with English curriculum reduced overall academic achievement in students. This furthers the understanding of the necessity for a Hawaiian integrated classroom experience, both for the sake of language preservation and success of indigenous students.

In addition to academic success, the revitalization of the Hawaiian language is important in the health of Native Hawaiians. In her 2014 dissertation, Claire Keiko Martin Townsend, of the University of Hawaii at Manoa, outlines the importance of social factors, like cultural trauma via colonization, in their relation to the health of Hawaiian peoples. The author views the decline in Hawaiian language as a source of cultural trauma for Native Hawaiians. When considering the value of holding a language for hundreds of years, living through the stripping of the language, then being forced into learning a new language, then being told that it is acceptable to use the initial language, the effects can be traumatic. Likewise, the stress put onto the generations of children forced into developing two separate sets of identity due to their bilingualism and the language marginalization present on the Islands. The grander idea is that promotion and reintegration of Hawaiian language into culture will promote self-esteem in the indigenous people. By incorporating case studies conducted with Native Hawaiians, a BLL would promote an optimal atmosphere for health within the indigenous people. With this, it is easy to recognize the importance of language maintenance for Native Hawaiians.

CONCLUSION

The journey of the Hawaiian language is one that should not go overlooked. It is rare to have a language so easily accessible to study that has gone through a near-extinction, renaissance, and revitalization in such a short period of time. It is also important to understand and identify the necessity of encouraging the survival of the Hawaiian language, both for indigenous Hawaiians and Americans. As we consider the Hawaiian language, it is important to remember the importance of identity. Each being uses language as a vessel to create and cultivate meaning, embodying their language(s) to shape and cultivate their identity. This overview serves as a mechanism for reminding readers the hardships undergone by the Hawaiian people, the history of the Hawaiian language, and the importance of retention of America's only official multilingual state. And so, we encourage the implementation of this minority language within classrooms, schools, homes, and society, as we aim to foster the recognition of importance for the Hawaiian language.

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Воскресенье

Volha Panco

ABSTRACT

“Воскресенье” (voskresen’e [vəskrʲɪsʲenʲje]) oil on canvas, 36" x 48", 2020, embodies a personal struggle to accept the uncertainty. In the Russian language, “Воскресенье” means Sunday and is named after the resurrection of Christ. A religious connotation of the name creates context for a plot. The oil medium allows the build-up of layers of paint, creating feelings of depth and translucency. Strong shapes are balanced out with soft drapery that connects the outer image and the inner emotions of the character. As the viewer’s eye moves around the elements of the painting gliding through sky blue drapery and architectural forms, it lands on the figure, the peculiar pose that expresses the inner conflict and reveals the raw personality of the character. The roughness and tension of the gesture and a masculine military-style uniform manifest the rebellious spirit and internal resistance to accepting the uncertainty, unwillingness to sacrifice control. The onion domes of Russian Orthodox Churches symbolize the power of conformity. Despite a religious background as a significant part of the artist’s identity, for her, the belief that everything is in God’s hands is hard to accept. Through “Воскресенье,” the viewer witnesses the unique in-between moment, the process of the artist’s spiritual growth. The artist uses the painting as a tool to arrive at an epiphany: the sudden realization that in reality, full control is an illusion and the only way for her to overcome hardship is to have faith and let go of the desire to have full control.

Воскресенье
Lola Panco, 2020
Oil on Canvas
36” x 48”

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Western Views and How They Harm Conservation Efforts

Cailyn Joseph

ABSTRACT

Western ideas have long infiltrated cultures, knowledge systems, and societies that differ greatly from it. This essay aims to expose the racist and violent principles upon which Western conservation is built by exploring how these have shaped conservation practices and how this negatively affects indigenous groups and communities culturally, economically, and physically. The history of the West, natural science, and the environmental movement are analyzed to understand the many moving parts that shape the positive associations with conservation agencies to the West's people. The cultural differences between indigenous groups and the West are also explored, and a way forward is offered to bridge the gaps between cultures, which will make for more ethical practices. Focusing on natural sciences through the lens of the West alone is not sufficient for successful conservation practices; traditional ecological knowledge and social science must be integrated into conservation science to protect indigenous rights while maintaining biodiversity. This paper provides a call for a new framework for conservation and calls upon scientists, conservation agencies, and the West to recognize the social issues of conservation today and change our perceptions of what it means to protect the natural world.

INTRODUCTION

West, in its simplest form, is the cardinal direction that points toward the direction of the setting sun. However, throughout time, the West and the East became a label not of geographic location, but rather socioeconomic class and race (Okere, 2007). This led to a stark divide among people and places globally. For example, places far away from each other geographically, such as the United States and Australia, are both considered part of the West, even though they are on opposite sides of the globe. Both of these countries typically have more political freedoms, wealth, and resources than many other countries. However, the Native Americans in the United States and the Aboriginal people of Australia are never considered part of this elite Western world despite their residing in these countries (Okere, 2007). Those places without the Western-like resources or high standards of living became the "others," the "heathens and savages," or the East (Okere, 2007).

Western conservation practices are the intersection of Western science and values. Feelings of superiority from the West combined with a scientifically driven approach left little room for assessing any social repercussions that conservation practices may cause. Many conservationists have beliefs rooted in hard science and often work hand in hand with environmental and governmental organizations driven by power and money (Chapin, 2004). As a result, conventional conservation has evolved into a violent and highly contentious subject. Western conservation practices have been responsible for the destruction of indigenous communities, culture, and lives. The remainder of this essay will argue that conservationists must acknowledge and respect indigenous schools of thought, follow policies that respect their ways of life, and include them as essential stakeholders in conservation projects. In order to accomplish these steps toward ethical conservation practices, the West must deconstruct how it views nature and conservation and form new perceptions of humans' interaction with the natural world. Understanding where these perceptions come from and how they shape our relationships with people, nature, and science is an important first step.

THE WEST'S INFILTRATION

The West has a long history of infiltrating cultures, using people, and pushing its views onto others. This began as far back as the domination of the Roman Empire and later made its way into religions and knowledge systems around the world (Paine, 2012). Early Western Europe expanded with the support of a strong military and the birth of a capitalist economy (Chirot, 1985; Douthit, 1991). These advancements led to the ability to explore the globe in the 16th century, leading to the colonization of the Americas and other parts of the globe. This not only provided Europe more wealth and land, but also contributed to a sense of "arrogance and self-confidence" within Europeans (Douthit, 1991). These principles soon spread to the areas that became colonized by the Europeans. Feelings of being the "master race" were associated with being part of the Western world, which gave the "elites" a reason to look down on those in the non-Western world (Okere, 2007).

The history of "nature" in the West

The imperialistic culture of the West's people also shaped their perceptions of the natural world. Just as the United States was built on the use of slave labor and the stolen land from indigenous Native Americans, the fascination of saving the natural world in the United States was built on conquering the wild frontier, where man could truly be man and opportunities were plentiful (Cronon, 1996). When the wild frontier began to disappear with the rapid colonization of the Western United States, the great environmentalism movement in the United States was born, and fears of pristine environmental scarcity arose. Untouched land became valuable, and thus resulted in the Western views that the presence of humans spoiled the purity of the natural world (Cronon, 1996; West et al., 2006). These fears of scarcity came at a time when more and more Americans were becoming wealthier due to a booming economy, and they no longer accepted environmental degradation as a side effect of progress (Rome, 2003). Influential essays by early environmentalists such as Henry David Thoreau and John Muir emphasized the beauty of nature and the need to preserve these untouched lands (Miles, 2009). This led to the establishment of Yellowstone as the first national park in the United States in 1872 and gave way to a movement of conservation in the American wilderness. This gave Americans comfort knowing they were able to experience the world in its most natural form (Miles, 2009). This movement, however, failed to acknowledge the role that Native Americans played in the forming of these landscapes. As these parks became attractions for some Americans, other Americans, such as those in the Blackfeet and Havasupais tribes, were forced to flee and arrested for traditional uses of the land (Lewis, 2007). Muir's writings normalized this type of marginalization and even

commented on the filths that humans, specifically Native Americans, leave on a landscape, describing the indigenous people of Yosemite as out of place and "altogether hideous" (NoiseCat, 2019). These thoughts became the norm of Western environmentalists and fit the preexisting feelings of superiority rooted deep in their Western culture, while also protecting the last pieces of land that was seemingly wild. The indigenous people who continued to "taint" the natural world with their presence were the enemy of the environmentalism movement, which soon became backed by data-driven science (a form derived for and by "The West") and thrived off the marginalization of people. Around the world, American ideals and practices have found their way into other cultures, including cuisine, entertainment, and government (Kuisel, 2000), and modern environmentalism and conservation practices are no exception to the spread of these Americanized views of nature and native groups.

Western science as a tool for oppression

Much like environmentalism, traditional Western science is yet another product of the dominative views of the West. Ancient sciences, such as mathematics, biology, and physics, have origins in Egypt, Mesopotamia, India, and China, which are largely considered part of the East. However, Galileo, a citizen of the West, encouraged what became standardized, a science of the Enlightenment period, which gave little attention to things other than quantitative data. Anything that did not yield a measurement was not considered to be a part of the "real world" in his eyes, so things like beauty, value, and spirit were not considered when practicing science (Okere, 2007). Furthermore, Carolyn Merchant (2006) has argued that the labeling of nature as a feminine and passive entity allowed for the natural world to be easier manipulated by Western scientists, who were predominately men, when these ideas arose in the 15th and 16th centuries during the Enlightenment. These ideas paved the way for a modern science that is seen as a gold standard of knowledge systems by Westerners and discredits all other forms of knowledge (Okere, 2007). Western science was the "right way" to become educated and was yet another reason to force Western thoughts onto people who were not a part of that world. In the shadows of Western science, indigenous knowledge was seen as invalid, much like how non-Western culture was overpowered by the spread of Western principles. For example, in the Partial Fauna Reserve in Burkino Faso, scientists drove the Gourmantché people off land considered sacred for this indigenous group (Mazzuca & Kaboré, 2017). Natural sciences fail to see the spiritual and social importance of land and rights of indigenous communities, and it can eliminate cultures and traditions quickly with the establishment of regulations. The histories of Western science, environmentalism, and culture all contribute to the marginalization of non-Western culture that we see today. The result is a world that is not complemented by the West, but rather dominated by it.

Conservation can be accomplished in a variety of ways, but projects often take the form of protected areas. Twenty million square kilometers of terrestrial land are already encompassed in protected areas, and their popularity is increasing with the desire to preserve biodiversity (West, Igoe, & Brockington, 2006). Multiple studies have shown that protected areas have higher biodiversity, higher species abundance, and less habitat destruction than surrounding areas that are not protected (Coetzee et al., 2014; Geldmann, 2013; Gray et al., 2016; Souza, 2020). Protected areas can also be another source of job creation, with management and patrol needed at several levels (IUCN, 2020). Human activities are often highly regulated within a protected area, reducing the amount of disturbances that are present. Through a Western lens, protected areas are a *sensible* solution to the huge losses of biodiversity occurring.

Conflicts in conservation arise when humans can be found inhabiting an area that is targeted for preservation. Groups most often found in this position are indigenous groups. As the title implies, protected areas are meant to protect a targeted area from supposed threats to biodiversity. As shown in the preceding paragraphs, humans are considered to be one of these potential threats to biodiversity in the West. Therefore, with the establishment of protected areas, indigenous communities face social, economic, cultural, and physical hardships from being physically and economically displaced from lands that were rightfully theirs for generations.

Communities around the world have felt the wrath of Westernized conservation, and many different stories provide evidence of this. Demolition of houses in Lalitpur, starvation and attacks on tribespeople in Muthanga, forced eviction of the Karen people in Kaeng Krachan National Park, lost livelihoods of the Sonaha people, and homicides in the Royal Chitwan National Park are just a few instances of unfair treatment to indigenous people in the name of conservation (Bijoy, 2003; Gurung, 2019; "Karen Indigenous People," 2016; Sedhai, 2015; Singh, 2019). These stories are often given little attention and go unnoticed in the mainstream media. Many times, acts within protected areas go undocumented, making it hard to assess the full scope of the issue (West et al., 2006). Information consumed about conservation through mainstream media masks these issues further. Advertisements filled with beautiful landscapes and exotic animals can easily be found, while information on the indigenous groups that inhabit these lands is less popular, leaving uneducated consumers charmed by the dreamy impressions of conservation. A simple internet search of "conservation" yields images of individuals who are primarily white working in a wild landscape. It is common for promotional mail from conservation organizations to highlight the work being done to protect attractive animals and much less common for them to contain updates on the area's indigenous groups. This creates a huge gap between what the public knows and what issues truly surround conservation, making conservation agencies popular in the West even if they may be harming native groups.

STORIES OF THE OPPRESSED

This section will explore two cases in which conservation efforts caused indigenous suffering. While these stories reveal the shocking horrors that surround conservation, it is important to note that they are not representative of all native groups that have experienced injustices and that many more instances can be explored.

Chitwan National Park, Nepal

Despite the hole in the media, a story from the Royal Chitwan National Park in Nepal attracted attention in recent years due to the brutality of the situation and the aggressors involved – the Nepalese government and the well-known global environmental organization of the World Wide Fund for Nature (WWF). In spite of it originally being set aside as a Big Game Reserve for the royal families, indigenous exclusion from park management, displacements at gunpoint, and use restrictions have been occurring in the park since its establishment in 1973 (McLean, 1999; Chitwan National Park Office, 2015). In 2006, an indigenous man by the name of Shikharam Chaudhary was wrongfully accused of poaching on park grounds. He was taken from his wife and home and transported to a nearby detention facility where he was tortured to death (Gurung, 2019). This sparked an investigation into park management, and many stories of torture, beatings, and homicides by the park guards surfaced. The WWF, a prominent conservation agency, made no efforts to speak upon

the loss of indigenous life. Rather, they continued to support the accused park guards and later lobbied for their release from prison (Gurung, 2019).

Bardiya National Park, Nepal

Physical displacements are dangerous and obvious threats, but economic displacements can also cause huge amounts of harm to an indigenous community. Economic displacement describes when a community is inhibited from activities or land that they relied on for income. This was the situation that the Nepalese Sonaha people found themselves in when Bardia National Park came to fruition. The Sonaha people relied on the Karnali River Delta for fishing and gold panning, which were important to them both economically and culturally (Sedhai, 2015). After park establishment, their traditional livelihoods became illegal, and the Sonaha people were soon pushed to the outskirts of the park to work exploitative agricultural jobs (Sedhai, 2015). Plans were made to compensate the Sonaha people for their losses, but they were highly flawed and eventually failed. This is often the case with both economic and physical displacements, as indigenous peoples are rarely compensated for the trouble they were put through and the hardships their future holds because of it. Often, economic displacement comes as a side effect of physical displacement, as groups are often moved to land with poor resources and less economic potential. Loss of livelihoods and the lack of compensation are examples of why economic displacement is highly problematic. Economic displacement is much less visible than physical displacement, making it considerably harder to gauge the severity of the already shady reporting of incidences in protected areas and considerably easier for the oppressors to get away with it (Brockington & Wilkie, 2015). Furthermore, restricting indigenous peoples from their traditional livelihoods often disconnect them from a huge part of their culture and heritage (Wenz, 1996).

A NEW KIND OF CONSERVATION

Much like the greatly skewed vision of conservation in the West, views of humans, more specifically indigenous peoples, interacting with nature are very flawed. While there are a wide variety of indigenous communities and tribes, each with unique cultures and traditions, there are similarities between them in their main principles. In contrast to Western views of nature, indigenous people widely view themselves as being a part of nature and likewise view the surrounding natural elements as a part of their society (Wenz, 1996). There is frequently a deep connection between them and the natural world; for example, the Orang Rimba tribe buries the umbilical cord of every baby under a certain tree, which is then deemed a "birth tree." The ties to a birth tree are so strong that it is equivalent to being charged with murder if one cuts it down (Kurniawati, 2009). Fears of resource scarcity drive high levels of competition and extraction that fuel consumerist economies in the West; conversely, sacred views of land held by indigenous groups prevent the overexploitation of natural resources (Wenz, 1996). Their survival often depends on the use of their land, so longevity is kept in mind when using resources, and greed rarely exists. Because of their dependence and ties to their land, they have been able conserve the majority of biodiversity found on Earth today. Both the IUCN and the Food and Agriculture Organization of the United Nations (FAO) estimates that 80% of all biodiversity is found within traditionally occupied indigenous lands (IUCN, 2019; FAO, 2017).

Flaws in conservation practices dependent on western science

Relying solely on traditional Western science is problematic because it fails to consider any social issues in conservation projects, and studies have shown that the effectiveness of protected areas is still not very well-known (Barnes et al., 2015; Geldmann, 2013). Furthermore, targets have been established by the IUCN to protect a certain area of land and sea, but the amount of land protected does not translate into *quality* protection (Minin & Toivonen, 2015). This can result in "paper parks" – a phrase used to describe a protected area that only exists on record and has little to show in evidence of effectiveness. Although the study from Geldmann (2013) found that the majority of protected areas have decreased habitat loss within an area, the authors also pointed out that studies pertaining to protected areas often take into account habitat loss only and ignore other important factors such as the quality of habitat. The "naturalness" of protected areas is partly what makes them so desirable in Western culture; however, looking closer into the history of parks, some of them are far from natural. For example, Keoladeo Ghana National Park in Bharatpur, India, has experienced high amounts of avifauna due to the over hunting of top predators and the fragmentation of habitat surrounding the park (Lewis, 2003). Therefore, without human disturbance in the first place, Keoladeo Ghana National Park would not exist. Furthermore, grazing animals kept by indigenous groups in the park kept the grass in the wetlands controlled. With the banning of grazing in the 1972 Wildlife Protection Act, the wetlands became overtaken by grass and the avifauna failed to reappear (Lewis, 2003; Shukla & Dubey, 1996). Some parks also require management to keep it beautiful and seemingly natural by using practices like prescribed burning and invasive species eradication, which some indigenous groups have already practiced for hundreds of years (Slutyer & Duvall, 2016). Finally, decreased inhabitation within protected areas has proven to be concerning as it has increased harmful activities within parks, such as poaching and drug trades (Meena, 2015; West et al., 2006). In March of 2020, two very rare white giraffes were discovered dead and thought to be poached within a nature conservancy in Kenya, where they were thought to be safe (Dahir, 2020).

The way forward

Even with its negative sides, conservation of our ecosystems and species is important for their ecosystem services and cultural value. The advances of Western natural science will continue to give valuable contributions to conservation efforts, since it can provide a pathway for research and data collection and produce positive outcomes in regards to improving biodiversity (as seen in the studies from Coetzee et al. (2014), Geldmann (2013), Gray et al. (2016), and Souza (2020)). Nevertheless, with indigenous peoples inhabiting their lands for many years, they have been successfully conserving ecosystems long before Western science came up with the label of conservation and have been condemning the destruction of natural resources by outsiders for at least 500 years (Alcorn, 1993; Slutyer & Duvall, 2016). The differences between Western culture and indigenous culture described in this paper can explain in part how this has been the case. Their beliefs and ways of life allow them to view the world in a dynamic, balanced, and interconnected way, and Western thought does not allow us to see their practices as conservation. Mulder and Coppolillo (2005) described five aspects of indigenous culture that contribute to both intentional and unintentional conservation: a lifestyle with little demand for local resources, an intricate understanding of the surrounding environment, customary regulations that protect species or areas (for reasons such as subsistence or religion [Colding & Folke, 1997]), sacred ties to their land, and a pride in their land that they often fought others off to protect. With an integration of these differing practices and cultures, protecting wildlife *and* people simultaneously is possible.

The scientific movement

Integrating these two very different worlds will require both awareness and understanding of the cultural divide for all involved. Conservationists will have to practice more than just "hard science" and begin to incorporate social science and, perhaps more importantly, empathy into their practices. When viewing conservation through an empathetic lens, it is easier to see why conservation practices based on Western science conflict so heavily with the lifestyles of indigenous communities. Furthermore, it can help conservationists frame their goals around the agendas of indigenous communities, viewing it as a service to help indigenous communities and their land. The social science of anthropology and the discipline's tool of ethnographies can be a valuable way of exchanging knowledge and learning a community's way of life.

A transformation in the way traditional Western scientists approach conservation will make way for much more ethical and more productive projects. Studies, such as one conducted by Epanda, et al. (2015) have focused on the positive effects of wilderness education and awareness of indigenous people for conservation efforts. However, this can potentially be another form of forced Western colonialization of knowledge in non-Western knowledge systems, and this must be utilized carefully and only with full willingness of the indigenous groups. The belief that "educating" indigenous people with Western science will solve the issues of our cultural divide ignores the issue of Western domination that created such conflicts initially. The sharing of knowledge from the West can be a valuable way to connect the two knowledge systems, but only if it serves as a complement to indigenous knowledge, rather than a replacement of it. History has revealed the supremacist practices of the West's natural sciences and colonization that stemmed from its imperialistic views and culture. For future conservation efforts to be improved, the dominative and elitist culture of the West cannot be present in the projects. The traditional ecological knowledge, or TEK, of local groups has been shown to be crucial in the success of protecting species (Silver & Campbell, 2005; Johannes, 2008) as it depends on years of observation and experiential knowledge, which scientific data sheets can often lack (Freeman, 1992). While Western science seeks to control variables, TEK seeks to find the relationships between these variables and their changing environment, which allows for a more complete analysis over longer periods of time (Finn et al., 2017). More research has shown that indigenous people have successfully been involved in the management and success of conserved areas, adding valuable knowledge to the projects (Artelle et al., 2019; Davies et al., 2018; Mavhura & Mushure, 2019; Wilkie et al., 2013).

The social movement

After the cultural differences are acknowledged by those involved in conservation projects, Western science will be much more inclined to follow policies that protect indigenous rights. Policies and guidelines like the IUCN Species Conservation Planning Guidelines, the U.S. Declaration of Rights of Indigenous Peoples, the *Two Agendas* of the Coordinating Body of Indigenous Organizations of the Amazon Basin (COICA), and the Forest Rights Act recognize the rights of indigenous groups and recognize the need for their inclusion as stakeholders in conservation projects. These documents must be taken seriously by conservationists and the IUCN, which describes itself as the global authority on the status of the natural world. Its agency is made up of six commissions to manage all parts of species protection including social and economic policy, and they must make sure conservationists are held accountable in project implementation. While it is important that conservationists shift their views of conservation, it does not guarantee that these policies will be followed. Conservation organizations often depend on support and funding from the public, government, and corporate sectors (Robinson, 2012). Because of this, it is important for the Western public to deconstruct what is believed to be true about nature and conservation. Openness and normalization of people within desired protected areas is crucial to understand that displacements are ethically wrong and unnecessary. Public awareness of the social issues around conservation is needed, and environmental organizations must make sure that is also a priority in their campaigns. A recent example of an environmental organization's awareness of social issues is evident within the Sierra Club and their removing of the monuments of their founder, John Muir, who was openly racist to indigenous groups in the natural world. A statement released by the Sierra Club stated: "In these early years, the Sierra Club was basically a mountaineering club for middle- and upper-class white people who worked to preserve the wilderness they hiked through – wilderness that had begun to need protection only a few decades earlier, when white settlers violently displaced the Indigenous peoples who had lived on and taken care of the land for thousands of years" (Brune, 2020). The organization then stated they would actively work to continue research, change monuments and practices within the club, and regain trust with marginalized communities to create a more diverse organization. This is a monumental step forward for a conservation organization, and it is a worthy example for other agencies to follow suit. With these issues in the forefront of the minds of the public, it is more likely that support from corporations and the government will follow.

The time has come for the Western conservationists, organizations, and the public to change their perspectives and encompass more culturally inclusive ideas in their practices. This transition will not produce quantitative numbers and significant statistics that will indicate whether or not it is the right path to follow. However, success will be measured by indigenous protection, stakeholder communication, morally improved projects, and healthier relationships between cultures and ecosystems. Breaking away from elitist and racist norms are arising from the West more frequently, with increased support in movements – like Black Lives Matter – and organizations – like Extinction Rebellion – that often protest against indigenous injustices. Conflicts in conservation are not necessary to sustain a biodiverse world, and it starts with breaking down the Western feelings of superiority and beliefs that humans and nature are mutually exclusive from each other. It is time to question the Western ideals and natural science that has long been thought to be universally correct and look to indigenous principles for a new forward direction.

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The Lowell Textile Mills:

The Economic Independence of the

Lowell Mill Girls

Samantha Steltzer

ABSTRACT

This paper explores the connection between the women working in the Lowell Textile Mills of Lowell, Massachusetts, from the early to mid-1800s, and the impact of their wages on their economic independence. The creation of the Lowell Textile Mills provided women new avenues for work and economic status. Recent historiography has focused on the economic history of the women; whereas past scholars centered research on the political movements formed by the women. The research discussed in this paper is important to the fields of women's social, economic, and gender history. This paper examines how the women spent their wages based on their lives before, during, and after working at the Lowell Textile Mills. While women experienced various forms of economic independence, their independence was limited by a patriarchal society.

INTRODUCTION

In the mid-to-late 1800s, American women had limited options if they wished to earn a wage. Patriarchal views and social expectations that celebrated the cult of domesticity confined women's roles in the home. The United States introduction in its Industrial Revolution through the textile industry affected women's economic status in New England, particularly in Massachusetts. The creation of the Lowell Textile Mills in 1813 by Francis Cabot Lowell, in response to British textile industry success, opened new prospects for working women. The employment of women by the Lowell Textile Mills provided them with exciting new avenues of economic, educational, and cultural freedoms. Women gained certain types of economic independence through the wages they earned at Lowell. The impact on their economic status and emancipation, however, greatly depended upon a woman's life before, at, and after working at Lowell. While women earned wages, their independence was still limited by the patriarchy. Women often sent their wages to family members, as supporting a brother's education was considered more important than spending wages on personal items.

HISTORIOGRAPHY

Scholars emphasize the changes to women's lives economically as they worked in the Lowell Textile Mills and the overarching impact this had on women's social, gender, and economic history. Thomas Dublin's scholarly monograph, *Women at Work,* is one of the forefront entries that provides a sweeping account of the mill girls on women's economic and social history. Since it was published in 1979, the scholarly approach to this topic shifted from social and economic history of the female workers to a deeper focus on the reasons and long-term effects of political movements enacted by the women. New primary evidence from Lowell Mills and the mill girls has been found, causing a reevaluation of previous sources, thus adding different perspectives to them. In his most recent work, *Transforming Women's Work: New England Lives in the Industrial Revolution*, Dublin contributes to previous scholarly conversations. Dublin stresses a wage labor-based discussion and female-focused analysis, diverging from the mainly male-dominated literature, about the workers of the Industrial Revolution. In the scholarly article, "The Effect of Wage Payment Reform on Workers' Labor Supply, Wages, and Welfare," economists Esther Redmount, Arthur Snow, and Ronald S. Warren Jr. exhaustively analyzed the correlation between worker's well-being and the changes that an 1886 Massachusetts wage-payment reform made. Their article argues that weekly payments for the average workers led to an increase in their overall economic well-being. Another work that focuses on women in Lowell during the 19th century is *The Lowell Mill Girls: Life in the Factory*, a volume edited by JoAnne Deitch. The collection offered general facts and suggested changes that happened to the mills and workers over the course of the mid-1800s. Historians have often considered the experiences of female laborers in Lowell Textile Mills, or "mill girls," in Massachusetts to be far-reaching within multiple historical fields of study. Overall, the female textile workers bore the effects of the Lowell Textile Mills and spent their wages, which were subject to fluctuations and reform depending on the personal need.

