



MINNESOTA STATE

**MINNESOTA
UNDERGRADUATE
SCHOLARS**



Proceedings of the 9th Annual Minnesota State Conference of Undergraduate Scholarly and Creative Activity

June-July 2020

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MINNESOTA STATE

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It is my pleasure to introduce you to the *Ninth Annual Minnesota Conference of Undergraduate Scholarly and Creative Activity*, sponsored by the Minnesota Undergraduate Scholars, a consortium comprised of a number of Minnesota State colleges and universities that supports the excellent research, scholarly works, and creative activity by our undergraduates across the state.

This year's conference *Connections and Collaboration* is a wonderful theme that captures the exciting opportunities that are available as a system of 37 colleges and universities. Congratulations to the undergraduate students who have embraced this learning opportunity and are presenting projects in a variety of ways, including presentations, oral papers, visual arts, displays, and performance art. And my many thanks to the faculty members who are engaging with students and spending time with and motivating undergraduates who are eager to take their work beyond the classroom setting.

I am deeply grateful that you are participating in the conference and celebrating the amazing accomplishments of these student-faculty collaborations!

Devinder Malhotra
Chancellor





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Welcome to St. Cloud State University.

We were delighted to host the Ninth Annual Minnesota Undergraduate Scholars Conference. While we wish this important event could have been hosted in-person, we were excited to be able to host it virtually through D2L Brightspace. This year's conference theme "**Collaborations and Connections**" recognized the interconnected world we live in and the integrated scholarship we seek to instill in our students as we prepare them for work, life, and citizenship in the 21st Century.

Like many regional comprehensive universities across the nation, St. Cloud State University had its humble beginning as a normal school and during its 150 year history has grown to be recognized as one of the largest regional comprehensive universities in the upper Midwest. As we are redefining our role and work as a distinctive regional comprehensive university in central Minnesota, we will reinvigorate the scholarship of teaching and learning and embrace the Teacher Scholar Model at St. Cloud State University. Our academic programs will be distinctive as demonstrated through unique characteristics such as experiential and applied learning embedded in the curriculum and experiences brought forth by our robust external partnerships with our community and beyond. The Minnesota Undergraduate Scholars Conference is indeed an avenue we are excited to present to our students and fellow students in the Minnesota State system and the region wherein they can showcase their scholarly and creative works.

At St. Cloud State University, our students' learning is embodied in the cross-cutting attributes, *Our Husky Compact*. We prepare our students to *think creatively and critically, seek and apply knowledge, engage as a member of a diverse and multicultural work, communicate effectively, integrate existing and evolving technologies, and act with personal integrity and civic responsibility* through curricular, co-curricular, and extra-curricular activities. We take pride in our students demonstrating their excellence in learning at distinguishing venues such as this conference.

I would like to congratulate all the students who participated in the newly reimagined conference and acknowledge all the students who were accepted to present at the original event. I also take distinct pleasure in congratulating all the faculty mentors for their dedication and superb work in mentoring these upcoming talents.

Best Wishes,

Dr. Robbyn R. Wacker
President



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A member of Minnesota State

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Message from the Conference Chairs

Thank you for participating in the 2020 Minnesota State Conference of Scholarly and Creative Activity, the premiere, annual conference in Minnesota to showcase high quality scholarly research and creative activity completed by undergraduate students at institutions across the Minnesota State Colleges and Universities system. The conference is arranged each year by the Minnesota State Scholars Consortium, a group of faculty and staff across the Minnesota State system. The current consortium roster is listed later in this proceedings. If you are interested in joining the consortium or in learning how to participate in the event, please send us an email!

This year, St. Cloud State University was chosen for the honor of organizing and hosting this event. Past hosts included Minnesota State University – Mankato (2012-2013), Minnesota State University – Moorhead (2014), Minnesota State University – Winona (2015-2017), Rochester Community and Technical College (2018), and St. Cloud State University (2019).

Obviously, the current year of 2020 has seen unique challenges presented by the global coronavirus pandemic, including closures of lab spaces, implementation of social distancing, usage of masks, and the accompanying personal consequences each of us has dealt with in terms of managing loneliness in some degree of isolation, maintaining motivation and discipline in rapidly changing professional circumstances, and repurposing our skills for remote interaction and teamwork. This conference was not exempt from coronavirus-related consequences. We made some tough decisions which culminated in both an opt-in set of online conference presentations hosted on a Minnesota State D2L website, as well as this proceedings, which represents the new addition to the conference of published student papers. We are hopeful that these efforts will support future growth and support for student research in Minnesota – even under the strain of adapting to global situations like COVID-19.