BACKGROUND ON LOWELL TEXTILE MILLS

The first Industrial Revolution in early 1800s America started in New England around the textile industry. Francis Cabot Lowell created the Lowell Textile Mills in 1813 after implementing models from England's successful textile mills operating in Lancashire and Manchester when he resided there for two years.[1] The workers in English textile mills produced greats amounts of revenue for England's economy, especially the Lancashire Textile Mills, which at its height produced over 30% of the world's cotton goods and half of Britain's exports in the late 19th century.[2] In 1833, British women ages 13 to 20 comprised 65% of the workforce sampled out of 82 cotton mills.[3] Also in 1833, British women aged 20 to 50 earned, accounting for minor differences, about six shillings and five pence a week while working in factories.[4] Compared to male earned wages after the age of 30, women gained "only one-third as much," which suggests that unequal standards were present at the British Mills and later seen in textile mills in America.[5] British workers were subject to wage reductions like the 1847-1848 depression in which "cotton masters imposed a 10 per cent *[sic]* reduction."[6] The work performed for low wages was dangerous. Lancashire factory conditions were unsanitary, with its "publicly exposed toilet facilities," and harmed worker's respiratory health through "sizing, a kind of glue used to stiffen thread and cloth ... combined with the lack of ventilation."[7]

Despite this, England had gone from an agricultural-based working nation to "an empire of world traders" because of its textile industry, a fact that Lowell wanted to capitalize on.[8] He believed that "New England would only prosper" if the area integrated textile factories.[9]

To bring the looms back to America, Lowell memorized the mechanical details of the water- or steam-powered spinning and weaving machines by studying the successful textile industries in Lancashire and Manchester. These types of looms were unavailable to the United States since England did not want competition in the production of cloth. The ban of exported goods to the United States was due to the Embargo of 1807, which placed restrictions on British imports.[10] When he returned to America in 1812, Lowell formed the Boston Manufacturing Company in Waltham, Massachusetts, with Charles, James, and Patrick T. Jackson; Nathan Appleton; and Israel Thorndike, also known as the Boston Associates.[11] Completed in 1814, the company built a cotton manufacturing mill on the Charles River in Waltham run by a newly built water-power loom.[12] The mill at Waltham was the first in the world to house the entire process of making cotton cloth under one roof.[13] The operation involved "basic carding, spinning, dressing, and weaving ... [then] print and dye works and bleacheries."[14] Carried out by Francis Lowell, the first Industrial Revolution in America started because of the textile industry, inspired by England's Lancashire Textile Mills.

A PATERNALISTIC INDUSTRIAL STRUCTURE

The industrial structure of Lowell Textile Mills was designed to shape women's lives and morals through paternalistic view. The industrial structure was called the Lowell-Waltham System and was an innovative, vertical-integration system for production and labor. The entire cloth-making process was housed under one roof unlike work done through the cottage industry. Its predecessor, established by Samuel Slater, was the Rhode Island System.[15] The main difference between the two was that the Lowell System hired individuals, not families. To staff the growing mills, Lowell turned to young, unemployed, and single women in New England.[16] These women were later known as the mill girls of Lowell. In contrast to England, the Lowell Textile Mills "were not dependent on a permanent factory population."[17] Discouraged by the poor working conditions and examples of workers in England that "were notoriously of the lowest character, for intelligence and morals," according to Nathan Appleton, the Boston Associates sought to provide a safe workplace with comfortable and positive living conditions.[18] Boarding houses and dormitories, usually made of brick, were erected to house the women and placed directly in front of the manufacturing company the mill girls worked in.[19] The system was paternalistic in nature to assure the families of the mill girls that they were safe to leave home for this work and that they exhibited proper behavior. Women were supervised by a boarding housekeeper, also called a housemother, who was often a widower. The job of housemother fit into the "women's sphere" and was an appropriate occupation that coincided with the "cult of domesticity."[20] The keepers, per company rules, regulated family-style meals, discouraged "the use of ardent and spirits [and] playing at games," and insured that the women attended church services.[21] The Hamilton Company, a textile mill in Lowell, set the following rules in 1848 for its boarding house. The rules included that "tenants ... are not to board ... any person, except those in the employ of the company" and workers will be "considered answerable for any improper conduct ... and are not ... to have company at unseasonable hours."[22] These rules confirm the reinforcement by paternalistic supervisors of the belief that women needed supervision and ensured to families that their daughters were safe and in a moral environment.

CULT OF DOMESTICITY

The cult of domesticity was encouraged among an American patriarchal society and preached dependence on males, which differed from the "cult of independence" encouraged by some of the female workers at Lowell. However, the "cult of independence" was sometimes contrasted by women who advocated for continued dependence on men. The cult of domesticity encouraged women to follow the four principles of "piety, purity, submissiveness, [and] domesticity."[23] In the 1800s, domestic women tended to their housework, which was deemed morally uplifting, to produce a home that kept men away from evil temptations such as infidelity.[24] Men, like John Ruskin, who was a social thinker, felt that a woman's "great function is Praise."[25] Ruskin saw men as the protector of the home and "the doer, the creator, the discoverer, the defender."[26] Conversely, Harriet Farley, who wrote under the pseudonym Adah, stated in the *Lowell Offering*, "man feels that women was made for his pleasures" and that young men were taught to "go into their society and recruit their spirits, and rest their intellects."[27] Farley's sentiment bolstered the cult of domesticity – that a woman's place in the world was in the home while the man went out as he pleased. Written by mill girls from 1840 to 1845, the *Lowell Offering* was a monthly journal that featured first-hand narratives, fictional stories, and poetry. Written in response to a request from a lady in France, an editorial in the *Lowell Offering* supported women being paid because it sustained the ideals of the cult of domesticity as "they are more likely to form habits of ... frugality ... [and] have more self-respect."[28] As the cult of domesticity prevailed in the 1800s, the female operatives had conflicting attitudes toward it and new forms of independence opened to them by the mills.

EARNING A WAGE

The employment of women in the Lowell Textile Mills during the 1800s presented a notable shift from women's limited access to a few poor-paying jobs in a rural society to diversified range of textile mill jobs that paid higher wages than the standard. The people of New England during the Industrial Revolution saw the switch from an agricultural-based, rural society to a more factory-based, city-dwelling society. In the rural New England society, a woman's job was to tend to her household, as some, in their words, described tasks like cooking and washing as "drudgery that brought little satisfaction" because they were repetitive and tedious.[29] Lower-class women went unpaid for their domestic labor, while the man earned wages through areas like business, profits from farming, and craftsman shops.[30] Few options for pay existed since positions in almost all professions, trades, and industries were closed to women. In *Loom and Spindle*, Harriet H. Robinson, a Lowell mill girl, maintained that "women had always been a money-saving, rather than a money-earning, member of the community."[31] As a servant, a woman could earn "fifty cents to one dollar a week," while as a traveling tailoress, a woman received "seventy-five cents a week and her meals."[32] Thus, women had very little or no options to financially support themselves in the rural society. However, Robinson noted that the Lowell Textile Mills promised wages anywhere from "six to ten dollars a week" with a dollar and twenty-five cents taken for board.[33] This was a significant amount of money that women could earn instead of little to none while at home.[34] In 1836, women employed at the Hamilton Company, part of Lowell, held major jobs that included being a "speeder, drawer, spinner, weaver, dresser, warper, drawing in, and sparehand."[35] Women's labor "did not require special training" or major physical exertion upon the women.[36] The average mean wage for a woman was sixty

cents to a man's dollar and five cents.[37] This suggests that women at the mills were paid less than their male counterparts because men had to be trained, which increased their skill set and payment. More women were hired than men leading to unequal wages because of the limited availability of other jobs elsewhere for women.[38] Nevertheless, women entering Lowell were contractually obligated to work for 12 months; if they left before this time, they would not receive "a regular discharge" and would be blacklisted from working at other textile mills in Lowell.[39] The transition for women in the 1800s went from limited, poor-paying jobs to a greater number of higher-paying jobs at Lowell Textile Mills.

WORK HOURS

The daily lives of mill girls were highly regimented into long work hours and questionable working conditions for greater amounts of production. Dated September 21, 1853, a Lowell Mill pamphlet reveals how Lowell mill girls worked an "average 11 hours per day," six days a week, with only a 15-minute lunch break, every year.[40] By March of 1845, a Massachusetts investigation into labor conditions found that employees worked an average of about 11 hours in January, March, November, and December; close to 12 hours and 45 minutes in February, May, June, July, August, and October; with April at the longest with 13 hours and 31 minutes.[41] Also in 1845, under the pseudonym H.F., Harriet Farley wrote an editorial in the *Lowell Offering* praising the mill girls who presented cheerful and respectful tone and manner in the face of "wearisome hours, [the] monotonous toil, [the] separation from friends, and [the] seclusion from the accustomed healthful...influences of nature."[42] This suggests that mill girls tried to maintain a somewhat positive attitude despite unfavorable work conditions to secure money. This also confirms the presence of many problematic working conditions that the mill girls worked in even though the mill was created to lessen the conditions. Reprinted in the *Lowell Offering*, Dr. William Scoresby noted in his appeal to British factories the contrasts between Bradford Textile Mill based in England and the Lowell Mills after visiting and that Lowell was better.[43] Nonetheless, Dr. Scoresby only discussed the outer appearance of Lowell and did not dive into deeper issues. He briefly mentioned how he "did not observe the smallest sign of levity or indecorum in any one individual" but did not ask mill operatives if they did.[44] Lowell mill girls infrequently presented public outward complaint about working protracted hours in harsh conditions to present an optimistic demeanor towards outsiders.

THE FORM OF INDEPENDENCE

The mill girls of Lowell all gained relative economic independence through the wages they received between 1830 and 1865, although the form in which the independence took varied depending on a woman's life before, and what she spent her wages on while at and after leaving Lowell. Women did not necessarily work at Lowell because they were all poor or came from destitute families. Instead, many women came to Lowell Mills to work by "their own accord."[45] Still, each woman earned money for different reasons, including helping their families pay off debts or financially support them, sending money back for a sibling, usually for their brother's, education, and adding to dowry so that they might be married, especially to desirable high-class men. Most women worked at the textile mills as a stepping-stone for other ventures, like Ann M. Blake, cousin of a mill operative, who wanted to work for a year to "be better prepared to learn a traid *[sic]*."[46] According to the editors of the *Lowell Offering*, the average wage for a mill girl was "higher than $1.75 a week, exclusive of their board" due to extra work.[47] Women were paid more the longer they worked at the mills. In a sample taken of the Hamilton Mill in 1836, women who worked six years or more earned 74 cents to a mill girl's 62 cents from one to two years of experience.[48] However, due to varying supply and demand of textiles, the mill girls were subjected to wage fluctuations. Mary Paul, a mill girl who tended to warp spinning frames, expressed her frustrations with the Lowell Mills in an 1848 letter reducing wages. Paul stated, "the companies pretend they are losing immense sums ... and ... are obliged to lessen the wages."[49] The mill girls of Lowell all gained some form of economic independence, which varied from woman to woman.

One reason women went to the Lowell Textile Mills was to send money back to their families to support a sibling's education, usually a brother. Women also tried to gain an education themselves at Lowell. Sarah G. Bagley, a mill operative who joined in 1837 when she was 31, justified in *Lowell Offering* that the "constant clatter of machinery, that I could neither speak ... nor think" of the mill "enabled [us] to assist aged parents ... or perhaps to educate some orphan brother or sister."[50] Bagley's piece illustrated that women endured harsh conditions for money so that they could support others but not themselves. Harriet H. Robinson agreed in *Loom and Spindle* that the "most prevailing incentive to labor was to secure the means of education for some male member of the family."[51] This emphasizes that while women earned money away from their families, they were still influenced by a patriarchal society with families focusing on supporting the needs of males first. Women at Lowell also tried to find greater education for themselves while working because schooling was offered at Lowell. Lower-class women did not usually go to or have time for formal school and did not have access to greater education beyond a district school like universities.[52] However, a *Lowell Offering* editorial asserted that there is "over-exertion in the attempt to gain, in a short time, an overplus" of an education by women.[53] Women generally worked at Lowell to fund the education of a male family member while also trying to gain schooling themselves.

Some women who were employed at the Lowell Textile Mills came from agricultural families and sent money back home to support them. The older daughters "were about three times as likely as the youngest [daughter] to work away from home."[54] As some large families could not feed or financially support everyone, the daughters worked away from their homes to support them. Women "brought up in the country ... generally return ... after an absence of from three to ten years."[55] In an 1860 letter written by Luther M. Trussell, the foster father of mill operative Delia Page, he reassured her about her earning ability after wages were reduced. Trussell stated that Delia "make[s] more than any man gets this season of the year who works on a farm."[56] This stresses that women made more money at the mills than at home in farming communities. However, the women then sent their wages back to their agricultural centered families to provide support.

Various women sent money back to struggling family members while experiencing difficulties with wages. In the case of Lucy Larcom and her sisters, wages earned went to their mother, and often in letters to each other, they would state reasons why they sent a certain amount. Lucy Larcom moved to Lowell at age 10 with her family and mother, Lois. Lois became a boarding housekeeper, which Lucy helped with before being employed at the Boot Mills. Since Lois's wage was not enough to support her and her children, Lucy and four of her sisters worked. In her autobiography, *A New England Girlhood*, Lucy stated that while her sister, Emilie, left to find more profitable work, she sought more leisure through the form of education. Still, Lucy noted that "of course we always gave away a little, however little we had ... at this time I was receiving two dollars a week, besides my board."[57] Lucy also saw that "those who were earning much more, and were carefully 'laying it up,' did not appear to be any happier than I was."[58] Lucy's

testimony suggests that women across the pay scale were dissatisfied in the amount of money they were able to save and felt it was not enough to either send back home or utilize for personal use. Lucy's sister, Emeline, often sent letters to her mother noting the amount of money, which ranged from an average of five to six dollars. In a letter from Lowell dated September 16, 1841, Emeline stated that she "enclosed 4 dollars this month ... it happened very unexpectedly that I did not receive so much as usual, but I hope to make up for it next month."[59] This reveals that women in mills were subjected to fluctuations in wages that interfered with them helping their families. Lucy is a credible source because of her almost 10 years of experience working in Lowell. Women sent wages back to families even if they did not come from a predominately agricultural-based household.

Women were also able to spend their wages on personal items, something they previously were not able to do in their rural towns and communities. Wealthy Page, a mill girl at Lowell, stated in an 1830 letter to her friends that her younger neighbor, Sarah Hodgdon, had bought Scotch gingham for 33 cents per yard.[60] Hodgdon worked as a sparehand, which meant she was a new operative at the mill, and was assisting an experienced worker. The Hamilton Company's daily-mean-pay for a sparehand in 1836 was 44 cents per day.[61] This reveals that Hodgdon spent almost one day's work for a personal amenity. Harriet H. Robinson detailed in *Loom and Spindle* how a fellow mill girl, Sarah Shedd saved her money. Shedd "saved, solely from her own money, enough to start a library" in her hometown, later giving $2,500 to the construction of it so that the residents would enjoy the "advantages she had so much desired."[62] This demonstrates that mill girls, especially those like Shedd who came from small New England communities, used their wages to provide themselves and others access to certain amenities that were not present before.

CONCLUSION

Heading into the 1800s, the arrival of the Industrial Revolution in the United States was brought by the textile industry. Created by Francis Lowell, the Lowell Textile Mills provided women with a wage and strict place for them to board. However, women's economic independence was limited because they were subject to patriarchal views. One reason some women worked at Lowell was that they were sending money back to their agricultural-based or poor family. Women also might send money back home to provide a male family-member's education. Additionally, they also would use the money for their benefit like personal items and dowry. Previous scholarly research was only focused on the working conditions and labor protests of women at Lowell. New research adds to women's economic history in the nineteenth century and its effects on women workers. The motives for women earning wages have carried onto modern discussion about women's wage equality and greater recognition for women in different fields of history. As Harriet Jane Robinson concluded, "a woman ought to be as proud of being self-made as a man ... enough to assert the fact in her life and in her works."[63]

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Affordable Housing First:

A Transition from Emergency

Care to Prevention of Chronic

Homelessness

Haley Taylor

ABSTRACT

Treatment and prevention of chronic homelessness in urbanized areas needs structural overhaul to effectively and efficiently meet housing needs, but what that entails depends upon both an understanding of Housing First and the Affordable Housing Crisis. This paper identifies the structural conditions that shape policy and proposes solutions for urbanized areas to address chronic homelessness holistically. The history of stigmatization of the chronically homeless as an "undeserving poor" contributes to a history of bias in solutions that deprioritize housing in the previously preferred treatment first programs. A resulting paradigm shift from treatment first to Housing First solutions emphasizes chronic homelessness as a housing problem rather than an individual problem and would, in part, create a more robust emergency care program. However, this paper also addresses the Affordable Housing Crisis, through which rates of chronic homelessness are driven to increasing levels that emergency care programs alone cannot combat. Through analysis of the relationship between chronic homelessness and the Affordable Housing Crisis, this paper seeks to include combating the Affordable Housing Crisis through housing availability as a necessary component of prevention of chronic homelessness. Urbanized areas must adopt policies reflective of that need while simultaneously emphasizing the necessary shift in public consciousness in favor of support for the so called "undeserving poor" for the overall success of Housing First programs.

INTRODUCTION

Despite decades of treatment first programs aimed at eliminating homelessness, chronic homelessness remains a pervasive and visible issue. The chronically homeless exist as a marginalized group within an already marginalized group. Stigmatization of the chronically homeless as an "undeserving" poor has led to a dehumanization of the problem, resulting in flawed solutions characterized by bias against the needs of homeless individuals. The advent of Housing First has shifted homelessness policy to be more reflective of homelessness causes rather than attributing homelessness to personal deficiency, as is often targeted in treatment first programs.

Housing First programs tackle chronic homelessness by providing affordable housing without condition; housing is treated as a basic human right rather than as needed to be earned, like in treatment first programs (Tsemberis, Gulcur, & Nakae, 2004). The U.S. Department of Housing and Urban Development (HUD) (2014) has adopted Housing First as the best practice model, using the Pathways to Housing manual and the Housing First Model fidelity index to aid in policy implementation. However, lack of affordable housing in urbanized areas limits the success of Housing First programs and contributes to the overall homeless population. The United States Census Bureau defined the term urbanized as densely populated regions with a population size greater than 50,000 (2020). By itself, Housing First is a symptomatic approach to treating homelessness and does little to change the structural conditions that result in an increasing chronically homeless population. Although Housing First works as an effective emergency care system to treat chronic homelessness, urbanized areas must develop affordable housing plans, based on the Housing First philosophy, to house chronically homeless individuals, which will begin the transition from emergency care to homelessness prevention.

HISTORY OF HOMELESSNESS

Complex social and economic factors and decades of ineffective homelessness policy have done little to prevent or treat chronic homelessness in the United States. In the late 19th and early 20th century, the homeless acted as a migratory workforce that led to a unique geography of homelessness. This geography was characterized by skid rows full of single room occupancy (SROs) housing that developed to serve the homeless population. Then, the rise of Keynesian economic policy in response to the 1930s Great Depression, which supported the growth of the government in the market and the increase of spending, introduced the Welfare system. Mitchell (2011) reported that new social safety net changed the face of homelessness; public housing, social security, labor programs, and development to eliminate skid rows reduced homelessness. Despite this, lack of affordable housing, specifically in low income areas and public housing, has contributed to an increase in the homeless population because of harmful development strategies (Mitchell, 2011). Development in these areas either fails to occur or the area is gentrified. These developments, also, left the remaining homeless stigmatized as an "undeserving poor" that were homeless because of personal failure irreconcilable with society.

In short, those in poverty are there despite existing policies and, as such, must be choosing to be impoverished, making them unworthy of outside help. This stigma is far reaching and impact the chronically homeless in a myriad of ways. For example, criminalization of the homeless through vagrancy laws add to the burden of homelessness rather than try to solve the problem. In Austin, Texas, homeless individuals were seen as an obstacle to downtown revitalization, as many gathered in the city center for access to available services. The City Council's response was to pass a $500

fine for sleeping or attempting to sleep in public (Tretter, 2016). Treatment first programs have also evolved from this stigma, as the solution to homelessness is rooted firmly in the ability of the individual to help themselves first, through overcoming addiction for example. The policies in place that have been shaped by the stigmatization of an "undeserving poor" rely on the individual first proving themselves deserving of help and continue to punish those who refuse to or are unable to justify receiving aid.

Classification of the homeless as an "undeserving poor" provides an excuse for inadequate policy and stigmatization, allowing for continued worsening of the structural conditions that cause homelessness in the first place. Homeless individuals left behind by New Deal programs and the Progressive Era became a symbol of personal rather than policy deficiency. Katz (2013) described two types of characterizations of the "undeserving poor": either individuals in poverty are immoral, unskillful, and lazy or individuals are inherently flawed to cause intellectual, moral, and economic failing. Both characterizations garner little sympathy, making the homeless appear to have been fully responsible for their poverty and failure to work their way into restored economic prosperity. Continued stigmatization of the chronically homeless as an "undeserving poor" allows for policy neglect, leaving those individuals responsible for their own treatment. It is not possible for the chronically homeless to succeed in a system designed, at best, to ignore them, and at worst, to stigmatize them as inefficient and undeserving members of society.

Within the homeless community, the chronically homeless are specifically vulnerable and underserved. The U.S. Department of Housing and Urban Development (HUD) (2018) defines chronic homelessness as "an individual with a disability who has been continuously homeless for 1 year or more or has experienced at least 4 episodes of homelessness in the last 3 years where the combined length of time is at least 12 months." Disability often occurs in the form of mental illness, making long-term permanent housing difficult to maintain or afford, hence the great lengths of time spent chronically homeless. Without permanent housing, chronically homeless individuals struggle to meet basic daily needs, like safety, let alone higher order tasks society expects, such as applying for jobs or voting – both of which may require an address. In just one January night, HUD (2018) surveyed approximately 98,000 chronically homeless individuals, two thirds of whom were improperly sheltered, residing in unlivable and unsafe conditions either outside, in vacant buildings, or elsewhere. For many chronically homeless individuals, a pathway to permanent housing has been unavailable or inefficient. Many rely on the shelter system for housing, forcing the system to work outside of its temporary and emergency care capacity. The basic needs, especially housing, of chronically homeless individuals is failing to be met by the current system.

Overreliance on the shelter system to treat the needs of chronically homeless individuals neither manages cost nor addresses structural deficiencies in homelessness care. Kuhn and Culhane (1998) calculated that despite their low population, accounting for 9.8% of their sample size, chronically homeless individuals used 46.9% of available shelter beds. In 2018, HUD reported that chronic homeless made up 24% of the homeless population in the United States. Temporary housing at shelters is best used for transition from homelessness into permanent housing, not as permanent housing. Shelters should be the emergency care model for short-term homeless populations, not the chronically homeless. An overreliance on the shelter system to treat chronic homelessness overburdens the system, harming emergency care programs ability to reduce and prevent homelessness. Despite the amount of resources required by the shelter system to house the chronically homeless, the financial burden of doing nothing is equally significant. Gladwell (2006) reported that Murray Barr, a chronically homeless individual living in Nevada, in 10 years cost the state an estimated $1 million in combined expenses mostly from costs related to alcoholism, including medical expenditures like hospital and doctor bills and substance abuse treatment cost. A specialized care model of treatment for the chronically homeless is necessary to ensure the effectiveness and efficiency of the entire homelessness treatment system.

A SHIFT TO HOUSING FIRST

The primary failing of treatment programs of the chronically homeless is the lack of emphasis on housing. Rather than treat chronic homelessness as a housing problem, treatment first programs fall back to the reigning paradigm of an "undeserving poor," forcing chronically homeless to prove themselves housing ready. Treatment first programs follow a continuum of care model; homeless individuals must complete gradually less restrictive stages of treatment for mental illness and substance abuse. Each stage is designed to either treat a diagnosis or teach skills determined necessary for successful placement in a home. However, individuals often live in nontraditional housing settings during treatment and can face eviction for failing to progress on the continuum. For individuals that complete the stages, many programs provide inadequate transition to independent living in permanent housing (Ridgeway & Zipple, 1990). Treatment first has proven to be an ineffective model because it fails to treat homelessness with housing. Forcing chronically homeless individuals to prove housing readiness while denying them autonomy creates a system designed to fail; group living does not adequately prepare for independent permanent housing, and mental illness or substance abuse should not be disqualifying factors. A reputation for failure and over control discourages chronically homeless from seeking out these programs as well (Tsemberis, Gulcur, & Nakae, 2004). Treatment first is an unsustainable and ineffective emergency care model that perpetuates the discriminatory "undeserving poor" philosophy in chronic homelessness policy, necessitating a paradigm shift to another more efficient and fairer emergency care model.

The Housing First model effectively addresses the failings of the treatment first model, proving the necessity for its shift to the primary emergency care treatment for chronic homelessness. Housing First, pioneered by Sam Tsemberis' Pathways to Housing organization, treats homelessness as a housing problem rather than a side effect of individual conditions. The model treats chronically homeless individuals with autonomy and respect, and places the priority of treatment on long-term permanent housing and harm reduction. Housing First emphasizes individual choice and provides an apartment without prior conditions or progress on a continuum. The program allows individuals to choose the level of treatment they wish to receive, often providing optional treatment services independent of housing. Chronically homeless individuals receiving permanent housing through the Pathways to Housing model must meet only two conditions to maintain their housing. The first condition is contributions to rent, generally 30% of their income, which is most often in the form of Supplemental Security Income, and the second of which is attending bimonthly meetings with a Pathways housing services employee (Tsemberis, Gulcur, & Nakae, 2004). Housing First programs offers supportive emergency care unbiased by the "undeserving poor" philosophy; the program assumes housing is a right. Access to permanent housing allows chronically homeless individuals to regain control of their lives, as seen in the

widespread examples of program success. Program success translates to greater success in long-term permanent housing, treatment of mental illness and substance abuse, and individual satisfaction.

Housing First has demonstrated success in effectiveness in treating chronically homeless individuals. McNaughton, Nicholls, and Atherton (2008) found Pathways to Housing reported an 85% success rate in long-term, permanent housing, while Project Renewal, another Housing First program, reported a 75% success rate. Finding and maintaining permanent housing for chronically homeless individuals is a difficult task; Housing First programs recognize the importance of consistency and stability. Commitment to establishing long-term permanent housing even if a chronically homeless individual fails in their first placement demonstrates the values of Housing First. With an emphasis on housing, rather than treatment or housing readiness, Housing First programs remedy the primary difficulty chronically homeless individuals' face – lack of shelter – and stand out as a treatment model that is consistently able to meet the unique needs of the chronically homeless population.

Remarkably, the Housing First model not only increases the number of chronically homeless individuals in permanent housing but does so more efficiently than other treatment models. The HUD Veterans Affairs Supportive Housing program significantly reduced time to placement in permanent housing for chronically homeless veterans through a Housing First plan compared to treatment as usual plans, dropping from about 223 days to about 35 days (Montgomery, Hill, Kane, & Culhane, 2013). Reduction of time to placement for housing is vital for effectiveness and reputation, the burden of living unsheltered is not abated by the knowledge of being placed on a waitlist. Without a reputation for efficiency, Housing First programs will lose credibility among the chronically homeless population, much like treatment first programs have. Housing First programs reduces procedural time and operates efficiently and effectively to place chronically homeless in permanent housing as quickly as possible. Housing First programs are successful because the model rejects the stigmatization of an "undeserving poor" and commits to treating homelessness with housing, leading to widespread implementation.

IMPLEMENTATION OF HOUSING FIRST

The Pathways to Housing model has been broken down into more generic core factors of Housing First that HUD has endorsed as the best practice model for treatment of chronic homelessness. HUD (2014) listed the core components as "few to no programmatic prerequisites to permanent housing entry," "low barrier admission policies," "rapid and streamlined entry into housing," "supportive services are voluntary," "tenants have full rights, responsibilities, and legal protections," "practices and policies to prevent lease violations and evictions," and "applicable in a variety of housing models." In general, the priority is on placing and keeping chronically homeless individuals in permanent housing with success being measured in long-term housing stability rather than treatment goals. As a specific emergency care program for chronically homeless individuals, Housing First relieves the burden on shelters designed for short-term care and reduces costs associated with hospitalization and policing. HUD's adaptation of the Pathways to Housing model establishes the necessary core principles urbanized areas must retain in their adaptations but leaves room for program flexibility.

In combination with HUD's Housing First brief, the Housing First Fidelity Model provides guidelines for other programs to adopt and implement successful Housing First models designed to fit local needs of urbanized areas. Watson, Orwat, Wagner, Shuman, and Tolliver (2013) surveyed 51 treatment programs classified as either abstinence based, Housing First with abstinence principles, and true Housing First to determine common characteristics associated with success. The survey demonstrated a significant but weak correlation between fidelity to true Housing First and housing retention. Adaptation of the model to fit the needs of the urbanized area implementing a Housing First program is essential for program success. Utilizing resources like HUD's Housing First brief or the Housing First Fidelity Model provide guidelines to maintain the integrity and consistency of Housing First programs that treatment first failed to achieve, but also allows urbanized areas to design programs for local success.

To be successful across the United States, urbanized areas must shape Housing First to fit their needs. There are resources available to aid in policy adaptation, such as the HUD Housing First brief or the Housing First Fidelity model previously described. Housing First need not be an exact replica so long as the spirit of the endeavor is maintained. That is, housing is prioritized as an unconditional right and chronically homeless individuals are afforded autonomy. Housing First works because it does not place the individual at fault like treatment first programs do, rather it focuses on resolving the main problem – housing – rather than trying to solve individual problems exacerbated by housing insecurity as a prerequisite to housing. Homelessness is solved by housing; individual improvements will follow (and can be aided by the same program) once that basic need has been met.

Housing First has found success in a diverse range of urbanized areas while still maintaining program integrity. Utah and California have adopted statewide Housing First policy areas, while New York City and Chicago, Illinois, have local programs. The city of Salisbury, Maryland, a small urbanized area on Maryland's Eastern shore, has adopted a Housing First program and is the first urbanized area with a population under 250,000 to do so. Salisbury's FY2020 budget aimed to increase the current chronically homeless population served, expanding from 20 to 29 chronically homeless individuals placed in permanent housing (City of Salisbury, 2019). This is an example of adaptation of the program to fit the needs of the urbanized area in that it has been scaled to fit the city budget, a barrier to entry that could not be avoided at the time of implementation. Housing First programs succeed in these diverse urbanized areas because the core principles of Housing First are uniquely adaptable. The flexibility of the Housing First model allows for local adaptation that facilitates program success and effectively treats chronically homeless populations residing in urbanized areas.

AFFORDABLE HOUSING CRISIS

The assumption of available housing has been apparent so far in the discussion of treatment of chronic homelessness. However, what emergency care programs, including Housing First, fail to do is address the structural conditions like lack of affordable housing that contribute to chronic homelessness and treatment program failure. While the adoption of Housing First is vital to treatment of chronic homelessness, emergency care programs will become overburdened without proper measures to address the Affordable Housing Crisis, which not only hinders emergency care programs but also directly contributes to the rising chronically homeless population. While urbanized areas must adopt Housing First programs for reasons previously outlined, simultaneous treatment of structural causes of homelessness like lack of affordable housing must occur to ensure the success of emergency care programs and lead to the eventual prevention of chronic homelessness.

The housing market must maintain a complex balance of demand, development, and mobility to ensure overall affordability. Since the 2008 recession, lack of housing affordability in the United States has continued due to overall scarcity compounded with little development outside of the high-end market. Rather than development outpacing housing demand, necessary to ensure mobility in the housing market for new buyers while keeping cost down, development has struggled to maintain replacement levels (Joint Center for Housing Studies of Harvard University, 2019). The stagnation of the housing market has crippled rental properties, leading to increasing rental costs that are either unaffordable themselves or with rents so high as to limit the possibility of buying a house. Housing has become unaffordable due to the combined loss of four million low-cost rental units from 2011-2017 and rising average house costs, with some urbanized areas reaching $1 million. One-third of renters and homeowners pay over 30% of their income toward housing, some even paying over 50% (Cohen, 2019). Affordable housing simply does not exist and there is little incentive for private development; the current system leaves little profit available. Without government reform to produce and protect affordable housing units, costs will continue to skew upwards as scarcity undercuts demand.

Government programs designed to maintain affordable housing access have been neglected and are in need of serious policy overhaul. Urbanized areas cannot rely on current federal programs to meet the urgent needs of their chronically homeless populations. The most notable of federal programs to consider in relation to chronic homelessness is the Section 8 Housing Choice Voucher. Under the voucher program, low-income individuals, of which 36% of current recipients are disabled, can rent from private rentals or purchase a house, paying only 30% of their income with HUD paying the difference. However, only a quarter of eligible applicants ever receive a voucher and the burden is on them to find a landlord willing to rent to voucher recipients (National Low Income Housing Coalition, 2019). Not only are properties nonexistent because of the Affordable Housing Crisis, but programs designed to support low-income individuals are limited, overburdened, and minimally protective against discrimination. Overreliance on federal housing policy and HUD programs, like the Section 8 Housing Choice Voucher, by urbanized areas will cause the Affordable Housing Crisis to worsen, weakening the effectiveness of homelessness policy.

The Affordable Housing Crisis indicates necessary structural changes to the system of chronic homelessness treatment for proper prevention to be possible, as lack of affordable housing has led to an increase of chronic homelessness. Bryne, Munley, Fargo, Montgomery, & Culhane (2013) found a positive correlation between adult homelessness and rent level and a negative correlation between adult homelessness and homeownership rates in urbanized areas. Higher rent levels mean higher rates of homelessness, and, conversely, higher homeownership rates mean lower rates of homelessness. The Affordable Housing Crisis has exacerbated these factors; there are more chronically homeless individuals and less housing available to treat them properly. The National Association of Home Builders (2019) has consistently ranked Californian cities among the least affordable for housing from 1991-2019. Simultaneously, HUD (2018) reported California as having 49% of the nation's unsheltered chronically homeless population, with 85% of the Californian chronically homeless population being unsheltered. The link between affordable housing, chronic homelessness, and homelessness treatment is clear. Without addressing affordable housing, increasing rates of chronic homelessness will continue and eventually overburden the Housing First programs designed specifically to treat chronic homelessness. Urbanized areas must combat the Affordable Housing Crisis locally while implementing Housing First programs to establish proper emergency care of homelessness, and eventually, develop a system of prevention.

STRATEGIZING SOLUTIONS

Urbanized areas must adopt a number of strategies to improve housing affordability locally to compensate for lack of efficient federal programs to address the structural conditions of homelessness. Without a safety net designed to keep homes affordable and place chronically homeless individuals in those homes, effective emergency care and prevention of homelessness will not be possible. Comprehensive change to the structural conditions is not possible without support in Washington and HUD reform, but local changes in development can ease the pressure of the Affordable Housing Crisis, which in turn will lead to a prevention of chronic homelessness when paired with Housing First.

Increasing development of new and existing homes while ensuring affordability and easing scarcity for low-income renters is essential for the recovery of the affordable housing market. Urbanized areas must incentivize development, specifically of affordable housing. Building affordable housing units is not cost productive; the labor pool is smaller, land is more expensive, and Not in My Backyard (NIMBY) activists oppose development of properties specifically intended as affordable housing (Joint Center for Housing Studies of Harvard University, 2019). Through reduction of restrictive zoning practices, urbanized areas can ease the regulatory process and limits on housing types that disinterest developers while adding inclusive zoning measures to stipulate a necessary number of affordable housing units built in an area. Promoting community land trusts will reduce the price of land as well, removing another barrier to cost-productive affordable housing projects. NIMBYism thrives on the narrative of the "undeserving poor," often stalling and increasing cost of development because of their bias (National Low Income Housing Coalition, 2019). However, urbanized areas must prioritize affordable housing units over the high-end, single-family housing developers seek to build. Increasing availability of affordable housing will reduce the scarcity that has driven rental prices so high. However, urbanized areas convincing developers to build affordable housing units only works to relieve the Affordable Housing Crisis if low-income renters can afford the housing.

Income stagnation and rising cost of rent or homeownership has exacerbated the Affordable Housing Crisis, necessitating a raise in the minimum wage to balance out affordability. The National Low Income Housing Coalition (2018) estimated that, using the United States' mean fair market rent, an individual would be unable to rent a two-bedroom apartment on the federal minimum wage of $7.25 an hour unless they worked 122 hours a week or 99 hours a week for a single-bedroom apartment. Even among the states with the highest minimum wages, cost of housing simply out paces possible earnings. Alone, raising the minimum wage will not make housing affordable, but when combined with developmental solutions to increase availability, the difference between income and cost becomes much smaller. Even though many chronically homeless individuals live on fixed incomes and would not directly benefit from an increase in minimum wage, policy change will help relieve the burden on federal housing assistance programs. However, policy alone will not be enough to implement the necessary structural reform to homelessness and housing policy.

The most difficult challenge facing comprehensive structural reform to chronic homelessness treatment – the reason why Washington has been ineffective at crafting comprehensive

housing policy, and the recurring theme of this paper – is the lasting stigmatization of the "undeserving poor" that dominates public opinion. Unless public perception of the chronically homeless changes, continued resistance to the necessary developments and policy measures by Not in My Backyard activists will railroad efforts to improve the Affordable Housing Crisis and availability of Housing First. Such sentiments can be overcome.

The Rhode Island Coalition for the Homeless (RICH) successfully organized a five-month grassroots movement to restore the Neighborhood Opportunities Program (NOP). The program, which had been previously cut by the governor, had implemented a Housing First program with a 90% success rate that saved an estimated $7,946 per individual housed (Ryan, Jeffreys, Ryczek, & Diaz, 2014). RICH utilized a multifaceted public relations campaign targeted at informing the community and convincing lawmakers of the necessity of protecting housing as right, that not only was it fiscally responsible but also morally responsible. Social media, letter writing, and phone campaigns all helped in disseminating material. Simultaneously, media and face-to-face interactions at events raised awareness and lobbying efforts put pressure on lawmakers. RICH even lead a tent tour through the state, putting up tents in green areas to demonstrate the increase that would occur without NOP and to make homelessness a more tangible problem for residents. The success of the campaign relied on convincing the public to support NOP and convincing lawmakers that the public supported NOP so as to be willing to provide funding. Without a shift in public opinion in support of chronically individuals and in the programs necessary to treat and prevent chronic homelessness, lawmakers will not allocate the necessary funding on a state or federal level.

The necessity of a grassroots movement is indicative of a national attitude apathetic to the plights of the "undeserving poor." Urban areas must set the example by leading campaigns for public opinion in support of homelessness policies like Housing First. Through specific policy reform and ideological shift, chronically homeless individuals will benefit from effective treatment and systemic changes that lead to overall prevention.

CONCLUSION

Effective treatment of the chronically homeless demands structural overhaul of the homelessness treatment system through a two-sided approach. Improvement of current emergency care through Housing First and increased prevention through Affordable Housing Crisis solutions will introduce a paradigm shift in homelessness and housing policy. The stigma of an "undeserving poor" has pervaded the public consciousness, and unless grassroots movements to educate the public occur in urbanized areas, homelessness and housing policy will continue to suffer. Urbanized areas must take responsibility to adopt Housing First policies and implement developmental strategies to ease the impact of the Affordable Housing Crisis and take efforts to change public opinion. Policies for treatment and prevention of chronic homelessness, which will finally adequately address the needs of an oft underserved and ignored vulnerable community, are possible. Change happens in backyards.

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Women's Education and Careers:

Understanding the Gender Gap in

STEM and Engineering

Brianna Domenick

ABSTRACT

Encouraging gender equality is important for diversifying fields of study and professional careers. Research has been conducted on how to encourage young girls to develop an interest in engineering and sustain their enthusiasm through college to obtain employment in the STEM field. However, this research has not established practices that show any significant change in the number of women who are successfully completing engineering degrees and obtaining careers in the field. This article focuses on practices that have been implemented in biology course curriculums and the workforce that have worked to close, or vastly reduce, the gender-gap in biology degrees and employment granted to women, along with how they could be applied to engineering to have the same effect. Using primary sources about both the best practices in biology and what is currently being implemented in engineering, this paper argues that methods such as active learning and gender matching can be applied to engineering.

INTRODUCTION

The gender gap in STEM and engineering is often examined by looking at the difference between male and female students and workers. A majority of research on this topic is approached in the binary, so this paper will as well; however, it is important to recognize that gender is non-binary. Female and nonfemale students along with engineers should be concerned with the lack of female representation in both engineering degree programs and in engineering professions. Teams with both males and females are able to compile more perspectives together. Research has demonstrated that female students are less likely to choose any STEM major (science, technology, engineering, and math) when they exhibit a stricter adherence to stereotypical femininity (Beutal, Burge, and Borden, 2017). Even when considering all these factors, the gender gap in STEM degrees has been on a gradual decline for several years, even though this is not true for engineering (Fisher, Mendoza-Denton, Patt, et. al, 2019). Research also shows that implicit biases against women in engineering are well ingrained in students by high school, so it is important that female students are reached at a young age (Bystydzieński, Eisenhart, and Burning, 2015; Sullivan and Bers, 2018). This article attempts to identify what practices can increase the number of female engineers, which will contribute to the larger scholarly discussion about career-related gender-gaps and gender-equality concerns in the United States. Constructive methods have been suggested by researchers to decrease the gender gap in engineering, but the best solution is to utilize the ideas that have already been successfully applied in biology, another STEM field, and apply them to engineering. By applying best practices from the field of biology, the number of women that successfully complete an undergraduate engineering degree and obtain employment in the engineering field may increase.

WOMEN'S EDUCATION AND CAREERS

There is a false societal impression that women attend college at a lower rate than men. This perception allows people to dismiss gender gaps in certain fields by claiming there is a gender gap in college institutions. Regardless of these inaccurate assumptions, women make up the majority of college graduates, a fact that has been true for over two decades (National Center for Education Statistics, 2018). Women earned approximately 57% of bachelor's degrees in 2018, continuing an over 20-year period of women earning more degrees than men (National Center for Education Statistics, 2018). Even though women have this majority, female graduates still hold less than 40% of STEM degrees (Fisher, Mendoza-Denton, Patt, et. al, 2019). Women tend to hold degrees in fields such as psychology, nursing, and business administration (National Center for Education Statistics, 2016). Because women do not obtain bachelor's degrees at a lower rate than men, the problem, then, may lie with inherent cultural biases regarding STEM. There is nothing preventing women from seeking higher education on a systemic level or seeking degrees in most other areas of study; however, there is something preventing females from pursuing STEM at the same rate as men. Since this is the case, the problem can only be attributed to the STEM programs, or to misogynistic cultural stigmas surrounding them.

These intolerant beliefs affect people's assumptions about working people as well as university attendance. Outdated ideas about the composition of the workforce can have a similar impact on the perception of working women. Approximately 47% of the workforce is currently comprised of female laborers (U.S. Department of Labor, 2010). While not exactly half, women were projected to account for 51% of the increase in the growth of the labor force between 2008 and 2018, showing that the percent of females in the labor force continues to increase (U.S. Department of Labor, 2010). It could be assumed that because there are less women in the total workforce, it cannot be expected that they hold STEM jobs in comparable numbers to men; however, this assumption is unsupported by evidence. The growth of women in STEM does not match the growth of women in the overall labor force. The inequality in STEM jobs must be contained in STEM, since that is where the discrepancy is seen.

One could argue that the reason for this difference is because there are inherent biological differences between males and females. These denigrated cultural ideas in the United States can be seen in children starting as young as elementary school and are one of the main causes for the gender gap in math and science fields. Starting in childhood, young girls are receptive to the biases of the adults around them. Beutel, Burge, and Borden (2017) found that when females exhibit a stricter adherence to stereotypically feminine traits, they are

far less likely to pursue STEM majors in college. These findings suggest that STEM degrees are not considered feminine, so when young girls realize that STEM is not associated with femininity or women, they become less likely to take an interest in it as to ensure they are displaying feminine traits. These stereotypes directly impact both how young girls perceive themselves, how they feel they should act, and what they take interest in.

Gender normative stereotypes are completely unfounded and unnecessary. Wang and Degol (2016) found that there are little to no biological differences in the brains of male and female elementary school children. Their research also concluded that any biological differences that do exist would play little to no role in determining areas of interest or excellence in children. This means that despite stereotypes, biology has little to no effect on the discrepancy seen between what young males and females find interesting or worth pursuing. Discrepancies that are seen in childhood interests largely derive from the same cultural norms that push women into other majors and jobs later in life.

GENDER GAP IN STEM AND ENGINEERING

Although the gender discrepancy in STEM remains apparent, there is potential that it will close sometime in the near future. Fisher, Mendoza-Denton, Patt, et. al (2019) found that the percent of women in STEM is increasing and likely will continue to increase, saying that even though women currently hold less than 40% of these degrees, the percent has rapidly increased over the last several years and will likely continue to do so. Fisher, Mendoza-Denton, Patt, et al. (2019) noted that the main reason for the increase is that women are entering STEM degrees at a higher rate and choosing to transfer out of them at a lower rate. Interestingly, these statistics do not hold true for all STEM disciplines, specifically engineering and computer science.

The problem in STEM results directly from the gender inequality in engineering. The fact that women hold around 40% of STEM degrees only applies when all disciplines are considered. When the number of engineering and computer science degrees held by women are removed, females actually hold the majority in all other fields of study (National Center for Education Statistics, 2016). Rincon (2019) analyzes these statistics in her research. According to Rincon (2019), women earned a combined 20% of bachelor's degrees in engineering and computer science. According to the National Center for Education Statistics (2016), only 11% of undergraduate engineering degrees were awarded to women. Rincon (2019) also noted that in 2017, only 9.5% of female freshmen intended to major in engineering or computer science compared to 27.9% of men. Even when women pursue engineering degrees in college, over one in four will switch out of the program (Rincon, 2019). Many women are deciding to leave engineering degree programs after enrolling, which is causing women to be severely marginalized in engineering degree programs (Rincon, 2019).

The number of women that become engineers is even more scarce. The number of women entering engineering degree programs is already low, and the number transferring out is high, at around 36% (Rincon, 2019). This means there are already very few women successfully receiving degrees in engineering. The women who do complete these programs often do not remain in the engineering field. According to Rincon (2019), only 13% of engineers are women. Of this 13%, only 30% will still be engineers after twenty years.

All of these statistics clearly indicate that this is an engineering problem. Every other area of study has been positively impacted by best practices that increase the number of women in their respective fields. Engineering is one of the only professions that has not seen any major impact (Rincon, 2019). Even in the broader category of STEM, the gap is beginning to close (Fisher, Mendoza-Denton, Patt, et. al, 2019). This means there is an issue in engineering undergraduate programs and in the engineering workforce that is going unaddressed. There is something specifically about engineering that separates it from most other areas of STEM that cause its gender gap to remain unaffected while introducing women to other areas of STEM is working so well everywhere else.

Understanding why this phenomenon persists is described by Ballen, Salehi, and Cortner (2017). According to their research, one significant reason that females do not become interested, or do not act upon any interest, associated with science or engineering is an absence of female mentors. Female students are receptive to the people around them starting from as young as elementary school. When young girls grow up without any female teachers or similar mentors, they develop an impression that women are not meant for that role. This discourages females in school from taking an interest in engineering and suppresses any interest they might have previously had. Young girls in school do, however, see themselves in areas like English or other humanities fields, so they assume those places are where they are supposed to be. This is the opposite for male students. They see themselves constantly represented by male teachers and mentors in science and engineering, which evidently encourages them to study in those tracks.

Hoh (2009) also speaks about the importance of mentors on females. Her research indicates that male and female mentors alike often hold implicit biases that affect how their students perceive scientists and engineers. Eaton, Saunders, Jacobson, and West (2019) found that professor's biases cause them to rate female students as less competent and hirable than their male counterparts with identical resumes. When these mentors unknowingly reinforce the idea that engineering is for men, they also reinforce stereotypes about engineers. Stereotypes are another reason for the gender gap in engineering. This phenomenon in part stems from stereotypical depictions of engineers as male figures. Hoh (2009) said that these stereotypes are prevalent to females of all ages. An absence of female mentors contributes to these stereotypical depictions. Young girls and college-aged women alike will not pursue engineering if they do not see an equal representation of their gender in the field. The same thing results when there is no representation of female engineers in popular media. When young girls only see men as engineers in the entertainment or professional industry, they become less inclined to envision themselves as engineers. Ballen, Salehi, and Cotner (2017) also found that when women are more represented in classroom depictions of any science profession, they become more interested in the material. This further demonstrates how a lack of female representation in engineering has created stereotypes that discourages young girls and adult women from seeking education or employment in the field as a consequence of societal norms that dismiss their interests at a young age.

Even though it has been disproven that biology plays a role in determining what males and females develop interest in, there is still a difference in how they best demonstrate their knowledge. Because these stereotypes are so prevalent, the way science and engineering curriculums are taught has been adapted for male learning and female students are expected to adjust how they learn. Ballen, Salehi, and Cotner (2017), noted a common occurrence in science courses, exams. This article mentions that there are performance discrepancies between male and female undergraduate college students in most STEM fields, including engineering. Ballen, Salehi, and Cotner (2017) claimed that this disparity is due to decreased exam performance by females. Women

report higher levels of test anxiety, and there is a negative correlation between self-reported test anxiety levels and exam performance. This pattern does not exist for male students since men have lower levels of test anxiety. Regardless of the level of anxiety, it is not associated with exam performance. This research cites psychological barriers as one substantial reason for this difference (Ballen, Salehi, and Cotner, 2017).

Women feel that they have to prove themselves on high-stakes assessments (exams, term-papers) in order to prove that they belong in their programs. This desire to perform well can often cause an increase in test anxiety, which can cause female students to score worse on exams than their male counterparts. Science and engineering courses rely heavily on exams to assess their student's learning, which demonstrates how curriculum is clearly geared towards male learning. Female students most often cite low grades as a reason for leaving science and engineering programs after introductory courses (Ballen, Salehi, and Cotner, 2017). When female students see that they are performing worse on exams than their male counterparts, they are more likely to leave, further increasing the gender gap (Ballen, Salehi, and Cotner, 2017).

One final major finding of this research is that interest in the subject and course performance are positively correlated for female students (Ballen, Salehi, Cotner, 2017). This is an especially important piece of evidence to consider when all the factors contributing to the gender gap in engineering are looked at in a cyclical nature. Often, young girls find themselves without many female mentors to look up to, whether they are in the classroom or elsewhere. Because of this predicament, people develop stereotypical ideas of what engineers look like, namely Caucasian males. Curriculum is then formed around what people believe is best for the students, but this may lead to a lack of female perspective in them. This causes female students to leave the engineering programs as curricula is not best suited for them, which results in fewer female mentors and a continuous cycle of gender inequality continues. If women could become more interested in engineering, more young girls would enter engineering programs and undergraduate women could see increased in their course performances. More women could then finish engineering degrees and female mentors would become abundant.

INCREASING ENGINEERING DEGREES FOR WOMEN

Increasing the percentage of undergraduate engineering degrees obtained by women has to start with encouraging their interest. Gottfried and Plasman (2017) found that the implications of the gender gap are already ingrained in students by the time they start high school. Mitigating these biases in student's most formative years can have large positive effects on increasing interest in females. Sullivan and Bers (2018) noted that elementary school girls in kindergarten through second grade were receptive to engineering curriculum through the use of specific robotics programs. When the KIBO robotics curriculum (one of several elementary engineering curriculums available for schools) was implemented, female interest, participation, and mastery of engineering concepts remarkably increased. The KIBO courses were also taught by an all-female team. In the preliminary surveys in this study, boys had a higher interest in becoming engineers compared to female students by a wide margin. After the curriculum was implemented, there was no longer a statistically significant difference in the children's level of interest. These findings support the conclusion that the gender gap starts in childhood and can be mitigated when curriculum is geared toward female students and they have female mentors to guide them.

Even though reaching female students in elementary school is often preferred, this type of approach is not only applicable to young children. High school girls could still benefit greatly from updated engineering curricula. Bystydzieński, Eisenhart, and Burning (2014) found that, contrary to popular misconceptions, high school is not too late to develop new interests in engineering. They noted that even though most available research focuses on elementary school children, female high schoolers are equally as capable of developing a serious interest in engineering. Bystydzieński, Eisenhart, and Burning (2014) found that a three-year program following sophomore girls thorough senior year increased their level of interest in engineering from 18% to approximately 50%. These results are promising, but do not address other factors, such as income. They noted that increasing youth interest was not enough to influence low-income female students to pursue engineering after high school. Khan and Rodrigues (2017) found that summer workshops increased lower-income girls' awareness and interest in STEM and increased the number of girls planning to continue in STEM after high school; however, this study did not specify engineering.

Another barrier that prevents interested female students from entering engineering degrees is standardized test scores. Ballen, Salehi, and Cotner (2017) noted that it is not only in introductory college courses where women are disadvantaged by exams. Because females report higher levels of test-anxiety, standardized testing like the ACT greatly disadvantages female high school students looking to get into highly esteemed majors, such as engineering because only women's scores suffer with increased test anxiety (Ballen, Salehi, and Cotner 2017). Standardized test scores are often one of the most important factors that admissions boards consider when deciding who to admit into college. Therefore, when women score worse than men, they are admitted at lower rates, even though standardized test scores do not accurately reflect their academic ability.

Certain practices from the field of biology have been implemented to mitigate factors that contributed to the gender-gap and they can be applied to engineering. One method known as active learning has worked to increase undergraduate degrees held by women. Ballen, Salehi, and Cotner (2017) explain what has worked in biology departments to prevent lower exam performances from women. Their research proposes that active learning, using formative and summative assignments to gauge performance, has shown significant results for equitable learning. Active learning often includes low-stakes, longer-term assignments such as group work, case-studies, and in-class worksheets and assignments. These types of assignments allow female and male students alike to be rewarded for long term preparedness and success instead of rewarding only male students for doing well on a few high-stakes examinations. This could cause a decrease in test-anxiety in female students which would allow for more accurate gauges of their performance in engineering courses. Because male students' grades overall are not negatively impacted by active learning (Balen, Salehi, Catner, 2017), this style of teaching will accurately assess which students are engaging with the material versus which students can perform well on exams.