The original planned participation this year included 20 presentations (9 poster and 11 oral) submitted by 35 students from four institutions across the system including Minneapolis Community and Technical College, Southwest Minnesota State University, St. Cloud State University, and Winona State University. The opt-in presentations on D2L ultimately included 3 oral presentations, 7 poster presentations, and 1 paper submission. We hope to aggressively advertise and encourage expansion of this conference for future events to more institutions to support research opportunities for their students.

Thank you for supporting undergraduate research in Minnesota!

With highest regards,

Kelly Branam Macauley, Ph.D.
Conference Co-Chair

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Published Works of Student Research

Book of Abstracts

List of Abstracts Accepted for the In-Person Conference

Accepted for Oral Presentation

| Presenters | Title of Presentation | Institution | Faculty Mentor |
|--|--|-------------|----------------------------|
| Sariah Cheadle | Underestimating Children's Literature: The War That Saved My Life | SMSU | Dr. Ruthe Thompson |
| John Erickson Mikhail Jagunich | An Everchanging Campus Community: St. Cloud State in the 1980S | SCSU | Dr. Galler |
| Cody Friedges Austin Domeier | Dominance Assessment of Madagascar Hissing Cockroaches | SMSU | Dr. Alyssa Anderson |
| Bijaya Ghorasainee Sanjeev Regmi | Laser Production and Characterization of Zinc-Oxide Nanoparticles | SCSU | Dr. John Sinko |
| Louis Lozinski Baylie Bloomquist Candace Thomas | Food Preference and Competition for Food Among Acheta domesticus (Orthoptera: Gryllidae) | SMSU | Dr. Alyssa Anderson |
| Rachel Michl | Reiki and Well-being in Minnesota | SCSU | Dr. Kelly Branam Macauley |
| Jenna Nelson Jace Engelmann Logan Olson Amira Zaher | Anti-diabetic Properties of Sodium Bicarbonate in a Mouse Model of Type 1 Diabetes | SCSU | Dr. Marina Cetkovic-Cvrlje |
| Maggie Powers | "This Is What Community Should Look Like": an Ethnographic Study of Community Building Within a Local Nonprofit Organization | SCSU | Dr. Kelly Branam Macauley |
| Sonya Smetana | Oppression and Resistance: Chinese Litigation in the Late Nineteenth Century | SCSU | Dr. Robert Galler |
| Jennifer Sonterre | David Davis: How One Decision By A State Legislature Decided the 1876 Presidential Election | SCSU | Dr. Robert Galler |
| Elatia Zaffke | Laboratory Simulated Supernova Shockwaves | SCSU | Dr. John Sinko |

Accepted for Poster Presentation

| Presenters | Title of Presentation | Institution | Faculty Mentor |
|---|---|-------------|--|
| Abigail Benvenuto Thomas Carlson Danielle Langworthy Elizabeth Schmitt | Perceived Stress and Mental Health: The Intervening Effects of Education, Income, and Race | WSU | Dr. Amanda Brouwer |
| Ryan Bohara Gregory Rossi Alma Boric Mohamed Mohamed Abdigadir Khalif | Prevalence of Antibiotic Resistant Genes in Environmental Isolates | MCTC | Dr. Renu Kumar |
| Jessica Craig | Towards a Less Divided Politics: solving the problem of uncompetitive electoral districts through geography | SCSU | Dr. Gareth John |
| Austin Domeier | Lotka-Volterra Theory: The Mathematics Behind Predator-Prey Interactions | SMSU | Dr. Heather Moreland Dr. Mu-wan Huang |
| Jacalyn Gustavson | Thermal Denaturation of MAPK14 | WSU | Dr. Emily Ruff |
| Rajesh Hamal | Application of Ultrasound in Food processing | SMSU | Dr. Peiyi Shen |
| Ryleigh Haynes | How Do College Students Justify Their Deviant Behavior? | SMSU | Dr. Cindy Aamlid |
| Nathan Kuhn | A Gambling System | SMSU | Dr. Heather Moreland Dr. Mu-wan Huang |
| Victoria Pounder | Math In Balance | SCSU | Dr. Melissa Hanzsek-Brill Dr. Patty Waletzko Dr. Bruce Klemz |

Perceived Stress and Mental Health: The Intervening Effects of Education, Income, and Race

*Abigail Benvenuto, Thomas Carlson, Danielle Langworthy, Elizabeth Schmitt
Winona State University*

Faculty Mentor: Dr. Amanda Brouwer

Presentation Type: Poster Presentation

Introduction: Previous researchers have demonstrated that individuals of ethnic minority did not experience a mental health advantage in schools, with lower income, and those who represent the ethnic minority experience higher levels of stress and poorer mental health outcomes than those who are in the majority. Therefore, the current study was conducted to better understand how education, income, and race affect the relationship between stress and mental health.