Along with active learning, gender matching has been found to increase transfer of girls interested in biology into similar majors. Chen, Sonnert, and Sadler (2020) found that gender-matching (when both the student and the teacher are the same gender) increased female student's science identity in biology. Gender-matching in high school was shown to increase both male and female student's science identity. This stronger science identity encourages interested high schoolers to pursue biology in college. The implementation of gender-matching in college can be useful as well. Hernandez, et al. (2017) found that same-gender mentors in the first two years

of undergraduate studies had increase females' science identity. Gender-matching was able to diminish the effects of opposite gender domination on females in biology. High school females that are innately interested in science do not pursue this because this field is heavily dominated by men. They often transfer out for the same reasons (Rincon, 2019), but gender-matching was able to mitigate this without sacrificing the interest levels of male students.

These methods will not only work in high schools and colleges to teach biology. They can and should be applied to engineering programs so they can counteract the problems that arise through the ineffective methods that have already been applied. It is already known that girls of all ages have the capability to become interested in engineering, especially when that interest is nurtured through engineering curricula (Bystydzieński, Eisenhart, and Burning, 2014; Gottfried, Plasman, 2018). Applying the ideas of active learning and gender-matching to this curriculum has the potential to increase its effectiveness in transferring interested high school girls into college-level engineering programs. Utilizing more low-stakes assessments such as in-class worksheets and group work as opposed to making the courses exam-based will equitably encourage post-secondary studies of engineering among women (Ballen, Salehi, Cotner 2017). Employing the use of gender-matching can have similar effects on female students. A stronger science identity can allow female students to overcome the opposing force of male-dominated engineering spaces.

INCREASING ENGINEERING JOBS FOR WOMEN

Even if the number of females who successfully complete engineering programs and receive undergraduate degrees increased by using these methods, this does not guarantee employment in the engineering field. Gottfried and Plasman (2017) found that there is a clear disparity between the number of women that pursue engineering professions after college compared to the amount of men. This shows that while increasing the percentage of women who complete engineering undergraduate programs is a necessary and crucial step, it is not the only thing that needs to be done in order to close the gap. Other steps need to be taken in addition to the ones previously mentioned, and that starts with understanding why females are entering the engineering workforce at lower rates.

One such reason is discussed by Eaton, Saunders, Jacobson, and West (2019). As previously discussed, professors have implicit biases against female students. These biases lead professors to give female students worse evaluations than men, especially in categories such as competence and hire-ability (Eaton, Saunders, Jacobson, and West, 2019). Women were usually rated as being more likeable, but this trait does not guarantee a job when the rest of the evaluation is subpar (Eaton, Saunders, Jacobson, and West, 2019). Another reason women may not find jobs in engineering after college is because they choose not to. Rincon (2019) discussed how engineering is a male-dominated field and with that comes a male-dominated climate. The climate affects some women so strongly that about 30% of women who leave the field cite this discomfort as their reasoning. Along with the field being male-dominated, women earn about 10% less than men in similar engineering positions (Ricon, 2019). All of these factors combine to cause only 30% of women who earned engineering bachelor's degrees to stay in the field 20 years later, meaning 70% of females with engineering bachelor's degrees leave the field within 20 years.

The biology field at large has implemented policies that have counteracted some of these comparable issues. Similar to increasing undergraduate degrees, having more female mentors for women can mitigate male professor's biases. Eaton, Saunders, Jacobson, and West (2019) found that women getting jobs in engineering depends on professor's gender bias being accounted for because male professors routinely give female students worse evaluations. Having more female professors available to mentor women will allow those female students to be evaluated in a more equitable way. When more women can enter the engineering field because their evaluations are no longer worse on average than their male counterparts, this can influence the male-dominated culture of engineering by introducing more women into the space. Women may become more comfortable taking on engineering roles when they are surrounded by other women (Rincon, 2019). The cyclical nature of women not entering engineering because they receive worse evaluations, and in turn there being less women to mentor female students, causing unaccounted for bias, can be stopped if these steps are taken starting in college to introduce women into the workforce.

CONCLUSION

Despite the reducing gender-gap in STEM degrees, engineering is prone to a disproportionately large number of males entering the field and females leaving. Women make up only 11% of bachelor's degrees in engineering and only 13% of engineering jobs (Rincon, 2019). Increasing these disparities must start with developing interest among elementary school students (Sullivan and Bers, 2018) and continuing to support that dedication throughout high school (Bystydzieński, Eisenhart, and Burning, 2015). These steps have proven to be effective, but there are further actions that need to be taken. In addition to developing interest, young females must be provided with female mentors all the way through college in order to properly encourage women making the transition from college to the workforce (Eaton, Saunders, Jacobson, and West, 2019). Women do not enter engineering because they are unsupported in a male-dominated field. Then, because there are no women entering the field, there are less women to support interested youth. This cycle must be broken by encouraging female students to develop an interest in engineering at a young age. This may help curb stereotype formation in students' most formative years. The methods that have worked in biology curricula, where women are now the majority, such as active-learning and gender-matching, can be applied to engineering. Future research should focus on how all-female teaching teams affect young students stereotype development towards women in engineering and how active learning affects women's engagement in engineering. Engineering is depending on women to change the current dynamics and encourage talented young minds to pursue it.

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DETONATE

D'Shon Jae McCarthy

ABSTRACT

"Detonate," 48'' x 60'' oil and acrylic on canvas, 2020, is a self-portrait I created during a semester of learning from multiple visiting artists, finding my own voice and place in the art world. As the discussion of radical feminism and gender inequality continues to be a central topic of discussion in the 21st century, this 2019 painting titled "Detonate" is my take on these discussions. Particularly my conversations with two professors. Professor Jennifer Kruglinski from Salisbury University gave a delightful lecture where she went into the history of women not being taken seriously as artists, often having to fight to get a small amount of recognition. Women's bodies were often sexualized and were present in most men's famous work while women artists were barely recognized. In a separate conversation with Professor Mina Cheon from Maryland Institute College of Art, I asked her how she painted her series "15 Billion Years of the Traveling Atom" and how she used shapes, colors, and form. She later thanked me for appreciating her artwork through this process. These two women inspired me to take my own experiences and think about my own place in the art world as a woman and as an artist, as I painted myself in my most natural form. I combined the flatter and two-dimensional technique with the background shapes and flowers, and I used acrylic paint for that effect. For the figure, I used a more realistic approach with oil paint. The interaction between this realism of the form, the repetition of shapes as well as their overlapping, and the scattering of the organs (the heart, the lungs, and the brain) and flowers, I aimed to symbolize the things that affect me in positive ways but also make me feel like I am going to explode. These things symbolize my connection from the hardships of reality and the blissful ignorance from idealization. It is a beautiful thing to be a woman who thinks (the brain), that feels (the heart), and that not only survives but lives (the lungs) with the many obstacles in front of her, but it is also painful.

"Detonate"
D'Shon Jae McCarthy

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Deforestation Policies in Oregon and the European Union

Matthew Bernor

ABSTRACT

This research paper studies the adapting forest management policies of Oregon and the European Union. Starting with an evaluation of current policies in both regions, methods of preserving forestlands and coordinating policies with timber harvesting corporations are examined in depth. Adverse challenges that promote the enlargement of deforestation, increases in carbon emissions, and consequences for biodiversity are then analyzed from a political decision-making perspective. Comparisons of legislation that factor socioeconomic outcomes for forestry and climate change are explained in further detail. Conclusions about the sustainability of future deforestation practices are then considered on a greater scale while emphasizing the positive and negative implications of optimal policies in Oregon and the European Union. Providing an evaluation of deforestation policies within a state polity and an intergovernmental organization establishes a comparison of small-scale versus multinational policy implementation. This analysis should be advantageous for environmental political theorists when studying the contrasting climate mitigation methods of affluent westernized nations.

INTRODUCTION

Throughout the past modernizing centuries, forests in Northern America and Europe have been exploited for their natural resources to advance the ambitious growth of urbanizing societies. Deforestation is the process of thoroughly clearing forests and converting them into established settlements for agricultural, industrial, or residential accommodations.[1] Oregon and countries of the European Union depend on this method of cultivation to provide trade commodities along with supplementing agrarian and timber-based sectors of their economies. However, with these practices drastically affecting climate change and environmental sustainability, policies for preserving forestry are constantly improving and being implemented. Policymaking strategies vary moderately in both Oregon and the European Union as a result of influential corporations, governmental administrations, and non-governmental organizations. Both of their environmental policies include deforestation monitoring, enforcement, reforestation, climate mitigation, water protection, site planning, and wildlife conservation. Legislation has attempted to set basic standards for ensuring that the correlation between increases in timber production and climate change are minimized. Conceptualizing their interdependencies on timber economies has resulted in comparable cultivating practices; however, the effectiveness of their emission reduction policies and preservation of natural landscapes moderately vary in standards. Understanding the fundamental priorities of their policies initiatives presents an explanation of how the effects of these deforestation practices could result in a mitigation of carbon emissions.

OVERVIEW OF POLICIES IN OREGON

The Oregon Department of Forestry regulates and establishes the legal parameters surrounding their private and state-owned forests. In 1971, the Oregon Forest Practices Act (FPA) was enacted as the guidelines to supervise and protect every aspect of their forestlands, including the lawful harvesting of timber.[2] In regard to harvesting timber in the FPA, corporations must adhere to strict limits on clearcutting, replanting, water drainage, and tree buffers. These policies are expected to keep the timber trade sustainable along with maintaining wildlife safety and a cleaner ecosystem from adversities.[3] Clearcutting limits the size of harvesting to 120 acres in selective areas of private forestry. Loggers must also avoid cutting down trees near streams and known wildlife habitats. This is meant to protect biodiversity and water quality from contamination. For every tree that is harvested, another tree has to be replanted in its place within a two-year period. The purpose of this policy is to rotate the number of trees being cut down and replanted in a plantation style of harvesting. Therefore, the number of trees chopped down are eventually replaced by new ones, thus avoiding mass deforestation. Water drainage is also important to manage because chemical applications from pesticides and displaced sediment could potentially flow into streams and disrupt aquatic wildlife. Tree buffers act as a natural barrier between logging sites and populated habitats. These selective tree lines are also fundamental for keeping wildlife safe and the ecosystem clean. As significant environmental changes in Oregon often transpire, policies within the FPA are constantly being enhanced and revised to suit the necessities for maintaining the welfare of their forests.[4]

Even though these various policies protect Oregon's forestlands and reduce deforestation, almost 522,000 acres of forestry have been lost since the year 2000.[5] This is primarily due to timber and secondary based products becoming the largest exporters in Oregon since the mid-20th century. Glenn Adelson, the author of *Environment: An Interdisciplinary Anthology* has stated, "trees are being harvested at a rate that will ultimately jeopardize the sustained yield of the forests and the economy of the local region" (195).[6] In consequence of Oregon's timber industry, other environmental activists claim overly aggressive timber harvesting is unsustainable and has severe hazardous offsets. It is estimated that logging related emissions contribute 33 million metric-tons of carbon dioxide into the atmosphere annually.

Perhaps the most illogical shortcoming with deforestation legislation in Oregon is their carbon flux policy. This authorizes logging corporations to use a misleading forest carbon accounting system that records carbon captured on a yearly basis instead of the accumulation of carbon build-up over decades. With tree saplings being replanted for every tree harvested, logging corporations can claim that they balance emissions and that Oregon's forestry industry is a carbon sink instead of the state's main source of carbon dioxide emissions. Numerous NGOs monitoring this policy have reported, "the rules agreed on LULUCF at COP7 in Marrakesh were designed largely by the forest industry and driven by Annex 1 Parties seeking to evade accounting for emissions in the agriculture, forestry and land use (AFOLU) sector and to reach their emissions targets more easily" (8).[7] Based on a U.S. Geological

Survey, substantial volumes of carbon dioxide emissions are detrimental to forest growth and is even capable of killing trees, thus contributing to further deforestation.[8] Forests of the Pacific Northwest have the potential to eventually capture more carbon emissions per acre than any other forest on the planet unless climate smart practices and carbon sequestration policies are implemented.

OVERVIEW OF POLICIES IN THE EUROPEAN UNION

Within the European Union, the Commission is responsible for executing directives created by the Council of Ministers and the European Parliament. Policies regarding forestry are influenced by advisory boards within the Agricultural and Rural Development Committee (AGRI) then proposed for implementation. A variety of ordinances have been established to counter deforestation and preserve forests in European countries. Several of these include the EU Forest Strategy, Forest Law Enforcement Governance and Trade Action Plan (FLEGT), and the Common Agricultural Policy (CAP). These sections of legislation explicitly focus on preventing deforestation; however, they have become part of an overarching strategy of environmental actions instituted by the European Union with the priority of reducing climate change.

The EU Forest Strategy was enacted in 2014 to assist the European Commission with instituting forest policies among the twenty-seven member states. Aside from promoting the European framework of Sustainable Forest Management (SFM)[9] principles, the strategy also ensures that European states cooperate together in protecting the biodiversity of rural and urban communities, fostering sustainable harvesting within timber based industries, analyzing the effects of climate on forestry, expanding research of ecosystems in forests, protecting ecosystems and forestry, mitigating carbon emissions to resist climate change, monitoring forests and collecting information, and examining forests from a global perspective.[10] Implementing concrete actions in these eight priority areas has consequently diminished the effects of deforestation and established a coherent vision of using the multifunctional contributions from the forestry sector to advance the environmental objectives of the European Union.

In 2003, the FLEGT action plan was implemented to prevent illegally harvested timber from being imported into member states of the European Union. The purpose of the FLEGT action plan is to not only reduce the amount of criminal deforestation, but also incentivize private corporations in developing countries to establish sustainable timber industries. In order to accomplish this objective, the European Union provides financial assistance to countries that aspire to reform their illegal logging policies. After standards for timber harvesting systems are accepted, markets for timber products are identified in member states and the exchanging of capital resources between two countries is permitted. Timber entering Europe is controlled by Voluntary Partnership Agreements (VPA), these are standard assurance programs that improve governance by guaranteeing that imported timber is legal. Another aspect of this legislation involves monitoring organizations that facilitate the supply of timber to minimize the risks of illegally harvested timber from entering the European market. If illegal products are found, they are traced back to its source of entry into Europe.[11] Ultimately, this policy strives to counter deforestation by allowing only legal timber products to be purchased throughout member states of the European Union.

Practically every forestry specific fund or policy of the European Union is financed through the CAP; this includes investments in afforestation programs, prevention of forest fires, restoration of woodlands after natural disasters, research on forest degradation, and improving the development of forests.[12] Between 2015-2020, nearly €8.2 billion has been spent by the CAP on these various projects to provide sustainable forest management.[13] Together, these policies operate to construct common strategies among nations to counteract the effects of deforestation, limit the effects of climate change, and improve conditions for proper timber harvesting.

Europe is responsible for using forest biomass as its largest source of renewable fuel. Even though burning wood pellets is classified as carbon neutral (due to the offset in emissions provided by their reforestation), it is largely counterproductive not only for their anti-deforestation policies, but also their initiative to mitigate carbon emissions. Burning wood pellets for energy is more environmentally dangerous than it seems; not only is this fuel cultivated from cutting down forestlands, it could potentially contribute to an increase of nearly 15% European carbon emissions by 2050.[14] This is because newly planted trees are incapable of sequestering the amount of carbon produced after burning wood at a rate that is considered equal. It requires decades for trees to become large enough for this reabsorbing process. In addition to the carbon emissions from biomass power plants and pellet conversion factories, the international transportation of wood is also contributing to an unnecessary amount of carbon emissions. Increases in the dependency of this resource to power Europe sets a negative precedent for other countries searching for an inexpensive source of renewable energy. Severe effects from global warming are inevitable if Europe does not change its main provider of renewable resources to more sustainable methods.

COMPARISON OF POLICY ACHIEVEMENTS

Quantifying the prosperity of deforestation policies in Oregon and the European Union requires an evaluation of their effectiveness in various capacities. These include assessing the capabilities of preserving forestry, the coherence of their policy-implementation processes, reducing adverse consequences for other environmental issues, impacts of improving the socioeconomic conditions of communities, and establishing a sustainable timber trade.

Oregon is only a fraction of the size that the European Union is; therefore, deforestation policies that administer monitoring and enforcement operations require marginally less human and financial resources for surveillance. However, the CAP also offers a much higher rate of funding for preventing deforestation to compensate for the vast supervision of Europe's forestlands. Both regions financially endorse efforts of reforestation, but Oregon has explicit policies through the FPA that obligates logging corporations to replant multiple saplings for each tree that is cultivated. In comparison, the European Union promotes reforestation domestically and abroad through financial incentives and tax deductions. Oregon and the European Union share identical perspectives concerning the protection of ecosystems and biodiversity. Furthermore, their preservation policies to improve conditions for wildlife are of exceptional importance to conservation policy-makers.

Implementation processes for deforestation policies in Oregon and the European Union differ significantly. Since Oregon policies are on a single-state level, organization and coordination for preventing deforestation is straightforward and easier to manage. When new conflicts present themselves to obstruct forest conditions, the Department of Forestry drafts pragmatic strategies to resolve the issues then adapts them into the FPA. From the perspective of non-European Union states, the structure of institutions and political actors that influence forestry are very intricate. This is based in part on understanding how forest policies are formulated. Procedures for influencing

legislation from advisory boards that are then proposed to the Commission attests to the complex system these policies are under within the European Union. This process represents how agendas must go through multiple levels of scrutiny before becoming established legislation.

Even with progressive afforestation policies, Oregon and the European Union consume substantial quantities of timber. In an attempt to counter the adverse effects of logging on ecosystems, wildlife, and climate change, both regions implement a variety of regulations to maintain environmental sustainability. Policies from Oregon are catered to prioritize the prevention of deforestation from harming biodiversity in their water quality and wildlife habitats. Endeavors from private interest organizations and political activists to promote such policies are usually met with opposition by timber harvesting corporations that intend to maximize their profits. The European Union initiates legislation to protect biodiversity and wildlife as well, however, the main focus of their deforestation policies incorporates strategies to mitigate climate change. With European countries advocating for a reduction of carbon emissions and securing climate-neutrality, the forestry strategy and FLEGT are both steps to accomplishing these demanding targets. Unfortunately, both regions have still not adapted a fully carbon neutral approach to deforestation as examined with Oregon's carbon flux policy and the European Union's contingent burning of wood pellets for renewable energy.

Legislators have the responsibility of preserving forested communities while also mediating the impact of timber harvesting corporations and the logging workforce. In Oregon, policies work cohesively to manage this balance. Since logging predominantly occurs in privately owned forests, the amount of non-wildlife communities affected are less abundant. Oregon's deforestation policies also prevent ecological disasters through proper site planning and water protection. For the European Union, establishing this balance between corporations and communities is more challenging because their deforestation policies have to be accommodated for imports from foreign markets. Policies legislate over the 27 member states of the European Union, preventing illegal timber and moderating the effects of logging in transatlantic nations requires even more financial and human resources to manage. Comparatively, Oregon has no need for imported timber and therefore does not have any policies regarding this issue. With timber harvesting becoming more profusely used to satisfy the demands of society, controversies have arisen over the prospect of viability in deforestation. Policies concerning this issue in Oregon primarily focus on aspects of improving environmental preservation and supervising logging corporations. The European Union tends to strategize policies from the perspective of domestic and international forest protection virtues along with mitigating climate change and fostering renewable energy. Environmental benefits produced by forests are too valuable for countries to neglect. Providing natural carbon sequestration and increasing biodiversity means that trees have become fundamental for the sustainability of humanity.

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The Effects of Music and Movies on Dental Anxiety

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ABSTRACT
The aim of this study was to determine methods that alleviate physiological symptoms of dental anxiety. Past studies have shown that visual presentations of dental stimuli lead to increases in the sweat gland response measured by skin conductance. According to Kato et al. (2011), physiological palm sweating is a phenomenon that occurs with changes in emotions such as anxiety, fear, and stress. Previous research focused on the behavioral impact of movies or music on dental anxiety. However, the physiological effects have yet to be examined. For this study, participants were presented with dental tools and images of dental tools while their skin conductance responses were recorded. Participants were placed into one of three groups; the movie group had a movie playing while they performed the task, the music group had music playing while they performed the task, and the control group had nothing in the background. The data indicated that music listening was more effective at alleviating physiological symptoms than movie watching while being exposed to dental tools. Surprisingly, this was even more evident for those who were exposed to images of tools and less so for those presented with the actual dental tools. This pattern was strongest for those participants who scored high on the Dental Anxiety Scale.

Keywords: dental anxiety, psychophysiology, skin conductance

INTRODUCTION

Dental anxiety (DA) is an abnormal fear or dread of visiting the dentist for preventive care or therapy and unwarranted anxiety over dental procedures ("dental anxiety," n.d.). DA affects patients worldwide, an issue prevalent in Western and Eastern countries such as the United Kingdom, Germany, Australia, Sweden, China, Iran, and Singapore (Ng & Leung, 2008; Saatchi et al., 2015). In North America alone, approximately one in five adults are affected by DA which leads to avoidance behaviors of dental treatment (Boyle et al, 2009). Other data indicates that as many as 80% of Americans have some anxiety regarding dental treatment (Saatchi et al., 2015).

However, DA is not the only concern for patients receiving treatment. The scarcity of proper dental insurance also plays a role in DA. An estimated 49 million people in the U.S. do not have access to a dental care provider (Families USA, 2012) due to insurance network access regulations and geographic residency. Additionally, 47 million Americans who have private health insurance do not have dental insurance (Families USA, 2012). These limitations play a role in perpetuating dental care avoidance. Furthermore, the lack of regular appointments can lead to larger dental issues such as cavities, tooth decay, or gum disease, which can worsen DA symptoms. Regardless of insurance availability, Americans avoid dental appointments due to their fear of procedures and potential pain. Therefore, it is not enough to have coverage and access to providers, but it is important to also treat the underlying anxiety that keeps patients away from the dentist.

Park et al. (2016) conducted a study to examine the relationship between socioeconomic status and dental care. Their study evaluated how different socioeconomic statuses affected oral hygiene. The researches evaluated participants' socioeconomic status, oral health behavior, and their physical health. The results aligned with previous findings, as they found that oral health is significantly associated with various systemic diseases such as cardiovascular disease, diabetes mellitus, chronic respiratory disease, and rheumatoid arthritis (Jin et al., 2015; Linden, Lyons & Scannapieco, 2014). Moreover, another study conducted (Espinoza et al., 2013) on Chilean adults found that individuals who have low-paying jobs tend to have a higher degree of clustering of multiple risk factors for poor dental hygiene, as compared with those in higher socioeconomic positions.

DA induces both physiological and behavioral manifestations that impact a patient's compliance to dental visits and impacts their overall health. Behavioral alterations of patients as a result of DA includes restlessness, irritation, and avoidance of the dentist. This is a particular concern in pediatric dentistry (Welly et al., 2012). However, researchers found that dentist office atmosphere, veracity of the dentist, and communicative abilities of the dentist played a role in whether a child was cooperative or uncooperative (Welly et al., 2012). DA also evokes physiological symptoms such as palpitation, palmar sweating, and excess saliva secretion. Patients with severe dental anxiety can suffer from intense symptom tachycardia (faster than normal heart rate) such as high blood pressure (Mejía-Rubalcava et al., 2015). Palmar sweating is

a common physiological symptom among young children when visiting the dentist office, thus demonstrating their fear and anxiety of the procedure. Kato et al. (2011) worked with the Department of Pediatric Dentistry in Japan to assess the state of stress, fear, and anxiety of children by measuring the amount of physiological palmar sweating while at the dentist office. The study had a sample size of 12 boys (mean age of 4.9 years) and 12 girls (mean age 5.3 years). The researchers measured participants' palmar sweating in three different locations: the waiting area, on the dental chair, and during dental procedure (e.g., tooth brushing and turbine sound). Significant amount of palmar sweating in children was observed as they were guided to the dental chair from the waiting area. Secondly, the turbine sound caused more palmar sweating than tooth brushing during the procedure. Lastly, the girls exhibited a significantly larger amount of palmar sweating than did the boys (Kato et al., 2011). It is possible that the significant differences in palmar sweating between both genders are due to cultural norms allowing more emotional displays from girls than boys underlying this effect (e.g., Sharman, Dingle, Baker et al., 2019).

DA is a prevalent issue in children and young adults that causes several challenges for dentists when providing treatment for their patients. Numerous psychologists and scientists have stated that this fear often manifests itself during childhood, which is usually due to traumatic past experiences and modelling. Ollendick & King (1991) state that children's dental fear results from observing others (e.g., media, friends, family), leading to a vicarious threat response. These observations of others' fear toward dental procedures will most likely be internalized and create some level of dental anxiety. Moreover, a study conducted by Öst & Hugdahl (1985) on young adults notes that 13% of their dental phobia were traced from vicarious experiences during childhood. Additionally, the presence of dental tools, sounds, and smells associated with the dentists' offices are generally frightening and likely to increase the fear response. For example, Kleinknecht et al. (1973) found that anesthesia needles, drills, and other dentistry tools are the greatest source of fear that increases a patient's dental anxiety. The dental tools along with the invasive procedures may be disturbing enough to the patient that they limit follow-up treatment or fail to schedule future appointments.

Another causal mechanism of DA is patients' exposure to dentists with poor bedside manners. For instance, Milgrom et al. (1992) found that young adults were nine times more likely to be anxious of dental treatment if they thought their dentist was unsympathetic. This is because individuals are more appreciative of dentists who are more sensitive to their anxieties. Moreover, Weinstein, et al. (1982a, 1982b) found that dentists who were coercive toward patients struggled with uncooperative and agitated behavior during the procedure. In contrast, dentists who utilized a more sympathetic and friendly approach had more success getting cooperation and their patients reported being less anxious and more at ease during the entire procedure. Townend et al., (1992) also found that dentists' bedside manner affected patients' stress and anxiety which then affected their behavior during the procedure. These authors indicated that dentists can modulate a patients' anxious behavior by being responsive to their needs.

There are various pharmaceutical treatments to reduce stress and anxiety caused by dental procedures. Dentists can provide nitrous oxide to their patients that is inhaled before a procedure (Mejía-Rubalcava et al., 2015). However, the inhalation of nitrous oxide causes very unpleasant side effects (2015). This treatment option is not accessible for uninsured and under-insured individuals. It may also not be an option for those in rural communities or even those with full dental coverage, as insurance companies do not view this treatment as necessary. Therefore, patients must pay the difference if they choose to receive nitrous oxide. Additionally, in a study by Zhang et al. (2012), patients were given nitrous oxide and were asked to watch a movie of their choice as the dentist performed a dental extraction. The movie was included during the dental procedure to assess its effectiveness in reducing their anxiety by creating a distraction. During the procedure, the researchers recorded patients' heart rate, respiration rate, blood pressure, and lowest arterial oxygen saturation prior to being sedated and every five minutes during the dental extraction. Zhang et al.'s (2012) findings showed that movie intervention was effective at steering patients' attention from dental tools (such as syringes, scalpels, and dental forceps) and procedures. Thus, causing lower levels of patients' heart rate, respiration rate and blood pressure. In addition, patients who were given nitrous oxide only (no movie) remained nervous as they continued to focus their attention on the local anesthesia syringe, the noisy drill, the bright light, and other dental tools (2012). In turn, patients with lesser quality health insurance are left to explore alternative options such as medicinal marijuana and/or twilight sleep sedation.

Music therapy is another non-pharmaceutical intervention that some dentists have utilized to reduce DA in patients and improve their overall experience during an appointment. Music therapy has been used in multiple clinical settings to test its effectiveness in affecting one's mood and reducing pain during a dental procedure (Klassen et al., 2008).

Apart from music therapy, which is a non-pharmaceutical alternative used to alleviate dental anxiety, Kemp (2005) assessed various behavioral modification techniques that are applied to resistance of dental treatment. Some techniques are modelling, desensitization, education/information, parent control, and distraction (listening to music, watching a movie or comedy show). Desensitization is a behavioral technique in which the patient is gradually exposed to the fear object or situation – dental instruments or simulations of dental procedures (tooth extraction and root canals etc.). Kemp (2005) found that desensitization is effective but expensive because it requires several therapy sessions. In modelling, the patients observe a similar procedure being done on someone else either live or recorded. During the session, the patients get exposed to some coping mechanisms that are being used by the individual in real life or video. Research by Allen and Stokes (1989) concludes that modelling is generally effective for patients resisting dental treatment or feeling apprehensive.

The purpose of the current study was to assess the effectiveness of music or a movie in reducing dental anxiety. Participants were presented with visual images of dental tools while recording their skin conductance responses (SCR). Some participants were presented with the physical dental tools while others were presented with pictures of the dental tools. These Stimulus Type groups were randomly assigned. Additionally, participants were placed into one of three groups; the movie group had a movie playing while they performed the task, the music group had music playing while they performed the task, and the control group had nothing in the background. Finally, this study focused on how individual differences in general dental anxiety as a trait affected SCR while viewing dental tools (or images) in the various conditions. Toward this goal, we had participants complete dental anxiety assessments and categorized individuals into anxious versus non-anxious groups. Thus, the experimental design was a 3 Conditions x 2 Stimulus Types x 2 Dental Anxiety Levels Between Subjects design. Based on previous literature, it was hypothesized that the Music and Movie groups would exhibit reduced SCR compared to the control group while viewing the dental

tools. We were also interested in testing two other exploratory hypotheses. First, that the presentation of images of dental tools would not activate the autonomic system as much as the presentation of the tools themselves. Second, that those who scored high on the Dental Anxiety scale would exhibit increased SCR and that this would interact with condition and stimulus type.

METHODS

Participants

The participants in this study were 49 undergraduate students (44 females and 5 males) enrolled in Psychology 101 and other upper-level psychology courses. Each subject received extra credit in their course for participating in the study. All participants gave informed consent, were informed that they would be de-identified and that they could withdraw participation at any point during the study. Grades were not penalized for those who chose not to participate or opt out at any given time during the study. The mean age of our sample was 21(SD= 3.48). The sample was predominantly female (90%) and primarily Caucasian (66%; 14% African American; 11% Bi-racial, 6.8% Hispanic, 2% Asian American). A full breakdown of participant demographics can be found in Table 1.

Measures

Beck depression inventory

Participants were asked to complete the Beck Depression Inventory-II (BDI-II; Beck, Steer and Brown 1996) for screening purposes. The BDI-II is a depression inventory for adults and adolescents that consists of 21 self-report items. Not typically used as a diagnostic tool, it provides a good indication of individuals experiencing depressive episodes based on two weeks of symptoms. The inventory requires 6th grade reading comprehension and takes under 15 minutes to complete and to be scored (Groth-Marnet, 1990). Beck et al. (1996) found an internal consistency of .92 and test-retest reliability of .93. Individuals who scored high (above 14) on the report were flagged and prevented from participating in the research. Additionally, any participant who scored above 20 was also referred to the Salisbury University Counseling Center. Participants who were excluded from the research still received extra credit.

Norman corah dental anxiety scale

The Norman Corah Dental Anxiety Scale (DAS-R; Corah, Gale & Illig 1978) consists of four multiple-choice items asking the participant how they would respond to various events associated with visiting a dental office (e.g., planning a trip to the dentist, waiting in the dental office to be called, sitting in the dentist's chair while watching the tools be prepared). Each item has five possible responses and are scored by using the following format; a=1, b=2, c=3, d=4, e=5. The total sum score possible is 20 points. Patients scoring 9-12 points are considered to have moderate dental anxiety, those scoring 13-14 points are considered to have high dental anxiety, and individuals who score 15-20 points are considered to have severe dental anxiety. The scale's validity and reliability have been widely accepted and it is used in numerous dental facilities (Corah et al., 1978; Ilguy et al., 2005; Neverlien 1990). Internal consistency has been found to be .85 (Neverlin, 1990) and reliability has been found to be .82 (Ronis, 1994; Ronis, Hansen & Antonakos, 1995). Further, Ilguy et al. (2005) suggest the DAS-R is a sensitive and specific test as well. These items were programmed into E-prime and presented, one question at a time, to the participants who responded with button presses on the keyboard.

Dental concerns assessment

The Dental Concern Assessment (DCA; Clarke & Rusyold, 2015) is made up of 26 three-point Likert scale items (1=low anxiety; 3=high anxiety) asking about specific aspects of the dental office experience (e.g., sights, sounds, and sensations associated with equipment or personnel). A score of 2 or higher on any of the items is considered to indicate anxiety toward the dental procedure being queried. The DCA items were programmed into E-prime and presented, one question at a time, to the participants who responded with button presses on the keyboard.

Stress response to stimuli

The participant's stress response to the presentation of the dental stimuli was measured by self-report and by recording skin conductance responses (SCR). The DAS-R and DCA were measured by presenting the participant with a question on-screen via E-prime asking them to respond, on a five-point Likert scale (1=Not Stressful; 5=Very Stressful), how anxious the dental stimulus in front of them was making them. To measure their SCR, electrodes were placed on participants' non-dominant hand and the signal was amplified and recorded using Biopac (Goleta, CA) MP-150 equipment. After placing the electrodes on two of their fingertips, participants were asked to remain still for about one-two minutes before beginning the experiment to collect baseline SCR data.

Procedure

Experimental procedures took place in the Laboratory for Psychological Science in the East Campus Complex at Salisbury University. Upon arrival, participants were seated in the waiting area and were given a consent form, demographic questionnaire, and the BDI-II to complete. Once the forms were completed and written consent obtained, experimenters confirmed that the participant understood the purpose of the study and what the procedures entailed. Consent was verbally confirmed before the experimenter escorted the participant to the testing area. Participants were seated at a table in front of a computer and keyboard. Once seated, the experimenters attached electrodes to the middle of the pointer finger and the middle of the middle finger. Once the electrodes were attached, the participants were asked to remain still for two minutes before the experiment began.

Random assignment to experimental conditions

The participants were randomly assigned to an Intervention group (music, movie or control) and Stimulus Type condition (real stimulus or an image). Participants in the Music Intervention (MS) group listened to an Apple music station (No Lyric Playlist) during the experimental procedures. Those in the Movie Intervention (MV) group watched *The Incredibles* during the experimental procedures. The participants assigned to the Control group were exposed to no movies or music during the experimental procedures. Finally, participants assigned to the Real Stimulus (RS) condition were presented with actual dental stimuli, while those in the Image Stimulus (IS) condition were presented with pictures of dental stimuli.

Stimulus presentation

After being connected to the transducers, the experiment began. For the MV group, the movie was started, and for the MS group the music was played. The control was not presented with any movie or music intervention. Then participants were presented with four dental stimuli (dental bone saw, dental forceps, dental syringe, and dental scaler) while SCR was recorded. As described previously, for the participants on the RS condition these stimuli were the actual dental instruments while the participants in the IS condition were shown images of the dental instruments. While each stimulus was presented, on screen the participants viewed a five-point Likert scale item asking how anxious the stimulus made them. Once the participant entered a response on the keyboard the next stimulus was presented. After the four stimuli were presented, the participants completed the DAS-R and DCA on the computer. Upon completion of these tasks, each participant

was debriefed, provided with a copy of the consent form, given an opportunity to ask questions, and escorted out of the lab.

RESULTS

Skin Conductance

Table 2 shows the descriptive statistics for the mean SCR amplitude obtained within each Condition x Stimulus Type x Dental Anxiety Level group. Assumption of normality was observed to be satisfied for each of the variables (Schmider, Zeigler, Danay, Beyer, Buhner, 2010). Additionally, we verified that the assumption of homogeneity of variance was satisfied according to Levene's *F* test for Condition ($F(2,30)=1.39$, $p=.27$), Stimulus Type ($F(1,31)=0.19$, $p=.67$), and Dental Anxiety Level ($F(1,31)=0.005$, $p=.94$).

The SCR amplitude measures were submitted to a 2 (Stimulus Type) x 3 (Condition) x 2 (Dental Anxiety Score) ANOVA. A significant main effect of Condition ($F(2,21)=8.8$, $p<.01$, $\eta^2=.46$) was observed. Figure 1 shows the mean SCR amplitude for each of the three groups. Bonferroni-corrected post hoc t-tests (family wise error rate set at .05) indicated that the Music group (M=8.23 S, SD=3.62) attained significantly lower SCR amplitude than the Control (M=11.30 S, SD=2.48) and movie (M=11.10 S, SD=5.16) groups. No significant main effect of Image Type ($F(1,21)=0.75$, $p=0.40$, $\eta^2=.04$) or Dental Anxiety Score ($F(2,21)=0.004$, $p=.95$, $\eta^2=.0002$) was observed.

A significant Condition x Stimulus Type interaction was observed ($F(2,21)=3.61$, $p<.05$, $\eta^2=.26$). Figure 2 shows the mean SCR amplitude for the three conditions grouped by Stimulus Type. Post-hoc analyses indicated that in the Real Stimuli group, participants exhibited significantly different mean SCR amplitude responses depending on their assigned Condition ($F(2,11)=8.00$, $p<01$, $\eta^2=.59$). Specifically, participants who viewed Real Stimuli in the Music condition attained significantly lower mean SCR amplitude (M=5.91 S, SE=1.66) compared to the Control (M=13.10 S, SE=1.47; $p<.05$) or Movie condition (M=14.80 S, SE=1.47; $p<.01$). There was no significant difference between the Control and Movie condition when viewing Real Stimuli ($p=.45$). Post-hoc analyses further indicated that in the Image group participants did not exhibit significantly different mean SCR amplitude responses between Conditions ($F(2,10)=3.43$, $p=.07$, $\eta^2=.41$).

A significant Stimulus Type x Dental Anxiety Level interaction ($F(1,21)=4.78$, $p<.04$, $\eta^2=.19$) was observed. Figure 3 shows the mean SCR amplitude for the two Stimulus Type groups by Dental Anxiety Level. Post-hoc analyses indicated that Anxious individuals (those who scored 9 or higher on the DAS-R) exhibited significantly higher SCR mean amplitude responses to Images (M=13.67 S, SE=1.12) as opposed to Real Stimuli (M=9.99 S, SE=1.17; $F(1,12)=5.00$, $p<.05$, $\eta^2=.29$). There was no significant difference in mean SCR responses to Images versus Real Stimuli for non-anxious participants.

Figure 4 shows a significant three-way interaction ($F(2,21)=15.15$, $p<.0001$, $\eta^2=.59$). Post-hoc analyses indicated a significant Condition x Stimulus Type interaction for Anxious ($F(2,12)=7.60$, $p<.01$, $\eta^2=.56$) and Non-Anxious Participants ($F(2,9)=8.78$, $p<.01$, $\eta^2=.66$). However, further analyses showed that significant differences between Condition was only apparent for Anxious participants who viewed the Image Stimuli ($F(2,6)=9.54$, $p<.05$, $\eta^2=.76$). There was no significant differences observed between Condition for Anxious participants who viewed the Real Stimuli ($F(2,6)=4.15$, $p=.07$, $\eta^2=.58$) or for the Non-Anxious participants who viewed Image ($F(2,4)=3.17$, $p=.15$, $\eta^2=.61$) or Real Stimuli ($F(2,5)=5.34$, $p=.05$, $\eta^2=.68$). Specifically, for the anxious participants viewing Image Stimuli, those in the Movie (M=22.12 S, SE=2.84) group exhibited significantly greater mean amplitude SCR than those in either the Music (M=8.58 S, SE=1.27; $p<.01$) or Control (M=10.33 S, SE=1.67; $p<.05$) groups. There was no significant difference in SCR amplitude responses for Music versus Control groups ($p=.43$).

Self-Report Responses

Participants' self-reported anxiety level in response to the dental stimuli were submitted to a 3 (Condition) x 2 (Stimulus Type) x 2 (Dental Anxiety Score) ANOVA. A significant main effect of Dental Anxiety Score was observed ($F(1,21)=4.76$, $p<.05$, $\eta^2=.19$). Figure 5 shows the average self-reported anxiety level response for Anxious versus Non-Anxious participants. Anxious participants responded with significantly higher self-report anxiety levels (M=3.06, SE=0.21) to the dental stimuli than did the Non-Anxious participants (M=2.36, SE=0.23). There was no significant main effect of Stimulus Type of Condition and no significant interactions.

Participants' self-reported anxiety level reaction times were submitted to a 3 (Condition) x 2 (Stimulus Type) x 2 (Dental Anxiety Score) ANOVA. A significant main effect of Stimulus Type was observed ($F(1,21)=5.32$, $p<.05$, $\eta^2=.20$). Figure 6 shows the average self-reported anxiety level reaction time to Real Stimuli versus Images. Participants assigned to the Images (M=6547.57 ms, SE=666.71) group took significantly longer to record their responses than did those in the Real Stimuli group (M=4284.7 ms, SE=720.38). There was no significant main effect of Condition or Dental Anxiety Level nor were any significant interactions observed.

DISCUSSION

These findings partially support the main hypothesis. The main hypothesis was that the intervention conditions (Music and Movie) would exhibit reduced SCR while viewing dental tools. Indeed, music intervention conditions proved to be better than the movie or control conditions at reducing SCR. These findings are aligned with those of Klassen et al. (2008) and Kemp (2005). Klassen et al. (2008) found music therapy effective at reducing dental pain while Kemp (2005) found that music was an effective distraction for patients with dental anxiety. Participants in the music intervention condition produced smaller SCR consistently, regardless of stimulus type or dental anxiety scale score. However, the movie group's SCR responses were not significantly different from the control group. Further, there was no evidence of behavioral differences (self-reported anxious responses to the dental stimuli) between the three conditions. Participants reported the same levels of anxiety in response to viewing dental stimuli across all conditions and did not differ in their reaction times to the stimuli.

While it was predicted that anxiety level would have an impact on how participants were affected by the stimulus type or condition, this was only partially supported. Anxious individuals produced higher SCR when presented images of stimuli as opposed to the real stimuli. However, this difference was not significant for non-anxious individuals. Further, levels of dental anxiety did not significantly interact with condition (Music vs. Movie vs. Control). Thus, anxious and non-anxious individuals' responses varied similarly within each of the three intervention conditions.

Relatedly, these findings do not support the original prediction that viewing real dental stimuli would activate the autonomic system to a greater extent than viewing images of those stimuli. Although, the significant Stimulus Type x Condition interaction (see Figure 2) indicates that those participants viewing pictures of dental tools were not differentially affected by the condition (Music vs Movie vs Control) in which they were placed. Conversely, those participants presented with real dental stimuli elicited SCR responses that varied differentially according to condition. Those participants

in the Music condition who viewed real tools produced significantly smaller SCR responses as the participants in the Control or Movie conditions.

The sample of our research was not representative to the general population as 90% of participants were female and participants were of average college age. The difficulty in recruiting enough males and females from various ethnic backgrounds to produce a representative sample is very common in graduate and undergraduate research, especially at primarily white institutions. According to Ellard-Gray et al. (2015), minorities and vulnerable populations tend to mistrust the research process due to a long history of ethical violations by experimenters. In addition, minorities are more likely to be in greater financial struggles with limited assistance. To make ends meet, some students are required to have several part-time jobs. This, as a result, hinders them from participating in research studies or other extracurricular activities while enrolled in school. Therefore, future studies should make an effort to ensure that subjects are recruited with an even ratio of minorities to non-minorities to provide greater external validity and better representation of the general population.

Although a specific playlist and movie were used for this study, songs were randomly played and participants in the movie condition were shown different scenes from the movie (*The Incredibles*). Some scenes were more violent than others, so it is inconclusive if participants' SCRs are a result of the movie or the dental instruments. Future experiments should consider various alternatives such as allowing participants to choose their own playlist or to make a playlist from a restricted range of options. Notably, Zhang et al. (2012) also found that movie presentation was less effective at reducing dental anxiety. Additional confounding variables include the plethora of outside stressors experienced by college students during the semester. Another potential concern is related to the presence of the experimenter while presenting the real dental stimuli.

Future studies could potentially measure and examine the physiological response of each dental instrument to see which dental equipment elicits more anxiety. Future studies may also want to attempt to study the impact of music and movies in a more genuine dental office setting. Perhaps music and movies would have a different effect on actual dental patients compared to participants being asked to fill out surveys in a laboratory setting. Finally, general or trait anxiety measures would have been useful as a control measure. People with DA do not necessarily also struggle with general or trait anxiety. Conversely, our non-DA participants might have had general or trait anxiety and that might have affected their response to the dental stimuli. Therefore, comparing DA responses to the dental stimuli with those who have more generalized anxiety symptoms would be informative. Nevertheless, our findings provide insight on the positive effects of music for reducing anxiety for those who struggle with dental anxiety and provide an applicable tool to potentially be utilized in real dental office settings.

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TABLES

Race	Male	Female	Total
White	3	29	32
African American	1	6	7
Hispanic	-	3	3
Asian	-	1	1
Mixed Race	1	5	6
Total	5	44	49

TABLE 1: *Participant demographic*

		N	M	SD	Skew	Kurtosis
Condition	Control	12	11.3	2.48	0.57	-0.87
	Music	9	8.23	3.62	0.46	-1.2
	Movie	12	11.1	5.16	1.3	1.01
Stimulus Type	Real	17	10.5	4.13	0.52	0.27
	Image	16	10.27	4.08	1.54	4.03
Dental Anxiety Level	Non-Anxious	15	10.87	3.81	0.93	0.74
	Anxious	18	9.99	4.29	1.13	2.66

TABLE 2: *Mean SCR Amplitude of Condition x Stimulus Type x Dental Anxiety Level Group*

FIGURES

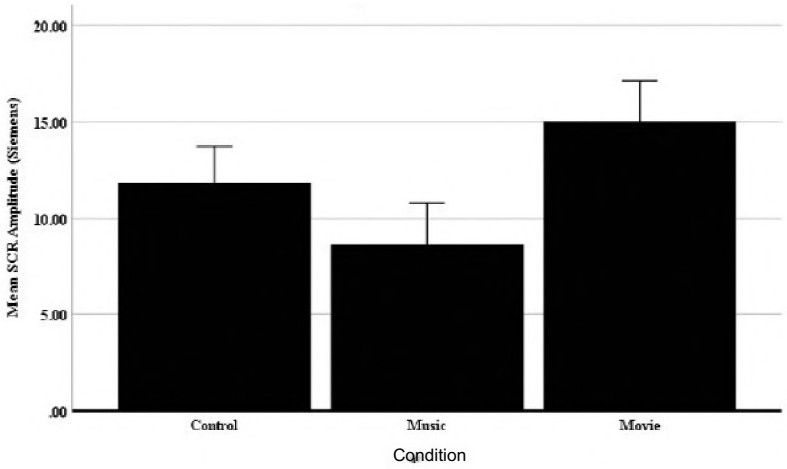


FIGURE 1: *Mean SCR Amplitude For Each Condition*
Note. Music Intervention was more effective in reducing Stress Conductive Response (SCR) in comparison to Movie Intervention and no intervention.

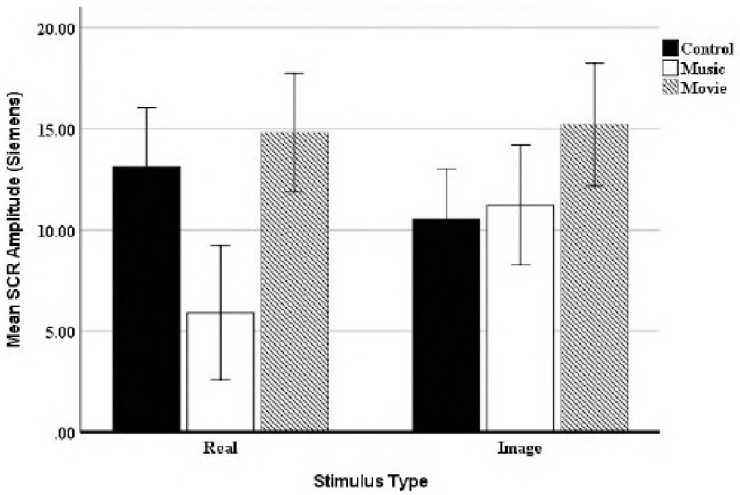


FIGURE 2: *Mean SCR Amplitude for Condition by Stimulus Type*
Note. Participants in the Music Intervention condition produced less SCR when exposed to dental tools rather than images of tools; whereas, participants in the No Intervention condition produced higher SCR when exposed to dental tools instead of images.

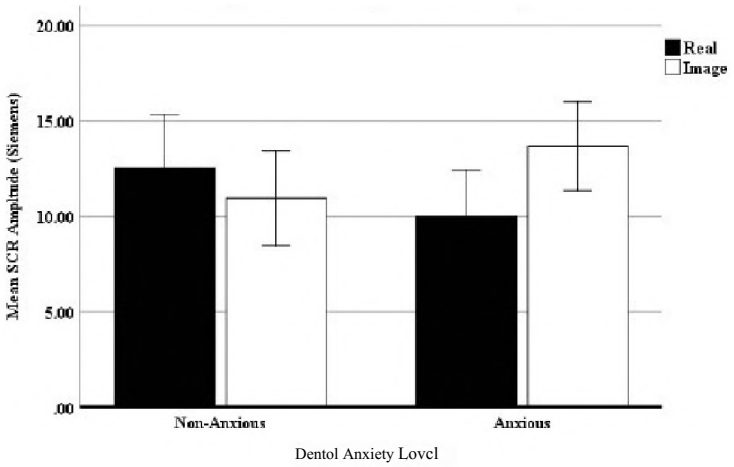


FIGURE 3: *Mean SCR For Stimuli Type and Dental Anxiety Level*
Note. Participants who reported not having dental anxiety produced slightly higher SCR when exposed to dental tools compared to participants who reported having dental anxiety. Reversely, participants who reported having anxiety exhibited slightly higher SCR when exposed to images of dental tools compared to non-anxious participants.

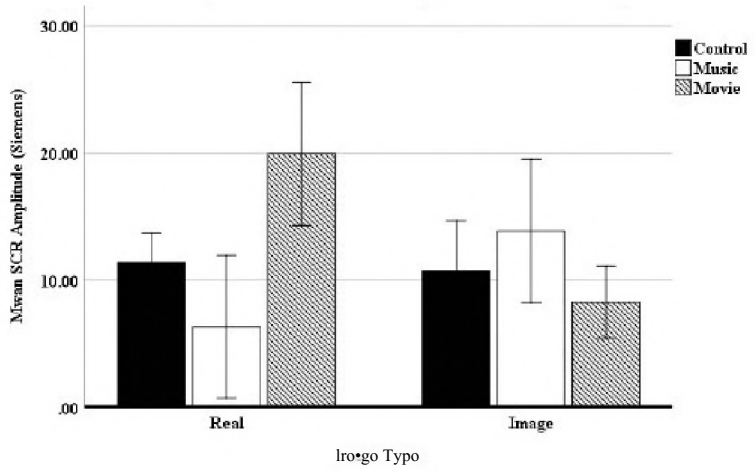


FIGURE 4A: *Mean SCR Amplitude Condition x Stimulus Type for Non-Anxious Participants*
Note. Non-anxious participants in the music intervention condition produced significantly less SCR when exposed to dental tools instead of images of tools; whereas, non-anxious participants in the movie intervention condition produced significantly higher SCR when exposed to dental tools instead of images.

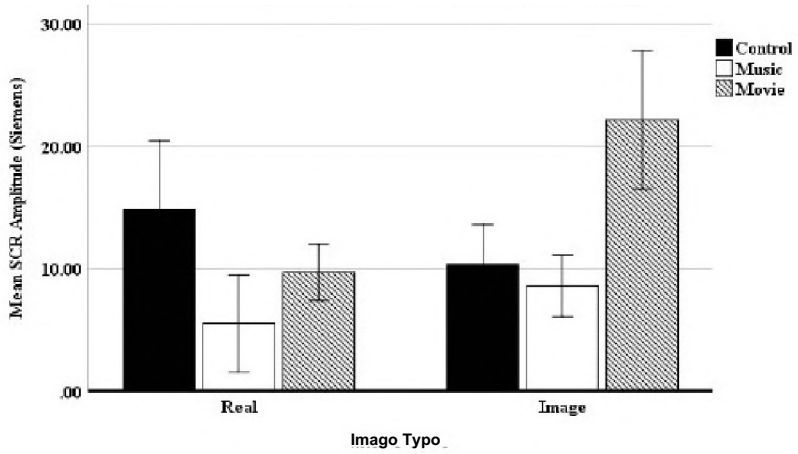


FIGURE 4B: *Mean SCR Amplitude Condition x Stimulus Type for Anxious Participants*
Note. In the Real stimulus, participants reported being less anxious when listening to music than individuals in the movie and control group. In the Image stimulus, participants in the movie group reported being extremely anxious, meaning movie intervention was a less effective distractor. Participants who reported dental anxiety in the movie intervention condition exhibited significantly higher SCR when exposed to images of tools rather than physical dental tools.

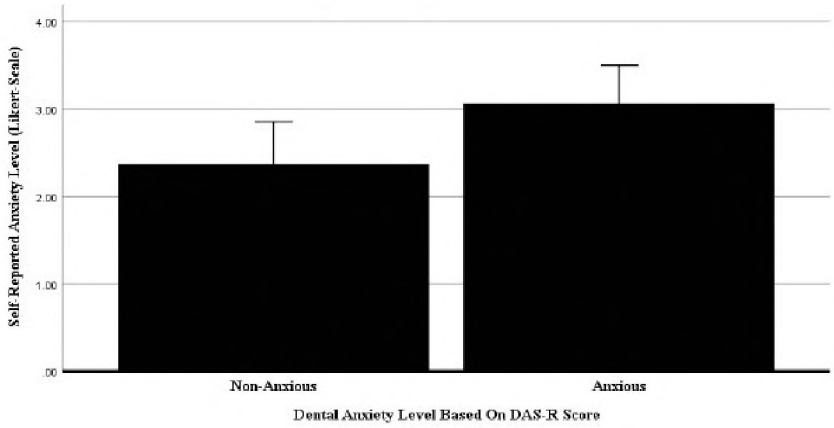


FIGURE 5: *Mean Self-Reported Anxiety Level To Dental Stimuli*
Note. Non-anxious participants scored lower on the DAS; anxious participants scored high on the DAS.

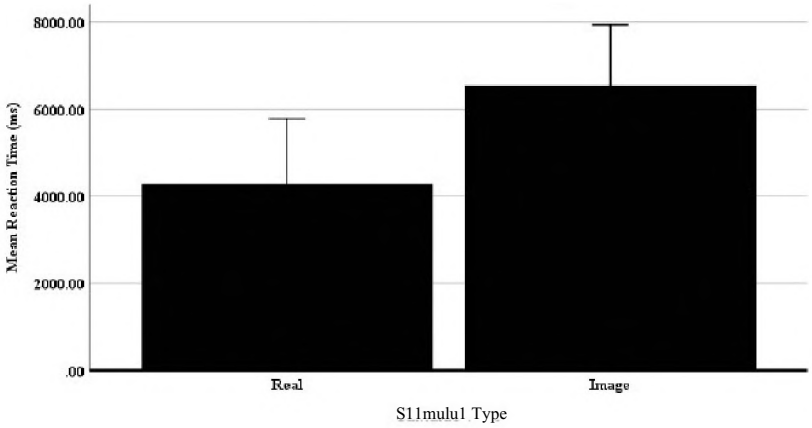
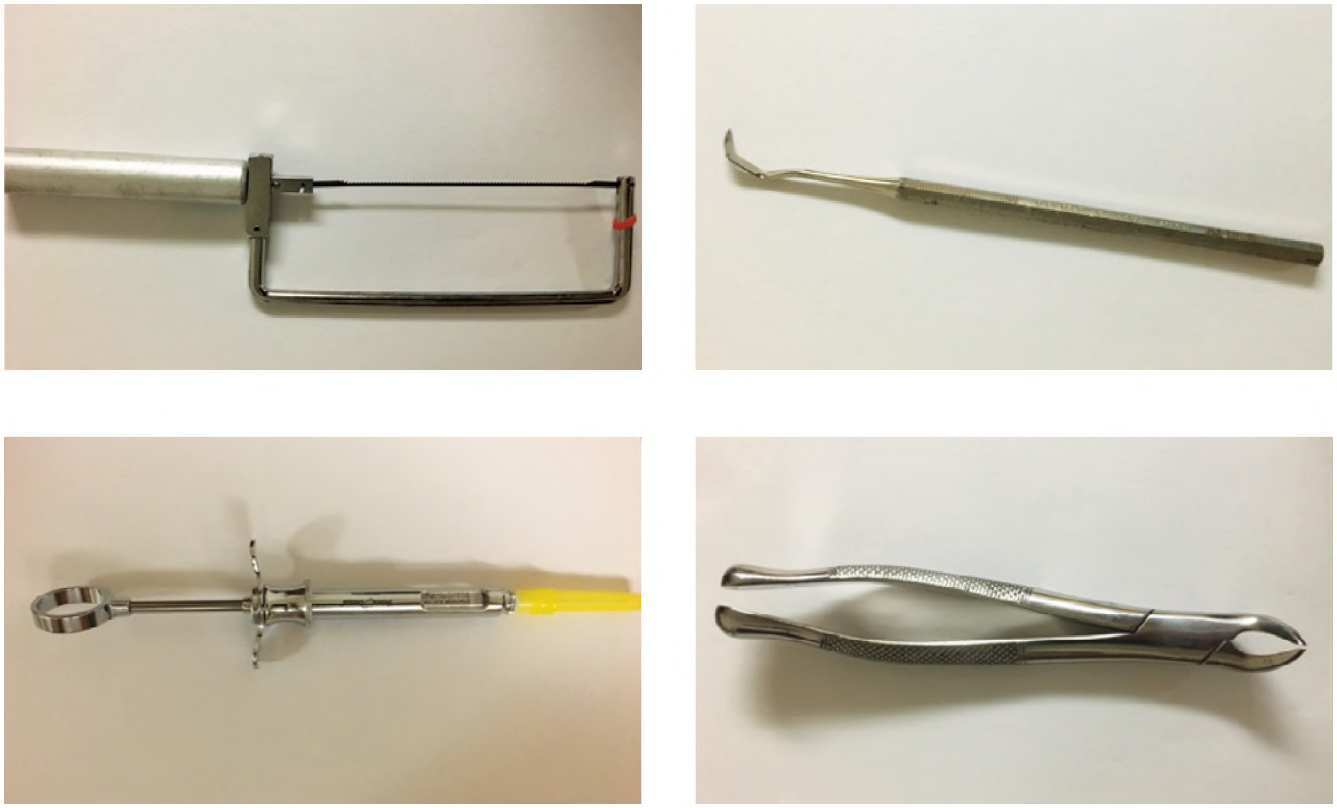


FIGURE 6: *Mean Reaction Times for Real Stimuli Versus Images*
Note. Participants in the RS condition quickly reacted once the dental tool was displayed; meanwhile those in IS condition reaction was slower.

APPENDIX
Dental Stimuli



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Germ-Free Environment Associated Immune Dysregulation

Anna Brennan

ABSTRACT

The prevalence of allergies and other autoimmune disorders has risen dramatically in recent years in western countries like the United States and Europe. The importance of the human microbiome and its impact on healthy body function has been a popular research topic, specifically in relation to infectious and autoimmune disease. In this review, the role of the microbiome in immune dysregulation is studied. Many studies concluded that there is a strong correlation between the presence and diversity of the human microbiome on immune regulation. The role of commensal microbes in the immune system is to contribute immunomodulatory molecules that activate the growth and differentiation of the gut associated lymphoid tissue, creating a symbiotic relationship between the gut microbiome and the immune system. Microbes influence immune cell function by regulating the expression of the TLR4 receptor on innate immune cell surfaces by inhibition. The presence of bacteria in the microbiome can diminish hypersensitive reactions to lipopolysaccharides and prevent a hypersensitive inflammatory response. These findings counter the general public's understanding of the "hygiene hypothesis" by suggesting that early exposure to certain bacteria can contribute to the development of the immune system and germ-free environments can cause immune dysregulation.

The microbiome in the human body is just now being studied concerning many health problems, such as Type-1 diabetes, obesity, cancer, and autoimmune disease. The hygiene hypothesis is a theory that gained traction in the late 1980s that suggested that maintaining a cleaner environment and reducing exposure to allergens will reduce the incidence of infection and other illness such as asthma and allergies. However, this is a misnomer that was popularized by the general public and grossly simplifies the immunological phenomenon. This theory has transpired in westernized countries, causing research on the importance of the human microbiome to remain novel. Understanding and characterizing the gut microbiome has revealed that bacteria and pathogens work in somewhat disorganized networks, which is summarized in a review by Eckburg et al. (2005). The diversity of the human microbiome is now being realized, but what has always been observed in research is that the presence of the microbiome directly affects human health. In this paper, the main focus will be on the development of the gut microbiome, which is developed post-natally. An important discovery by Mazmanian et al. (2005) suggests that certain bacteria are essential for immune cell development, specifically Helper T Cell 2 (T_H2) cells. Researchers have suggested that the presence of bacteria during gut-associated lymphoid tissue development is crucial for the normal functioning of immune cell signaling (Kalliomaki et al., 2001). Specifically, many researchers have found that germ-free environments, such as those caused by increased hygiene, during the development of the gut-associated lymphoid tissue are linked with hypersensitivity of the immune system and the presence of atopic disorders like allergies and asthma. Microbial diversity during development can regulate the TLR4 receptor function and is associated with hypersensitivity, highlighting the complexity of the "hygiene hypothesis."

Atopic disorders are increasing in recent years, specifically in the western world and in more developed countries. An observation by researchers pointed out that children that grew up on crop and livestock farms were usually not affected by allergies, asthma, or illnesses like hay fever (Downs et al., 2001). By studying these observations, these researchers determined that there is a direct correlation between the environment in which young children grow up and their immune system development. Downs et al. (2001) even discovered a distinguishable difference between the types of farms and this correlation to disease. The study revealed that livestock farms affect immune function, but crop farms may not elicit the same immunological response. Farm animals have high microbial colonization, and farmers will encounter these bacteria when grooming, cleaning, and processing the livestock for food and sales. Livestock farms cause an increase in microbial contact; whereas, crop farms will introduce less microbial diversity to the farmers because the microbial colonization of crops does not compare to livestock. Bodner et al. (1998) studied family size in relation to the prevalence of allergies and asthma and found that larger family sizes usually correlated to less atopic disease; whereas, small family sizes correlated with more atopic disease because of less exposure to infection in young children. Another group of researchers had a similar observation but were particularly interested in the genetics of the phenomenon. To study this, Kalliomaki et al. (2001) utilized probiotics of a particular strain of bacteria and studied the prominence of atopic eczema in children whose mothers had tested positive for the atopic disease before the children were born. These researchers observed that the neonates given probiotics were much less likely to have atopic eczema than neonates that were not given probiotics, suggesting that the presence of a particular strain of bacteria may decrease the prevalence of this atopic disease (Kalliomaki et al., 2001). Matricardi et al. (2000) performed a similar retrospective study in Air Force Cadets and found that the soldiers with higher colonization of bacteria in their gut were usually less likely to have either asthma or allergies. All of these studies look at bacterial exposure in relation to atopic disease, and a common theme is that more bacterial exposure is usually correlated to less frequent allergies and asthma.

This correlation suggests that the presence of bacteria during development has an influence on the presence of atopic disorders, but researchers are studying how the presence of bacteria can influence the function of the immune system specifically. The disorders that are most commonly elevated in germ-free environments are hypersensitivity disorders, such as asthma and allergies. Shirakawa et al. (1997) studied how bacteria could affect hypersensitivity in relation to the environment using a common mouse

model. This team evaluated the type of allergic response that comes with a germ-free environment. Shirakawa et al. (1997) found that the type of allergic response was related to the strain of bacteria present. Research from Dahl (2018) also supports this, showing that the absence of gram-negative bacterial colonization could contribute to a high prevalence in allergic reactions to lipid dense substances, such as a hypersensitivity reaction to pollen. This further supports that a germ-free environment can influence the immune response, specifically hypersensitivity in immune cells.

Several studies followed these ideas, evaluating how different immune cell types are affected by the presence of bacteria during immune system development. Olszak et al. (2012) evaluated the effect of microbial development in relation to invariant Natural Killer T-cell (iNKT) function. They discovered that CXCL16, a chemokine ligand, has modified expression levels in the absence of microbial colonization (Olszak et al., 2012). This altered chemokine expression is also associated with increased mucosal iNKTs. A study conducted by Herbst et al. (2011) compared the reaction of lymphocytes and eosinophils in response to cytokines and discovered that in germ-free mice, the types of cells that responded were different than in the mice with bacterial colonization. Cahenzli et al. (2013) observed that elevated immunoglobins of the E isotype (IgEs) were a biomarker of autoimmune diseases as well as allergies. They studied this phenomenon to further investigate the "hygiene hypothesis" and how microbial presence can affect the immune system. They discovered that IgEs are an observable marker of autoimmune disease; however, they are not the molecular basis of the disease (Cahenzli et al., 2013). All of these studies suggest that the presence of bacterial colonization is critical to the normal functioning of the immune system and immune regulation.

These studies point to a symbiotic relationship between bacterial colonization and the immune system; however, the exact reason for this likely varies depending on the immune cell type and the specific microbe being studied. Mazmanian et al. (2005) studied this relationship by comparing a germ-free mouse model with a specific pathogen model. Mazmanian et al. (2005) observed that reintroducing only *Bacteroides fragilis* into a previously germ-free mouse would correct CD4+ T-cell deficiencies, induce cytokine production, and trigger the development of lymphoid tissues. This suggests that *B. fragilis* is contributing to normal immune cell function and regulation. Troy and Kasper (2011) were able to summarize that the introduction of *B. fragilis*, a commensal-bacteria in the human body that produces Polysaccharide A (PSA), modulates immune cell activation and specific T-cell immune responses. These studies demonstrate that different bacteria can each contribute important immunomodulatory molecules, and the absence of diverse microbial colonization can cause serious immune dysregulation.

The presence of certain endogenous ligands may be the key to understanding immune dysregulation when bacteria are not present in the body. Poltorak et al. (1998) examined the responses to lipopolysaccharides (LPS), which are ligands on the surface of certain bacterial (species), in strains of mice deficient of functioning Toll-Like Receptor 4 (TLR4). This receptor for the ligand LPS is often studied in hypersensitivity of certain immune cells. The specific strains of mice were either Toll-Like Receptor 4 gene knockout mice, or they had a point mutation in the TLR4 gene. Both mutations caused the mice immune response to be unable to function normally in the presence of LPS. This case demonstrates that this gene encodes the receptor that contributes to the LPS immune response, and evidence of the dysregulated immune response would be gram-negative bacterial sepsis (Poltorak e al., 1998). The knockout of TLR4 was an important finding in this study and in understanding that TLR4 functions as part of the proper immune response to LPS. A study conducted by Bashir et al. (2004) looked at the C3H/HeJ strain of mice to see how the deficiency of the TLR4 receptor can influence the prevalence of food allergies. They emphasized that the absence of the gut microbiome can cause a hypersensitive T_H2 response, which will ultimately lead to an allergic reaction (Bashir et al., 2004). This study suggests that the TLR4 receptor and its function is correlated to hypersensitive immune responses like allergic reactions.

The function of the TLR4 receptor clearly affects the immune response, but the question researchers are now asking is how bacterial colonization is affecting the TLR4 receptors. A study conducted by Lee et al. (2016) utilized a pig model to test the effects of the gram-positive bacteria *Lactobacillus acidophilus* on the inflammatory response after LPS exposure. They found that the *L. acidophilus* response downregulated the expression of TLR4 and NK-kB in peripheral blood mononuclear cells, demonstrating that the bacteria inhibits TLR4 expression (Lee et al., 2016). Inhibiting this expression also inhibits the hypersensitive response that would occur normally in the presence of LPS. A study by Martin et al. (2008) noticed that interleukin-12 (IL-12) deficient mice strains were still exhibiting a normal allergic response, despite the absence of the essential interleukin. They discovered that both TLR4 and IL-12 genes must be knocked out in mice for the allergic contact hypersensitivity response to LPS. When inducing the response in mutant phenotypes, they discovered that double mutant germ-free mice could not be induced, suggesting that some endogenous ligands coming from the microbiome may be necessary for function in the allergic response (Martin et al., 2008).

The research that has been conducted studying the correlation between bacterial colonization and atopic disease demonstrates that it is vital for bacterial exposure in young children with developing immune systems or immune dysregulation may arise. Allergies, eczema, asthma, and other atopic disease states are examples of immune dysregulation. This research demonstrates that immune function can be affected by the presence of microbes, and this is especially important in young children during the development of their immune system. It is also clear why allergies and asthma are becoming increasingly common in more developed countries, where the "hygiene hypothesis" has gained traction. Cleanliness and hygiene are critical for the reduction of infection and spread of disease, which is what the public health perception of the hygiene hypothesis is. However, it can also reduce immune tolerance to certain allergens, leading to hypersensitive immune responses. The general perception of the hygiene hypothesis suggests that extreme cleanliness leads to a reduced disease state, which as evidenced by the preceding research, perpetuates it instead. Maintaining a clean environment and promoting hygienic practices like hand washing can prevent the spread of infectious disease. However, extreme cleanliness, popularized by the misunderstanding of the hygiene hypothesis, is contributing to the rise of atopic disorders.

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QUANTIFICATION OF Mg^{2+} ION UPTAKE AND RELEASE WITH *ESCHERICHIA COLI* CELLS

Amber Ngo

ABSTRACT

The interactions of metal ions with nucleic acids, proteins, and lipopolysaccharides are significant factors in biological structure/function relationships. Much work has been done on the protein mechanisms of these interactions; however, the stoichiometry of metal uptake by the protein has yet to be determined. In this project, we developed a fluorescent assay for measuring magnesium ion uptake or release by bacterial cells. This fluorescent assay was determined for its suitability for determining stoichiometry for magnesium ion binding to macromolecules. The dye 8-hydroxyquinoline-5-sulfonic acid (HQS) fluoresces only in the presence of Mg^{2+} and can therefore act as a sensor for free magnesium ions in solution. Comparison of the fluorescence signals with or without the presence of the Mg^{2+} binding complexes leads to the calculation of the stoichiometry associated with this ion binding interaction. We have extended this assay to interactions of Mg^{2+} ions with the surface of *E.coli* cells by probing the effect of high temperatures to lyse the cells, and by introducing competitors such as Zn^{2+}, Co^{2+},and Fe^{2+}. We also have applied the assay as a way of monitoring cells' need for Mg^{2+} ions while going through different growth phases, as well as dormant and active states. The results show that actively metabolizing cells are sensitive in terms of responding to changes in extracellular Mg^{2+} concentrations that can be measured with this fluorescent assay.

BACKGROUND

The interactions of metal ions with nucleic acids, protein, and lipopolysaccharides are known to be essential in biological processes. Metal ions stabilize the formation of secondary and tertiary structures in RNA and DNA by using their positive charges to neutralize the electrostatic repulson of the negatively charged backbones of nucleic acids [1,3]. Divalent magnesium ion, Mg^{2+}, is a key player in nucleic acid structural stabilization and also serves as a cofactor in many enzymatic reactions including transcription and translation [1,3].

Along with being an important requirement for nucleic acid and protein metabolism inside the cell, Mg^{2+} ions neutralize the outer surface of the cell [3]. In order for cells to function properly, they have to be able to sense the concentration of magnesium ions from the intracellular and extracellular environment. The PhoP/PhoQ model is used to explain how *E. coli* cells have an ability to sense Mg^{2+} ions (Figure 1). This system consists of two regulatory components that sense Mg^{2+} ions in *E. coli*. When Mg^{2+} ions are present outside of the cell, they will form metal bridges between the PhoQ's periplasmic domain and the cytoplasmic membrane. This binding promotes the more stable conformation of PhoQ, which leads to dephosphorylation in PhoP [3]. This dephosphorylation inhibits PhoP from binding to the bacterial DNA, resulting in the cell sensing the amount of surrounded Mg2+ ions [4,5].

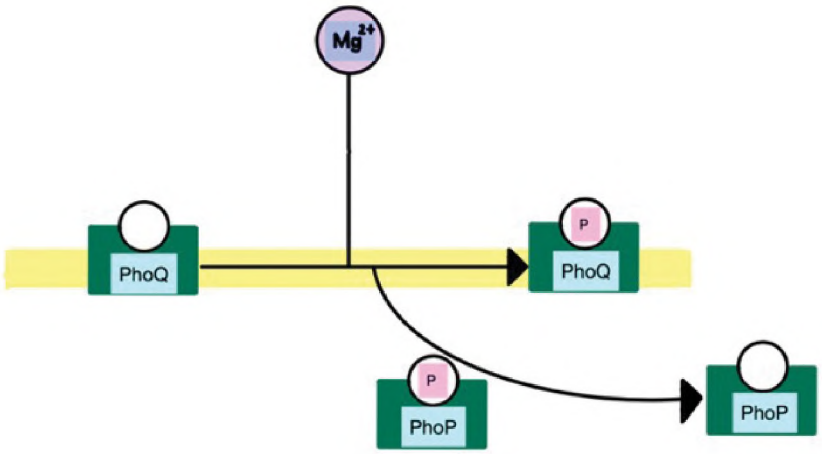


Figure 1: PhoP/PhoQ model for Mg^{2+} ions sensing in *E.coli* cells. The binding between Mg^{2+} ions with the system assists cells in sensing the extracellular concentration of Mg^{2+} ions.

Concentrations of Mg^{2+} in solution are traditionally obtained using a combination of equilibrium dialysis and atomic absorption/emission spectroscopy. This approach does not have the ability to monitor changes in Mg^{2+} concentration in real time [1]. In this project, the method of fluorescence spectroscopy was used to detect changes in Mg^{2+} levels. The fluorescent dye 8-hydroxyquinoline-5-sulfonic acid (HQS), a soluble quinoline derivative, was used to obtain the stoichiometry of Mg^{2+} present in solution[1]. The high sensitivity of this dye for changes in Mg^{2+} concentration makes it suitable for this project. This dye-magnesium interaction was originally investigated early in the 1960s [1]. However, the information about the stoichiometry of Mg^{2+} release and uptake that it offers has been underutilized since. The binding of HQS dye to Mg^{2+} ions enables the fluorescence of HQS (Figure 2). All HQS dye and HQs- Mg^{2+} complexes do not interact specifically with DNA or RNA [1]. Therefore, the dye and these complexes will bind preferably to Mg^{2+} ions in a solution. The concentration of Mg^{2+} ions in solution can be determined by measuring the fluorescence of HQS spectroscopically, either in a fluorimeter or fluorescence microplate reader. The presence of another Mg^{2+} binding entity in solution will result in

a competition between HQS and this biochemical system. The binding constant for HQS-Mg^{2+} is weaker than known binding biochemical constants for Mg^{2+} [1]. Therefore, HQS will only be able to bind to the free Mg^{2+} in solution that was not absorbed by the biochemical system of interest, serving as a direct sensor of this free [Mg^{2+}].

By observing HQS fluorescence both in the presence and absence of a Mg^{2+} interacting species, the amounts of Mg^{2+} uptake and release can be calculated by:

$[Mg^{2+}]_{uptake}$: $[Mg^{2+}]_{+cell} < [Mg^{2+}]_{-cell}$

$$F_{HQS,+cell} < F'_{HQS,-cell}$$

$$\Delta F = F_{HQS+cell} - F'_{HQS-cell} < 0$$

$[Mg^{2+}]_{release}$: $[Mg^{2+}]_{+cell} > [Mg^{2+}]_{-cell}$

$$F_{HQS,+cell} > F_{HQS,-cell}$$

$$\Delta F = F_{HQS+cell} - F'_{HQS-cell} > 0$$

$[Mg^{2+}]$ +cell is the concentration of magnesium ions when cells are present in the solution. $[Mg^{2+}]$-cell is the concentration of magnesium ions when cells are absent in the solution. When the calculated difference between the HQS fluorescent intensity in the presence vs the absence of bacterial cells is negative, the cells are uptaking Mg^{2+} ions. When the calculated difference is positive, the cells are releasing Mg^{2+} ions.

HQS fluorescent assay is a promising strategy for its selectivity in binding to Mg^{2+} ions. The experimental design is seen below in Figure 3.

METHODS

HQS Purification: 70.00 mL of H_2O and 3.000 mL of concentrated HCl were added to 7.265 g of 98% 8-Hydroxy-5-quinolinesulfonic acid hydrate (Sigma Aldrich) and heated to a boil to dissolve. The solution was cooled to room temperature, then placed on ice to allow for slow growth of fine needle shaped crystals of HQS. The remaining water was decanted. This process was repeated seven more times with decreasing amounts of pure H_2O and concentrated HCl.

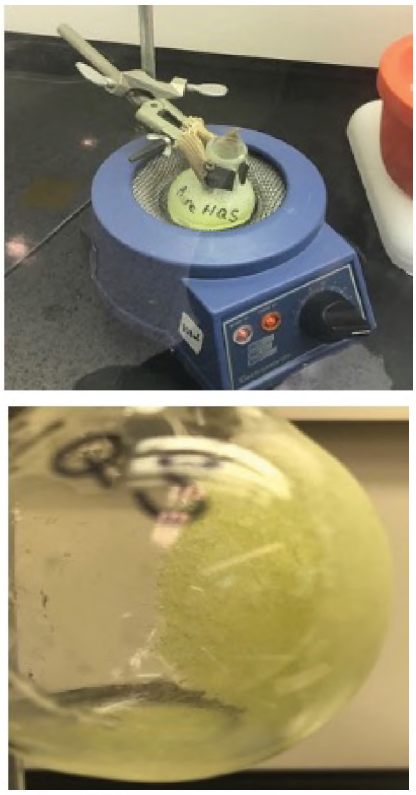


Figure 4: HQS purification. Set-up of heating HQS to a boil during purification in acidic conditions. Purified crystals. Images courtesy of Thomas Montag.

HQS: The solution of HQS dye was made from purified HQS powder. In order to determine its concentration, the absorbances at wavelength of 326 nm and 418 nm were obtained. The concentration of HQS dye solution was calculated using Beer's Law with ε of 2600 $cm^{-1}M^{-1}$ at 326 nm and ε of 135 $cm^{-1}M^{-1}$ at 418 nm. The optical path length was 0.75 cm. The average concentration was calculated to be 0.0007 mM. This concentration was kept constant throughout the experiments. 20 µL of HQS dye solution was used in each 100 µL well of the microplate.

Fluorimeter: All fluorescent measurements were taken on a Shimadzu RF-6000 Spectrofluorophotometer at 25.0°C with an excitation wavelength of 405 nm. The emission wavelength of the excited sample was tracked from 450-550 nm.

Microplate reader: Samples were measured uisng Tecan Infinite 200 Pro. The temperature was set at 25.0°C. The multiple reads per well were set at 2x2. The excited wavelength was set at 405 nm with an emission wavelength of 502 nm. The gain number was 75, and multiple reads per well were filled circle of 2 x 2.

Bacterical cells: XL1 Blue competent cells (Qiagen) were used for magnesium-cell assays. Active cells had been growing for one day, while dormant ones were frozen at -80.0°C until just prior to the

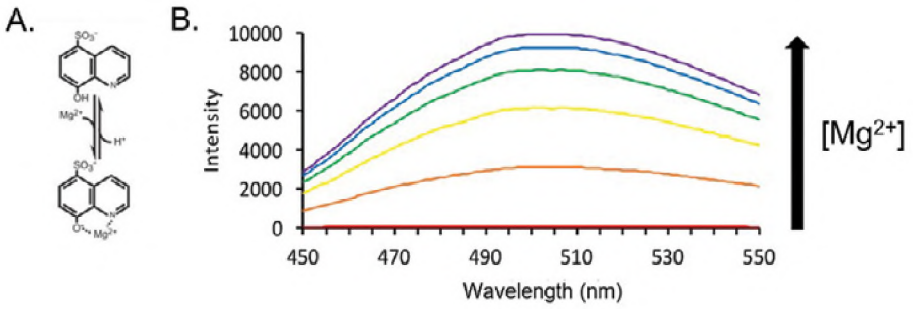


Figure 2: The interaction between HQS and Mg^{2+}. A. The deprotonated state of HQS can bind to Mg2+ in solution. This ion-dye complex can then be excited by 405 nm light and emission can be observed with a peak around 500-510 nm. Image adapted from reference [1].
B. The fluorescence intensity of HQS increases with increasing magnesium ion concentration when excited at 405 nm. At 0 mM MgCl (red line), there is no significant fluorescence observed, while saturation of signal starts at approximately 15 mM $MgCl_2$ (purple line) for a 30 M HQS sample. Data courtesy of Dr. Sokoloski and Thomas Montag.

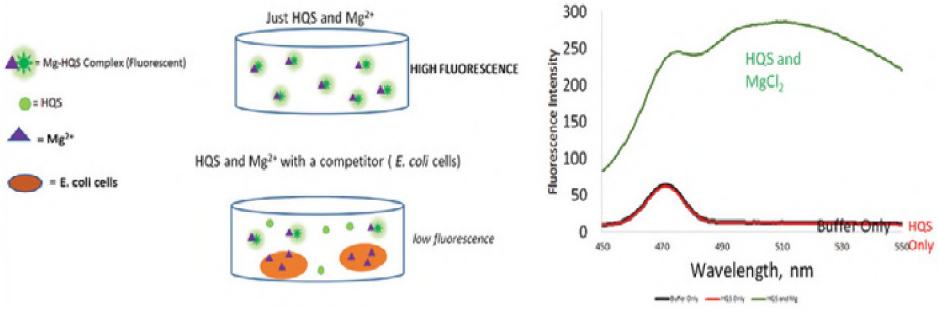


Figure 3: Experimental Design. High level of fluorescence is produced when a solution only contains HQS and Mg^{2+} ions (Left). A lower level is shown when there is a presence of a competitor. Without binding competitors, the amount of HQS-Mg^{2+} complex is optimized, which produces a high fluorescence similar to that seen for HQS in $MgCl_2$ solutions (Right, green line). When the cells bind Mg^{2+} ions as well, the number of Mg^{2+} ions available to bind to HQS is reduced. Therefore, the fluorescence is low, similar to HQS in buffer only (red line).

experiments. The environment for the cells was in lysogeny broth for both. The amount of cell was kept at 5 µL across all experiments.

Competitor metal ions: The concentration of competitor ion chloride salts of Co^{2+}, Zn^{2+}, and Fe^{2+}, were kept at 10 mM in 100 µL well throughout the project.

Experiment 1

The fluorescence of different concentrations of Mg^{2+} ions added in active or dormant states was obtained. The active state consisted of cells taken from a currently incubated culture. The dormant state consisted of cells taken from the -80.0°C freezer that were allowed to thaw to room temperature before measurements. The concentrations were 0.5 mM, 1 mM, 5 mM, 10 mM, and 50 mM $MgCl_2$. The total number of samples in this experiment was 242.

Experiment 2

The fluorescence of dormant and active cells in Co^{2+}, Zn^{2+}, and Fe^{2+} ions was compared in this experiment. The concentration of ions was kept at 10 mM, and the concentration of Mg^{2+} ions remained at 10 mM $MgCl_2$. The total number of samples in this experiment was 361.

Experiment 3

The fluorescence of active cells when they were intact or lysed at different concentrations of Mg^{2+} ions was analyzed in this experiment. The temperature for cell lysis was set at 55.0°C. The concentrations were at 0.5 mM, 1 mM, 5 mM, 10 mM, and 50 mM $MgCl_2$. The total number of samples in this experiment was 62.

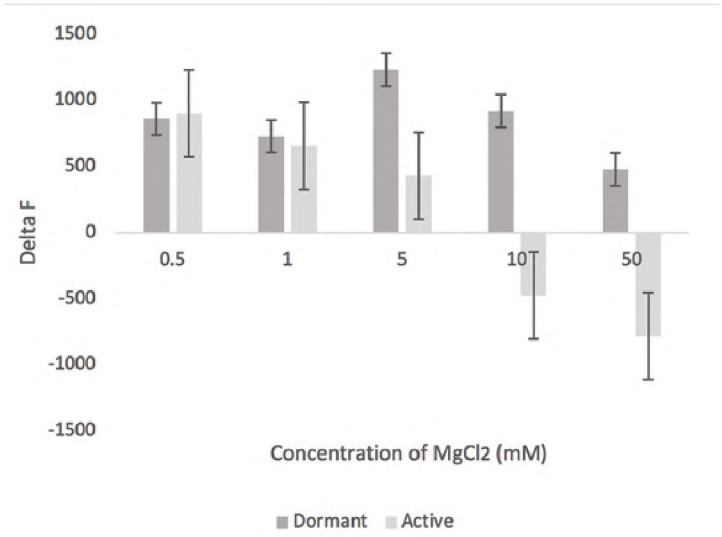
ANOVA

The two-way ANOVA was used to compare the mean differences between the two independent factors in each experiment. In experiment 1, the independent factors were the Mg^{2+} ion concentrations and the states of the cells (Dormant vs. Active). In experiment 2, they were the state of the cells (Dormant vs. Active) and the different types of competitor ions. In experiment 3, they were the states of cells (Active vs. Lysis) and the Mg^{2+} ion concentration. The statistical significance of the factors in this experiment was set at α=0.05.

RESULTS

Experiment 1

The fluorescence of different concentrations of Mg^{2+} ions added in active or dormant states

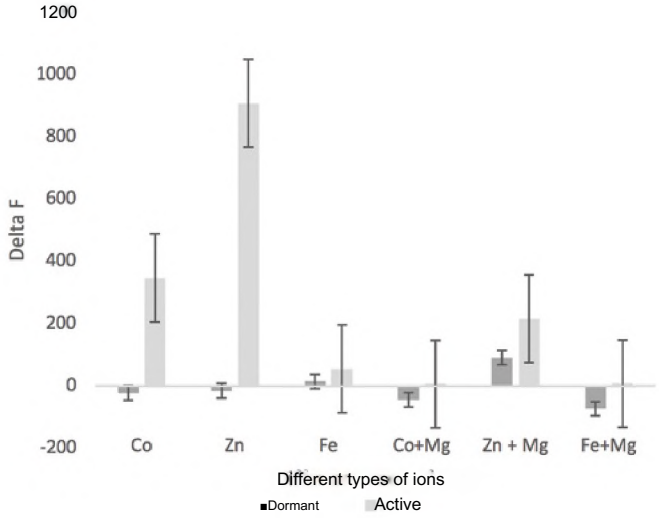


Source	P-value
Concentration	< 0.00001
State (Dormant vs Active)	< 0.00001

Figure 5: Positive delta F shows that the cells released Mg^{2+} ions and negative shows that the cells uptook Mg^{2+} ions. The fluorescence measured at different concentrations of Mg^{2+} ions when cells were dormant and active. The statistical significance of the factors in this experiment was set at α=0.05.

Experiment 2

The fluorescence of dormant and active cells in Co^{2+}, Zn^{2+}, and Fe^{2+} ions

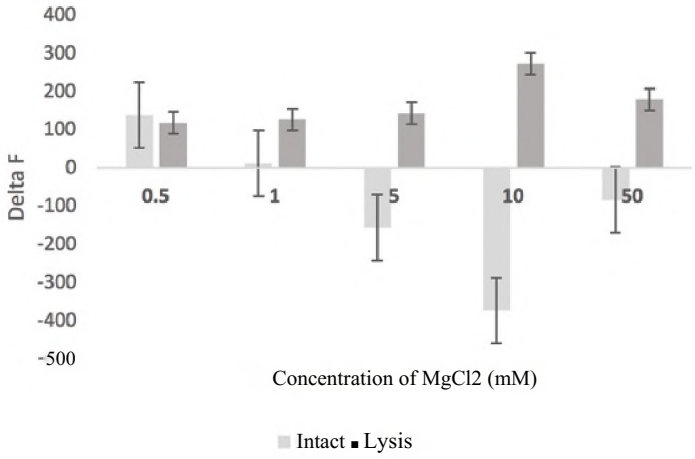


Source	P-value
State (Dormant vs. Active)	< 0.00001
Ions	< 0.00001

Figure 6: The fluorescence measured of different ions when cells were dormant and active. The statistical significance of the factors in this experiment was set at α=0.05.

Experiment 3

The fluorescence of active cells when they were intact or lysed at different concentrations of Mg^{2+} ions



Source	P-value
State (Intact vs. Lysis)	< 0.00001
Concentration	< 0.00001

Figure 7: The fluorescence measured of when active cells were intact and lysed. The statistical significance of the factors in this experiment was set at α=0.05.

DISCUSSION

In experiment 1, the p-values of different concentrations of Mg^{2+} ions added in active or dormant states show the significance of cell metabolic activity. Growing cells were uptaking/sequestering Mg^{2+} ions from the extracellular environment at concentrations of 10 mM and 50 mM $MgCl_2$. Dormant cells were releasing Mg^{2+} ions at all applied extracellular concentrations. These results show that cells with active metabolism have an active response to increasing extracellular concentrations of $MgCl_2$, while dormant cells freshly removed from -80.0°C did not exhibit a clear trend for response to added metal ions because the amounts of ion uptaking was inconsistent (Figure 5).

In experiment 2, the p-value of different ions shows that the presence of other metal ions can cause a change in fluorescence. The p-value of different states indicates that there is a statistical significance in fluorescence of dormant and active states with regards to other metal ions. When cells were dormant, they were uptaking/sequestering more Mg^{2+} ions than when active in the presence of other added metal ion species. When both the competitor and Mg^{2+} ions were present in the extracellular environment, the active cells tended to release more magnesium into the extracellular solution. This observed release of Mg^{2+} may be due to a complicated change in cellular transport response due to the presence of high extracellular metal ion concentration. The best competitor among Co^{2+}, Zn^{2+}, and Fe^{2+} is concluded to be Zn^{2+}. When both Zn^{2+} ions and Mg^{2+} ions were present in the cells, Zn^{2+} ions competed with Mg^{2+} ions and led to either the release of cell-surface bounded Mg^{2+} ions or the transport of Mg^{2+} out of the cell. Either response would cause a high fluorescence signal because the amount of free Mg^{2+} ions in the extracellular environment increased (Figure 6).

In experiment 3, the p-values of different concentrations and different states show the significant difference between the response of intact alive cells versus that of lysed cells. At different concentrations, there is a statistical significance in fluorescence. When active cells were intact, they were uptaking/ sequestering Mg^{2+} ions from the extracellular environment. When active cells were lysed, they were not able to uptake Mg^{2+} ions. One of the possible causes was that the PhoP-PhoQ system might have been destroyed, which disabled the ion sensing ability of cells (Figure 7).

CONCLUSION

The sucessful development of the HQS fluorescent assay in measuring Mg^{2+} ions has given us a different approach to analyze the uptake and release of Mg^{2+} ions by *E. coli* cells. With these forementioned findings, we are able to conclude that when cells are active, they tend to uptake Mg^{2+} ions from the extracellular environment. When cells are dormant, observations show a possible release of Mg^{2+} ions. The reason for this response in dormant cells is unclear and merits further exploration. The best competitor for Mg^{2+} ions is concluded to be Zn^{2+}. The impact of lysis may destroy the PhoP-PhoQ system, which causes the cells to lose their ability to sense Mg^{2+} ions. All these results indicate that living, actively metabolizing cells have vigorous, dynamic responses to changes in extracellular Mg^{2+} ion concentrations that can be measured with the non-perturbing fluorescent assay. Futher understanding of the effects of metal ion movement during cell divison or heat shock transformation in real time using the HQS flourescent assay will be studied in order to provide more details about these proceses by *E. coli* cells.

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Defying Gravity

Volha Panco

ABSTRACT
Brooding, yet exciting, gracefully, and stunningly resplendent, “Defying Gravity,” oil on canvas, is a dramatic, large-scale art piece based on the epiphany the artist achieved through earlier work. Having faith and letting go of the desire to have full control is the only way to get through challenging circumstances. Furthermore, through this painting, the artist explores the human tendency to gravitate toward a familiar known environment and to avoid change. With fear at its core, this tendency restricts us from moving forward. The array of symbolic elements of this painting includes a complex reflective surface that highlights the significance of self-reflection, the rectangular box-like structure represents limitations founded by the inner fears that the figure detaches from. Unaffected by the gravity of the past, it is peacefully floating in space, immersing herself in nature, flowing free like a river, and slowly going around obstacles. This painting illustrates how connections can be created among nature and personal identity that may appear to differ in many aspects; whereas, they profoundly share an abundance of values. “Defying Gravity” embodies the artist’s response to a rapidly changing reality. She believes that when one defies the gravity of the convenient known the unique opportunity to evolve arises. For that reason, instead of holding on to the past, she makes a conscious choice to let go, and jump into the unknown, embracing the challenge.

Defying Gravity
Oil on Canvas
60” x 48”

INVESTIGATING REGULATION OF 3-HYDROXYPROPIONATE ASSIMILATION IN *RHODOBACTER SPHAEROIDES*

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ABSTRACT

3-Hydroxypropionate is a carbon compound found commonly in bodies of water and plays a role in carbon metabolism across all domains of life, yet little is known about the regulation of 3-hydroxypropionate metabolism. The metabolically diverse bacterium *Rhodobacter sphaeroides* can utilize 3-hydroxypropionate as a sole carbon source, assimilating 3-hydroxypropionate for the production of biomass through two simultaneous metabolic pathways. The first is a reductive pathway producing succinate, a central metabolic intermediate. The second, is an oxidative pathway that converts 3-hydroxypropionate to CO_2 and acetyl-CoA, the entry molecule of a separate metabolic pathway, the ethylmalonyl-CoA pathway. During 3-hydroxypropionate metabolism, *R. sphaeroides* also employs metabolic steps to incorporate CO_2 into biomass, restoring carbon lost previously by metabolic processes. Regulation of the enzymes AcuI, Ccr, PrkA, and PrkB involved in 3-hydroxypropionate metabolism will be evaluated by quantifying the presence of RNA sequences coding for each enzyme in *R. sphaeroides*. Quantification of specific enzymes involved in each pathway of 3-hydroxypropionate metabolism provides information about pathway operation. Whole cell RNA was successfully extracted from *R. sphaeroides* cells and used as template to generate cDNA. Generated cDNA will be used as a sequence template in future qRT-PCR studies to assess the relative amounts of corresponding RNA sequences and therefore enzymes. This work and future work will offer information about how *R. sphaeroides* and related organisms regulate carbon metabolism.

INTRODUCTION

In order to be competitive in an environment, an organism must import and utilize external material in the most efficient way possible. Metabolism refers to the process by which an organism imports external material and uses it to generate energy and biomass necessary for cellular function and growth. Metabolic pathways are specific series of enzyme-catalyzed chemical reactions which convert external materials. All metabolic pathways feed into two central metabolic pathways: glycolysis and the tricarboxylic (TCA) cycle (also known as the citric acid cycle or the Krebs cycle), which are responsible for the generation of biomass and are present in all organisms.

One way to study metabolism is to assess how external carbon-containing molecules are converted into biomass for cell growth along with how this process is regulated. In order for a metabolic pathway to be functional, a cell must first produce the enzymes required to carry out such pathway. This process involves the production of RNA sequences using the gene sequence encoding each required enzyme as a template. Enzymes are then constructed; their amino acid sequences each directly dependent on the RNA sequences previously produced. The amount of any one enzyme in a cell is then directly proportional to the quantity of the RNA which codes for such enzyme. In isolating and quantifying specific RNA sequences, the relative amounts of specific enzymes within a cell can be accessed, yielding information regarding the operation of the metabolic pathway(s) in which they are involved.

Rhodobacter sphaeroides, a purple non-sulfur bacterium, is incredibly metabolically diverse, meaning *R. sphaeroides* can utilize a wide range of metabolic strategies to generate the biomass and energy required. The ability of *R. sphaeroides* to use sunlight to generate ATP makes the bacterium a useful model system for studying carbon assimilation. Since no external carbon-containing molecules are required for generating energy, all external carbon-containing molecules are incorporated into quantifiable biomass[5].

3-Hydroxypropionate is a carbon-containing molecule found commonly in both fresh and saltwater and exists as an intermediate compound involved in osmoregulation[1]. 3-Hydroxypropionate can be metabolized by *R. sphaeroides* as the sole source of carbon[5]. Through a reductive pathway, *R. sphaeroides* converts 3-hydroxypropionate first to acrylyl-CoA. Acrylyl-CoA reductase (AcuI), an enzyme encoded by *R. sphaeroides*, then produces propionyl-CoA which is converted to succinate, an intermediate of central metabolism[2] (Fig. 1B).

During aerobic growth – growth in the presence of oxygen – with 3-hydroxypropionate, *R. sphaeroides* cells also oxidize a portion of 3-hydroxypropionate to acetyl-CoA and CO_2[3,5] (Fig. 1A). Some molecules of acetyl-CoA are converted to intermediates in central metabolism by the ethylmalonyl-CoA pathway, which employs the enzymes Ccr and Mch. This pathway, while important for balancing the relative amounts of oxidation and reduction in the cell and restoring TCA cycle intermediates, is not essential for growth with 3-hydroxypropionate[5] (Fig. 1).

Metabolically produced CO_2 can be reincorporated into metabolism via the CBB cycle in *R. sphaeroides*

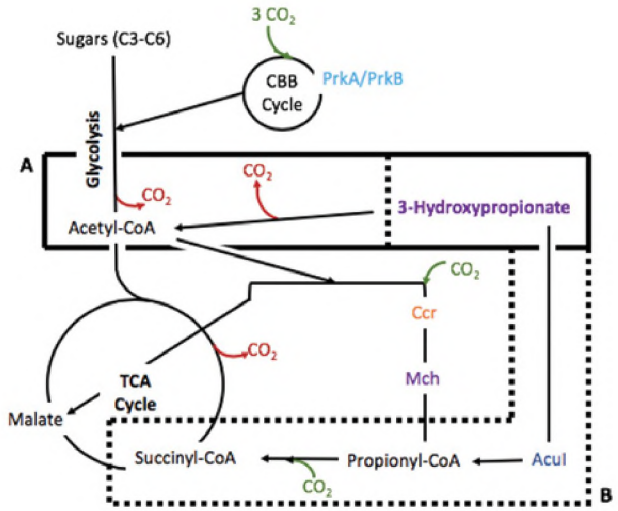

Figure 1. Biochemical pathways of *R. sphaeroides* linking 3-hydroxypropionate assimilation to central carbon metabolism (glycolysis and TCA cycle). CO_2 lost as a result of oxidation is shown in red. Fixed atmospheric carbon (CO) is shown in green. A) Metabolic scheme showing possible routes by which 3-hydroxypropionate can enter central carbon metabolism at both the level of acetyl-CoA via an oxidative path and B) at the level of succinyl-CoA via a reductive path. Abbreviations: AcuI, acrylyl-CoA reductase; Ccr, crotonyl-CoA carboxylase/reductase; Mch, mesaconyl-CoA hydratase; CBB cycle, Calvin-Benson-Bassham cycle or reductive pentose phosphate pathway. Adapted from [3].

(Fig. 1), thereby restoring the carbon lost during 3-hydroxypropionate metabolism. Operation of the CBB cycle is dependent on the enzymes PrkA or PrkB, which function as variations of a phosphoribulokinase. PrkA and PrkB produce ribulose 1,5-bisphosphate, a crucial intermediate of the CBB cycle, and are therefore produced when the CBB cycle is active.

GROWTH ANALYSIS OF MUTANT STRAINS

The ethylmalonyl-CoA pathway does not seem to play a role in 3-hydroxypropionate assimilation directly (Fig. 1). To test this, *R. sphaeroides* mutant strains lacking enzymes involved in the ethylmalonyl-CoA pathway were generated and grown with 3-hydroxypropionate in a previous study. An *R. sphaeroides* strain missing Ccr, a key enzyme of the ethylmalonyl-CoA pathway, grows similar to wildtype *R. sphaeroides* with 3-hydroxypropionate. This data suggests there is no requirement for the ethylmalonyl-CoA pathway during 3-hydroxypropionate-dependent growth. However, a mutant lacking Mch, an enzyme that carries out a later step of the ethylmalonyl-CoA pathway, was unable to grow with 3-hydroxypropionate. A *R. sphaeroides* strain lacking both Mch and Ccr regained the ability to grow like wildtype in the same conditions (Fig. 2)[3].

Additional *R. sphaeroides* mutants were produced, each lacking an enzyme catalyzing a consecutive step of the ethylmalonyl-CoA pathway. With each consecutive deletion, growth with 3-hydroxypropionate was increasingly deficient, which suggests a buildup of intermediates as the cause for hindered growth. Given that each of the intermediates of the ethylmalonyl-CoA pathway is a coenzyme A ester, the gene *yciA*, which encodes an enzyme categorized as a thioesterase, was introduced into each mutant. Wildtype growth was restored in each mutant, further suggesting the buildup of intermediates (and consequently the depletion of Coenzyme A) inhibiting cell growth, rather than the absence of ethylmalonyl-CoA pathway intermediates[3].

SPONTANEOUS MUTATIONS IN *prkB* RESCUE GROWTH WITH 3HP IN PREVIOUS GENE-DEFICIENT MUTANTS

Continued observation of mutant growth with 3-hydroxypropionate yielded a recovery of wild-type growth (Fig. 3) due to a spontaneous mutation in the gene coding for PrkB, the phosphoribulokinase present in the CBB cycle.

It was hypothesized that the mutated PrkB was capable of reverting carbon flow (flux) from the ethylmalonyl-CoA pathway to a central metabolic pathway, glycolysis, through the production of intermediates of the CBB cycle. To test this, the gene coding for YciA was once again introduced into mutants, yet growth with 3-hydroxypropionate increased only for mutants lacking spontaneous mutations (Fig. 4).

This data, along with analysis of components present in the media

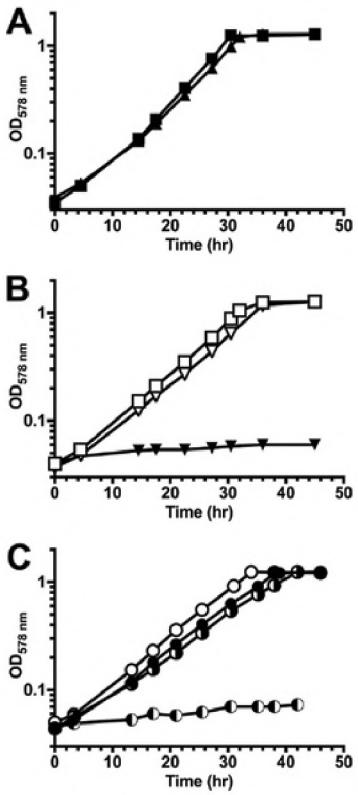

Figure 2. Photoheterotrophic growth of wild type and mutants of *Rhodobacter sphaeroides* with 3-hydroxypropionate as the carbon source. (A) Growth of the wild type (squares) and RsΔccr23KB (triangles). (B) Growth of RsΔmch49KB (filled triangles), RsΔmch49KB (*mch*) (open triangles), and the wild type (*mch*) (squares). (C) Growth of RsΔccrΔmch24AF (filled circles), RsΔccrΔmch24AF *(ccr)* (left-half-filled circles), RsΔccrΔmch24AF (*mch*) (right-half-filled circles), and RsΔccrΔmch24AF (*ccr mch*) (open circles). Reproduced from [3].

following growth of each strain, indicated that carbon flux is diverted from the ethylmalonyl-CoA pathway in spontaneous mutants and instead enters central metabolism via the CBB cycle.

Current work is aimed at the quantification of RNA sequences produced in *R. sphaeroides* that code for the hallmark enzymes mentioned above – AcuI, Ccr, PrkA and PrkB – by isolating whole cell RNA from R. sphaeroides grown in varying conditions. RNA molecules coding for each aforementioned enzyme will be present in proportion to each respective enzyme, so the quantification of specific RNA sequences will yield information about the relative amounts of each enzyme present. This will provide data regarding the relative operation of each respective pathway (Fig. 1)[3] in *R. sphaeroides* during the metabolism of different carbon sources, and thereby the regulation of each pathway.

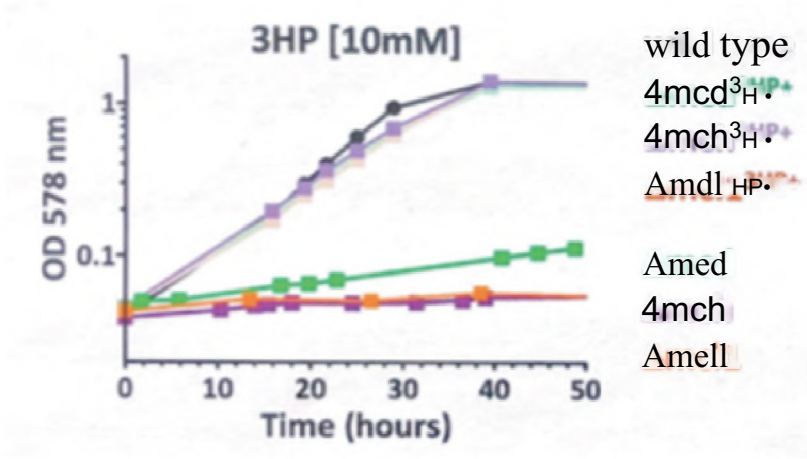

Figure 3. Growth with 3-hydroxypropionate following spontaneous mutations in *prkB* in previous *R. sphaeroides* mutants. Previous mutants lacking enzymes involved in the ethylmalonyl-CoA pathway each experienced an additional, spontaneous mutation in *prkB* allowing them to grow with 3-hydroxypropionate. Spontaneous double mutants ($^{3HP+}$) were isolated then grown alongside initial mutants and wild type *R. sphaeroides* with 10mM 3-hydroxypropionate.

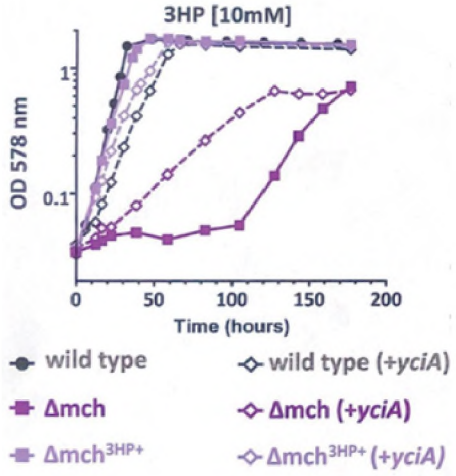

Figure 4. Growth of *prkB* spontaneous mutant strains producing YciA. Wildtype, the initial *mch*-deficient strain and the *mch*-deficient strain with a spontaneous mutation in *prkB* (Δmch^{3HP+}), all producing the enzyme YciA (+*yciA*), were grown with 10mM 3-hydroxypropionate alongside corresponding *yciA*-negative strains.

RESULTS

Intact whole-cell RNA was obtained from *R. sphearoides* strains using a modified protocol.

RNA was extracted from WT 2.4.1 *R. sphearoides* grown with 3-hydroxypropionate using the modified Omega E.Z.N.A. protocol and processed through an agarose gel for visualization (Fig. 5). The RNA sample produced clear bands with minimal smearing, suggesting negligible degradation of RNA during the extraction process (Fig. 5, Lane 1). The RNA sample was run through an agarose gel following treatment with DNase, an enzyme which selectively degrades DNA, and the resulting bands did not look significantly different than the initial RNA sample (Fig. 5, Lane 2). An RNA sample was used as a PCR template following treatment with DNase to ensure no contaminating DNA. No significant products were detected. In addition, contaminating DNA can be observed within the well of Lane 1 (Fig. 5) but is absent in the well of Lane 2 (Fig. 5), suggesting successful digestion of DNA within the DNase-treated sample. The process of introducing DNase did not significantly degrade the RNA sample and left minimal contaminating DNA making it a reasonable process to degrade contaminating DNA fragments prior to downstream applications.

Detectable cDNA samples were generated from whole-cell *R. sphearoides* RNA samples.

cDNA, or "complementary DNA," was generated via a reverse transcriptase enzyme, using RNA molecules isolated from WT 2.4.1 *R. sphearoides* grown with 3-hydroxypropionate as sequence templates. Generated cDNA was used as template molecules in six PCR reactions which employed primers designed for qRT-PCR – quantitative real-time PCR (Table 1). The reactions were processed through an agarose gel and the expected base pair sizes were successfully observed for all six reactions (Fig. 6, Lanes 1-6). Detection of positive controls (Fig. 6, Lanes 5-6) – sequences corresponding to the genes *recA* and *rpoZ* consistently required for basic cell function – indicates successful generation of cDNA from *R. sphearoides* RNA samples. Amplification products of expected sizes in lanes 1-4 suggest that sequences complementary to and representative of the transcripts of interest can be successfully detected within the generated cDNA sample. Faint bands present in lanes 7-9 and 11 are likely the result of primer dimerization, while bands present in lanes 10 and 12 may be due to small amounts of contaminating DNA in primer solutions. Given that the PCR reactions analyzed in Fig. 6 were amplified for 40 cycles, this contamination is not of major concern, but such PCR reactions will be replicated in future studies to ensure accuracy.

DISCUSSION

In the regulation of metabolic pathways, organisms limit the expenditure of biomass and energy in order to optimize the production of both. During the assimilation of 3-hydroxypropionate by *R. sphearoides,* several metabolic pathways occur in unison in order to maintain the balance between oxidation and reduction in the cell by offsetting the loss of biomass as CO_2 and feeding central metabolic pathways. Understanding the regulation of these pathways is crucial to understanding carbon metabolism in *R. sphearoides*.

Previously, it was determined that while the ethylmalonyl-CoA pathway is

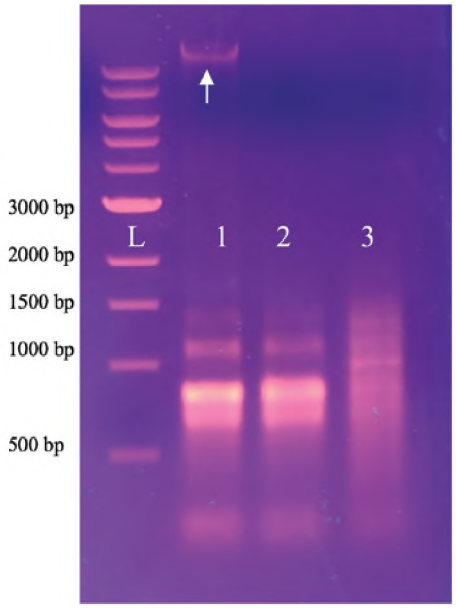

Figure 5. Agarose gel electrophoresis of whole cell RNA, RNA treated with DNase and cDNA obtained from WT 2.4.1 *R. sphearoides* grown with 3-hydroxypropionate. 1) Whole-cell RNA; 2) Whole-cell RNA after treatment with DNase; 3) cDNA generated from DNased whole-cell RNA; Lane L) New England BioLabs 1kb Plus DNA Ladder (sizes labeled). Contaminating DNA in the well of Lane 1 is marked with an arrow.

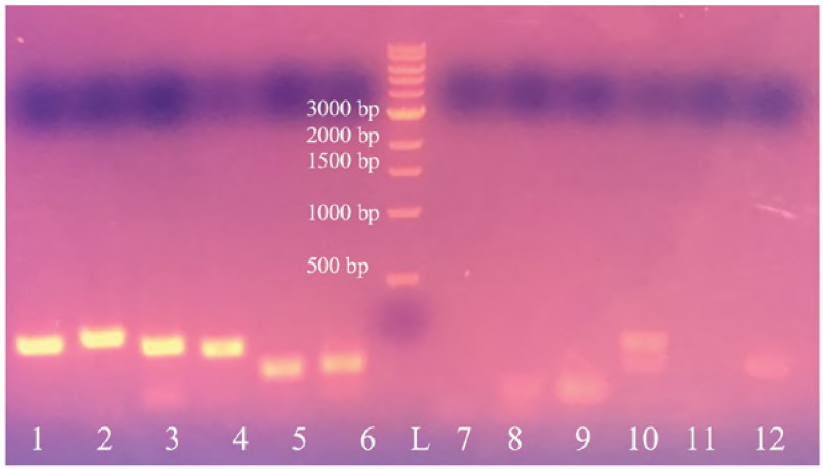

Figure 6. Agarose gel electrophoresis following PCR of cDNA obtained from WT 2.4.1 R. sphearoides grown with 3-hydroxypropionate using primers designed for qRT-PCR. Primers: Lanes 1/7) RTprkAF1 & RTprkaR1 (255 bp); Lanes 2/8) RTprkBF1 & RTprkBR1 (275 bp); Lanes 3/9) RTacuIF1 & RTacuIR1 (235 bp); Lanes 4/10) RTccrF4 & RTccrR5 (219 bp); Lanes 5/11) RTrecAF2 & RTrecAR2 (145 bp); Lanes 6/12) RTrpoZF2 & RTrpozR2 (150 bp); Lane L) New England BioLabs 1kb Plus DNA Ladder (sizes labeled). Reactions in lanes 7-12 were run without DNA template.

not necessary for the growth of *R. sphearoides* with 3-hydroxypropionate, disruption of the pathway via gene deletion leads to a lethal depletion of CoA in the cell[3]. In mutants containing an altered PrkB this depletion is avoided by deferring carbon flux to the CBB cycle and away from the ethylmalonyl-CoA pathway (Fig. 4).

This study set out to assess the regulation of 3-hydroxypropionate metabolism in *R. sphearoides* by quantifying the relative amounts of enzymes required for the ethylmalonyl-CoA pathway and the CBB cycle, along with the reductive and oxidative pathways which directly break down 3-hydroxypropionate. Utilizing methods in qRT-PCR, RNA transcripts encoding the enzymes of interest can be detected and their relative quantities – which are directly representative of enzyme quantity – can be compared.

Analysis of whole-cell RNA samples in an agarose gel suggests that intact RNA can be successfully extracted from *R. sphearoides*. Comparison of extracted whole-cell RNA to RNA treated with DNase along with PCR assessment revealed an acceptable method for eliminating potentially contaminating DNA fragments. The introduced DNase left minimal contaminating DNA and did not significantly affect the integrity of the RNA in each sample. This data evidences the success of preparatory procedures prior to downstream applications to generate and quantify cDNA sequences. Amplification of a cDNA sample revealed that cDNA could be successfully generated from the previously obtained RNA samples and detected using the designed primers.

Moving forward, the same steps will be taken to obtain cDNA samples representative of *R. sphearoides* cells grown in succinate or acetate – carbon sources in which the pathways for degrading 3-hydroxypropionate are not expected to be significantly active – for use as controls. Sequential studies will quantify cDNA sequences representative of 3-hydroxypropionate metabolism transcripts in all three growth conditions via qRT-PCR reactions. In doing this, the relative expression of 3-hydroxypropionate metabolism genes will offer insight on the regulation of the pathways required.

MATERIALS AND METHODS

RNA Isolation and Quantification.

Whole cell RNA was extracted using the Omega E.Z.N.A Bacterial RNA Kit. The provided protocol was adjusted, eliminating incubation at 70 °C, vortexing solutions for 15 seconds each time the protocol calls for vortexing, and heating nuclease-free water to 70 °C prior to elution. Samples were quantified using a NanoDrop and analyzed through an 8% agarose gel to assess RNA integrity.

DNasing Samples.

RNase-free recombinant DNase provided by Sigma Aldrich was added to samples after RNA extraction. 1 µL of DNase was added for every 1000 ng of whole cell RNA in addition to the supplied 10X buffer. Reactions were incubated according to the provided protocol. Samples were quantified using a NanoDrop and analyzed through an 8% agarose gel.

Reverse Transcription.

RNA samples are reverse transcribed in a 50 µL reaction including 1µL 10 µM oligomer of random sequence, 1 µL 0.1 M DTT, 1µL dNTPs, 1 µL SuperScript IV enzyme and 5X buffer incubated first at 65°C for 10 minutes prior to the addition of enzyme and deoxynucleotides, then 50°C for an hour. Produced cDNA was quantified using the Nanodrop and analyzed through an 8% agarose gel.

Amplification of cDNA.

Generated cDNA was used as a template for 6 PCR reactions. Reactions included 15 µL d-H2O, 5 µL PrimeStar GXL Buffer, 2 µL dNTPs, 1 µL cDNA, 1 µL PrimeStar GXL Polymerase, and 2 µL each of 10 µM primers amplifying one of the following: *acuI, ccr, prkA, prkB, recA*, or *rpoZ* (Table 1). Thermal Cycler conditions were as follows: 98°C for 15 s, 64°C for 15 s, 72°C for 45 s, for 40 cycles. Reactions were analyzed through an 8% agarose gel. Amplification of the housekeeping genes recA and rpoZ were used to as positive controls.

Table 1. Primers used in this study

Primer Name	Sequence	Purpose
RTprkAF1	CGCTTCGGCATCGTCATGGACGTAG	Amplify *prkA* for detection
RTprkAR1	GTGAAGCACACGTTCGACCAGATCTTCC	Amplify *prkA* for detection
RTprkBF1	GTCCGCCATGCCGATCTGAAGC	Amplify *prkB* for detection
RTprkBR1	TTGAACCGGATCACGATCAGGCTCTC	Amplify *prkB* for detection
RTacuIF1	CGGACCTTGCCGGTCAGTTCGTTG	Amplify *acuI* for detection
RTacuIR1	GCTATACGGCCATGCTCTGCGTTCTG	Amplify *acuI* for detection
RTccrF4	ACGCGCCCAAGAAGGACCTCTAC	Amplify *ccr* for detection
RTccrR5	CCATGTGCCGAAGGAGATGTATGCC	Amplify *ccr* for detection
RTrecAF2	GGCAAGGGCTCGATCATGAAACTG	Amplify *recA* for detection
RTrecAR2	TTTCGGGGCCGTAGATCTCGATGATTC	Amplify *recA* for detection
RTrpoZF2	ATCGACCGCGACAATGACAAGAAC	Amplify *rpoZ* for detection
RTrpoZR2	CAGCGCCATCTGATCCTCTTCCG	Amplify *rpoZ* for detection
RT-10mer	NNNNNNNNNN*	Generation of cDNA

*pool of multiple primers with random, 10 nucleotide sequences

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IMPLEMENTATION OF IMPROVED PARALLEL STABLE MATCHING ALGORITHMS

Michael Mandulak & Enyue Lu

ABSTRACT

As introduced by Gale and Shapley, the theoretical stable marriage problem seeks to find a stable matching given sets of n men, n women and $2n$ ranking lists where each man (resp. woman) ranks each woman (resp. man) based on marital preference. A stable matching is defined as a matching of each man (resp. woman) to a single woman (resp. man) such that no man or woman prefers another partner over their currently matched partner. The sequential algorithm proposed alongside the problem guarantees a stable matching with a quadratic worst-case time complexity ($O(n^2)$), warranting improvement. Thus, the stable marriage problem has been a focus of modern high-performance computing methods to improve upon the algorithm's applications in the fields of computer networks and general set matching. These explorations have led to the development of parallel stable matching algorithms such as the Parallel Iterative Improvement (PII) algorithm and the Convergent Parallel Iterative Improvement (CPII) algorithm, which propose improved time complexities with variance in the success rate utilizing multiple processing elements. Based on the algorithm propositions, this research seeks to support the efficiency claims of each algorithm through implementation to test runtimes and success rates across a high-performance computing cluster for the sake of validity and results verification. These implementation results will also provide data to support a formal runtime complexity analysis proof for the CPII algorithm.

BACKGROUND AND MOTIVATION

The stable marriage problem and the idea of a stable matching, as defined in the 1960s by David Gale and Lloyd S. Shapley in [1], details the idea of matching similarly sized, property separated sets to each other with preferences in mind. This problem has modern applications in general matching fields such as the matching of students to specific schools or programs, organ donors to recipients and medical professionals to patients or programs under residency. Further applications consider computer network communication topics such as packet switching and peer-to-server distributions to communicate content to users quickly and at a low cost under the preference of proximal connection [2].

Based on modern advancements in high-performance computing methods, the facet of stable matching focusing on the application of these methods has rapidly developed. In 2003, a parallel stable matching algorithm was proposed to improve upon the sequential Gale-Shapley (GS) algorithm (presented in [1]) titled the Parallel Iterative Improvement (PII) algorithm, as presented in [3]. Since then, further improvements have been made to the PII algorithm's success rate while supporting its improved efficiency compared to the GS algorithm. These improvements are reflected in the algorithm line, beginning with the Parallel Iterative Improvement: Smart Initiation and Cycle Detection (PII-SC) algorithm as presented in [4] and leading up to the Convergent Parallel Iterative Improvement (CPII) algorithm as presented in [5]. While these algorithms and their subsequent improvements are supported theoretically, there is a notable lack of diversity in testing platforms and verification for the efficiency and success rate claims for each algorithm. Thus, validity is warranted through implementation-based results with a focus on the PII and CPII algorithms to test the applicability of the runtime complexity improvements across a high-performance computing cluster.

STABLE MATCHING PROBLEM AND PARALLEL ALGORITHMS

Stable Marriage Problem

Given a set of n men and n women where each person generates a marital preference ranking list of the members of the opposite gender into a total of $2n$ lists, the stable marriage problem seeks to find a stable matching between the two sets. A matching is considered stable if there exists no pairings of men and women who mutually prefer each other over their current partner; such pairings are considered unstable pairings. Alongside the problem proposition by Gale and Shapley, the sequential algorithm known as the GS algorithm was proposed and proven functional with a quadratic ($O(n^2)$) time complexity and a guarantee to produce a stable matching within any preference list permutation. This time complexity is considered relative to the maximum number of n^2-$2n$+2 steps required to find a stable matching, as demonstrated in [6].

Parallel Iterative Improvement

As proposed in [3], the PII algorithm generates an initial matching, identifies unstable pairings within an $n \times n$ matrix of preference list pairings, identifies type-1 new matching pairs (nm_1-pairs) and type-2 new matching pairs (nm_2-pairs), then generates a new matching based on these pairings and the initial matching. The nm_1-pairs are defined as the set of male-female dominant pairings, or the set of pairings in which the women pick their most preferred man from their received proposals. The nm_2-pairs are found through the nm_2-generating graph, which consists of paths, cycles or individual nodes that are determined by the positions of nm_1-pairs and the current matching pairs within the $n \times n$ matrix of preference list pairings. Using the sets of nm_1-pairs and nm_2-pairs, a new matching is generated to reduce the number of unstable pairings from the previous matching until a stable matching is found by eliminating all unstable pairings. When the number of unstable pairings remains constant between iterations, cycling occurs, preventing the generation of a nm_2-pair. These cycling data sets do not result in a stable matching, lowering the success rate of the algorithm. Due to cycling, the PII algorithm is estimated to have a 90% accuracy in [4], but when cycling does not occur, the algorithm terminates with a stable matching in at most $c \bullet n$ iterations given a constant c.

In terms of parallel processing, this algorithm utilizes n^2 processing elements (PEs) that mimic that layout of the proposed $n \times n$ matrix of preference list pairings. The communication method between these PEs within the matrix is determined by the implementation platform and the supported topological model. Each supported topological model

provides a different runtime complexity based on the time required to distribute information across the PEs.

Convergent Parallel Iterative Improvement

The CPII algorithm, as proposed in [5], is built off of the PII algorithm and follows a similar parallel structure with the main difference in the initiation phase and the overall improvement of the success rate. Thus, the same matrix-based structure of preference list pairings that is used in the PII algorithm is utilized to retain the information distribution efficiencies. In the initiation phase, the CPII algorithm builds a matching by initializing all individuals as single and comparing preference list pairings instead of the PII algorithm's arbitrary initial matching. As the matching is reformed each iteration, the algorithm repeatedly checks for unstable pairings and continues until all unstable matching pairings are eliminated. During this iteration, previously replaced pairings are intentionally excluded to avoid repetition in tested matching pairs and the lowest preference pairing values are considered first based on desirability to limit the number of unstable pairings. This algorithm claims to guarantee a stable matching in all possible preference list sets, eliminating the cycling data set issue faced by the PII algorithm, while preserving the runtime complexity. Despite the success rate improvement, the CPII algorithm places a quadratic upper bound on the number of iterations before a stable matching is found ($O(n^2)$). This runtime complexity draws similarities to the sequential GS algorithm, but the growth of the algorithm and the performance in the average-case is currently unknown.

PARALLEL IMPLEMENTATION AND METHODOLOGY

Regarding the implementation platform chosen, both algorithms, the PII and the CPII, were implemented in C++ using an open source message passing interface (MPI) implementation known as OpenMPI for parallel processing. The choice of coding language and message passing was based on ease through familiarity and the applicability of a fully connected mesh topology with the high-performance computing cluster available. The use of OpenMPI allowed for the representation of the $n \times n$ matrix of preference lists used in both algorithms by using a single PE for each preference pairing in the matrix and separating the nodes into rows and columns through communicators. This node separation simulates the fully connected mesh of trees (MOT) topology based on the identification of rankings within the set

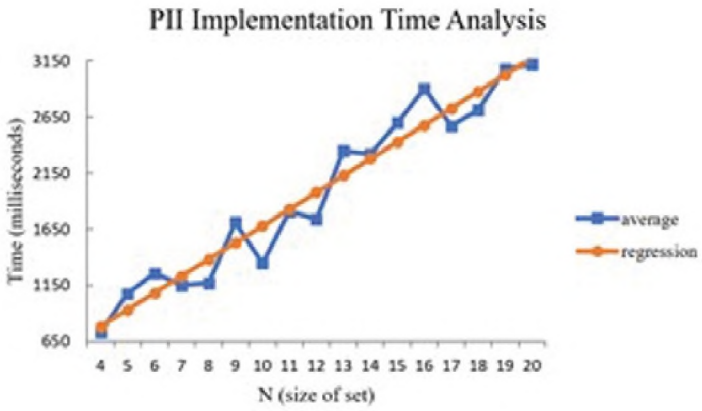

Figure 1: Linear regression of time trials on size n sets

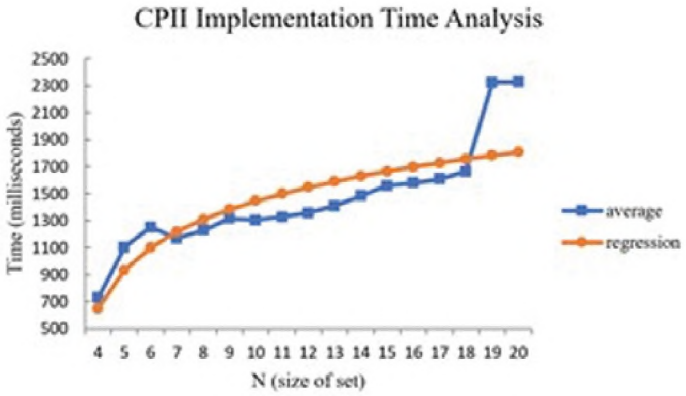

Figure 2: Logarithmic regression of time trials on size n sets

world of communicators. Despite the performance of operations within the PII algorithm being of a logarithmic time complexity through binary tree structures, the implementation used for results collection utilized linear operations due to the incompatibilities within the latest version of OpenMPI (version 4.0.0) and non-primitive, C++ data structures. Logarithmic-time operations are the most optimal for applicability of the PII algorithm and are suggested for an optimal PII implementation as shown in the topology-dependent time complexities in [3], but given the success rate discrepancies between the PII and the CPII algorithms due to cycling and the focus on OpenMPI compatibility through a fully connected MOT topology, the implementation detail is trivial.

The high-performance computing cluster available for implementation testing is a Slurm-managed 424 core cluster intended for MPI applications. Utilizing each PE for a single preference list pairing, the cluster maximizes at approximately 400 tasks or n^2 nodes, limiting the maximum set size n to 20. Over-subscribing the PEs on the cluster was tested to allow for tests of n up to 60, but the added overhead and loss of hyperthreading exponentially increased time results for n over 20.

RESULTS

Results were collected for the PII and CPII algorithms by testing the implementation 10,000 times for each value of n from 4 to 20. For each test, an arbitrary preference list generator was utilized to provide a testing set for each run of the algorithm. A shell script was used to generate an arbitrary preference list set, mark the start time of the run, test the algorithm and mark the end time. Cycling data sets within the PII algorithm implementation testing were not included in the time analysis but were noted in the success rate considerations.

Based on the implementation of both the PII and CPII algorithms, the time data follows the estimated runtime trends as proposed in [3] and [5] respectively. Specifically, the runtime trend of the PII best fits a linear regression model with a coefficient of determination of 0.94 with

the implemented linear operations. Data variation and the focus on linear growth, as shown in Figure 1, is attributed to the implementation platform and the variance within the arbitrary generation of testing data.

Cases that did not terminate under n iterations were noted as cycling cases based on the claims of the PII algorithm's iteration maximum. The success rate in the test cases of n from 4 to 20 is estimated at 97%. As claimed in [3], however, the PII algorithm experiences cycling more frequently at very large values of n, so the exact success rate percentage is not absolute. Further testing across various implementation platforms is required for an exact inaccuracy value, but the cycling issue as a hindrance to an improved success rate is present.

Considering the CPII algorithm implementation, testing yielded a logarithmic regression model with a 0.74 determination coefficient. The outlying data at n of 19 and 20, as shown in Figure 2, causes divergence from the regression model.

The spike in time from n of 18 to 19 is assumed to be caused by the limitations that small sizes of n place upon the tested data within runtime complexity analysis. Potentially, n of nineteen can be considered the n_0 of the growth trend in time complexity exhibited by the CPII algorithm. This n_0 is expected to follow the quadratic worst-case runtime complexity suggested in the algorithm proposition but requires further analysis outside of an implementation setting. This idea is also applicable to the PII algorithm implementation, as hardware limitations prevented the testing of large n. In terms of success rate, the CPII algorithm always terminated with a stable matching and zero unstable pairings, supporting the claim in [5] of convergence and the removal of the cycling issue present in the PII algorithm.

CONCLUSION AND FUTURE WORKS

Utilizing the cluster available to test parallel stable matching algorithms such as the Parallel Iterative Improvement and the Convergent Parallel Iterative Improvement algorithms, the data collected supports the claims made regarding the runtimes (per iteration for CPII) and the success rates of these algorithms. The PII algorithm does face the cycling issue in certain data sets (with respect to termination under n iterations) and the CPII does converge with the tested values of n, verifying these claims under the utilized implementation platform. As further theoretical analysis is warranted to investigate the n_0 of the CPII algorithm, these results are expected to contribute towards such a cause as support for a formal proof.

In terms of future work, the implementation of the PII algorithm can be improved upon utilizing tree structure operations for an efficiency increase but seems unnecessary due to the cycling issue and the convergence of the CPII algorithm. This, however, would be effective given the hardware to test sizes of n larger than 20. Parallel implementation can also extend to the PII-SC algorithm, the stable roommates problem and other stable matching problems for implementation-based results across a diverse set of implementation platforms for verifiability. Despite these verification goals, proving an average case run time for the CPII would further determine the applicability of the algorithm compared to the sequential GS algorithm, as they both share a quadratic worst-case time complexity. If demonstrated that the CPII shows logarithmic growth trends in the average case and this average case is more prevalent than the worst-case, as suggested in the implemented first twenty n, the algorithm would be a strict improvement upon the PII algorithm.

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Time

Jaden Long

ABSTRACT
"Time" is a poem about the end of my senior year of high school. Since the age of 12, my family has dealt with poverty. At the end of senior year, things grew worse. The cable was cut off regularly, food was scarce in the house, and my family was faced with the impending threat of losing our home. As time passed, I was beginning to develop a fear of the unknown. I feared losing my home and my friends. Controlled by this fear, I began to lose interest in my hobbies, namely poetry. I stopped writing. I became obsessed with managing money and dealing with the emotional impact of poverty. It was debilitating to me. I started noticing how the people I knew were beginning to achieve noteworthy feats in their own hobbies. A jealousy began to grow from this realization. There was an artificial distance being placed between my goals, my friends, and my future over money. I felt like life itself was leaving me behind. "Time" portrays these emotions through a description of the last day of high school. It portrays the state of my home. It captures the sentiment of being left behind. It is a description of how out of place I felt among my friends. Finally, "Time" displays my desire to escape life into poetry.

On the recliner in my childhood
apartment, I could hear

the middle school bus. It would stop
on the corner at 6:45. I laid back

and remembered snagging
my nails on the threads

of leather seats. Plucked out
the cotton. Let anxiety drivel

down the seams. Sewed
it into friendships. I sat hemming

worry into promise. Pinned
encouragement into the wings

of stuffed dragonflies until they flew.
Watched as time played fire

to polyester passengers, leaving me
to inhale exhaust. Children wait for the
bus,

while I sit on a fourth-hand recliner. The
bus isn't
there for me. So, I don't shower. I'm
welcomed

to my chair by the odor of abandonment:
mildew on wet plastic. The fumes
congealing

over warm oats. My pores ventilate
the burning asphalt. The bus is not

for me. It hunkers forward at 6:55.
The car will start at 7:10. I worry when

mother is still, daydreaming
on the couch. It will be 7:15 if she

wakes with a headache, back pain,
some other malady. I know she's

tired. But the car always starts. Keys
rattle at the same time. At the same

time every day, the shape of *good
morning* passes her lips. Strains

the cracks around her mouth.
I finish my oatmeal; I dread.

The sun berates the pavement
with a snark gaze. The neighbors

will stare from their garage enclaves
as I play hopscotch to invisible

lines. The car starts at 7:10. But
the car is not for anyone.

There is no a/c. Broken for two
months. No need to look

at the dashboard when dripping
sweat often grasps at the yellow

lights. The car is not
for me. It leaves at 7:30.

The lunch bell rings at 12:15. I sit
amongst the active – some laying

flat on top of desks, others pacing
between rows of chairs. Moving

people. Friends. And I feel myself
whirlwinded, my clothes threatening

to leave my body. Our conversation begins
over the popping of ears. I notice

a cavity within the patterns
of speech. Topics play tag

over tiled floors. Only to drag their feet
before contact. Eyes linger a moment

too long. Scuffs are left
behind the collar. My neck craned

towards the leg of a table. There are no
mentions of eating out, meet-ups,

or mall hopping that would laden
the four corners of my wallet

with excuses. I notice the happenstance.
There is me. There are people

unlike me. And we are shrinking. Melding
into a Thursday afternoon.

The lunch bell rings at 12:15.
Although, it's not for me.

My mother picks me up at 2:15. The radio
is playing 98.3: political

ramblings flushed out
over the unconcerned drone

of pop hits. I think – in summer –
all songs are love

songs. There is absence. Fragility.
Repetition. Sometimes

thought in the shaping of radio waves.
Shouts and overexertion and abuse

made ethereal. My mother and I.
We pull out of the school parking lot

and discuss the day. Grin to our favorite
lyrics. Stop for gas. Sip iced tea at

the pump. It is a thirty-minute drive
home. But I hear home howling.

The recliner begging me back
to its crushing. And I don't want

the drive to end. When we begin
to approach the house I ask

that we keep going. There are
suited thieves standing in the front yard,

traces of cotton at their feet.
And the house keys rattle,

reverb with almost as much
ire as my reaching arms.

The radio always played
for me. It stops at 2:55.

We drive down the long road to
the middle school where

my mother taught me to drive. Thin
breaks between the clouds. The pines

are wrestling with the wind.
The world posing itself to erase

our progress. We park in the farthest
corner of the lot. Facing the road so

the passersby might see our faces.
If only to pretend we see at all. My mother

and I make small talk. Time feels like
it is passing so slowly each word

might shrivel. The moisture in my eyes
dries over the tedium. She catches

the soft refraction in them. And in a way
only a mother can do, she poses

a question, *What's going on*
with your poetry?

My thoughts rearrange as I straighten
my back, stretch down the hem

of my shirt, try to stop my teeth
from mashing together. I explain

my ideas for a poem. Stumble over
words just to repeat them. Ask

again and again if she gets what
I mean. It felt like

physics. That the ideas in my mind
might split the clouds entirely.

That written down, the softest
silken words could sew them

back together and leave
everything good in the world.

My stonewashed
face becomes charcoal

denim. Thoughts of poetry seated in the
tags. I
am distanced from my mother. There

is a tiny loom teetering on the dashboard.
It coaxes in my rambling as the drops of
rain

enrapture worms with each reed
separating my words into silhouettes

without shadows. I was not talking
to my mother anymore. I was pleading

to an audience. I was hoping
that in my words this fickle thing, this

apparition, this poetry would hear me.
Applaud and toss a bouquet down

the dashboard. Her friends' assonance
and empathy screams louder than

the recliner. Louder than suited thieves.
I could see the loom shaping my words

into cotton peregrines. Expected them
to fly. Saw them flutter up and then

dive at the muddied mats
around my feet. My rant died on

their coattails. The sun visor drawn
over the stage. But my mother tells

me she understands. Everything
I meant to say. Poetry was not

for me in this
moment. But I felt it.

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