Methods: Participants ($N=162$, $M_{age}=38.17$, $SD=12.53$) answered questions about perceived stress, mental health, and socio-demographics. Moderation analyses were conducted to assess whether income, education, and race moderated the relationship between perceived stress and mental health.

Result Section: The relationship between stress and mental health was moderated by education ($\Delta R^2 = 0.037$, $F(3,136) = 2.84$, $p = 0.04$), but not by income or race. As stress increased, individuals with a high school education or less experienced a greater increase in mental health symptoms compared to individuals with some college education, $b = -7.64$, $t(136) = -2.23$, $p = 0.03$. No other education group differences were significant.

Discussion Section: Having some college education may armor individuals with tools and skills which enable them to be more resilient to mental health symptoms linked with perceived stress. Race and income were not moderators which suggests that the effect of perceived stress on mental health is similar for different racial groups and income groups. Future researchers should delve deeper into the possible moderation effect could have when there are different sociodemographic.

Prevalence of Antibiotic Resistant Genes in Environmental Isolates

Ryan Bohara, Gregory Rossi, Alma Boric, Mohamed Mohamed, Abdigadir Khalif
Minneapolis Community and Technical College

Faculty Mentor: Dr. Renu Kumar

Presentation Type: Poster Presentation

According to the Center of Disease Control and Prevention, nearly 270,00 people die in the United States as a result of antibiotic resistant septic infections. Where are these antibiotic resistant infections coming from? How does mass use of antibiotics in agriculture effect the local microbiome? In the agricultural industry, large amounts of antibiotics are used to enhance animals for poultry and meat productions. These type of factory farms use antibiotics as feed-additives which leads to animal waste being deposited into surrounding ecosystems affecting animals and humans. Recent studies indicated a correlation between the use of antibiotics in factory farms with rise in antibiotic resistant bacteria resulting in the increased numbers of untreatable infections in our society. This study focuses on antibiotic resistant bacteria isolated from the soil and water samples collected from a fence-line near an animal farm in Minnesota. In the study, 47 bacterial colonies were isolated. Then were purified by using streak plate technique. Kirby Bauer method was performed to determine antibiotic profile of these bacterial isolates. Results revealed that several of these bacteria strains were resistance to ampicillin, penicillin and tetracycline. Genetic analysis through DNA Isolation and Polymerase Chain Reaction techniques identified the presence beta-lactamase antibiotic resistance genes in a few isolates. The information acquired from this research will enhance the understanding of antibiotic resistant bacteria in the farming industry. By detailed analysis of farming environments, we start to understand the relationship between outbreaks of antibiotic resistant infections and the environmental reservoirs of resistant bacteria.

Underestimating Children's Literature: The War That Saved My Life

Sariah Cheadle

Southwest Minnesota State University

Faculty Mentor: Dr. Ruthe Thompson, English

Presentation Type: Oral Presentation

In the academic and 'adult' world, there are many who overlook children's books as a viable source of information and instruction. Doing so, however, neglects this vast body of literature whose authors put as much research and significance in writing these stories as do authors who write adult fiction and nonfiction. Framed around *The War That Saved My Life* by Kimberly Brubaker Bradley published in 2015, this presentation discusses Bradley's use of simple, concise and yet poignant narrative to portray a variety of topics such as family, mental health, and physical disabilities with a refreshing and clear approach. Using the example of *The War That Saved My Life*, I will explore the potential that can be found within literature written for children.

Towards a Less Divided Politics: solving the problem of uncompetitive electoral districts through geography

Jessica Craig
St. Cloud State University

Faculty Mentor: Dr. Gareth John, Geopgraphy and Planning

Presentation Type: Poster Presentation

“If voting made any difference, they wouldn’t let us do it.” A humorous quote by Mark Twain but it does make one think. Political parties and candidates routinely carve out safe districts for themselves and the topic of electoral bias is perhaps more relevant now than ever. Partisan gerrymandering, or electoral map bias, may be easier to achieve today because a Supreme Court decision in 2019 that said the states must decide the issue of gerrymandered districts, not the federal courts. Since most states decide electoral districts through acts of legislation, it means that the party in power is likely to be the one to draw the maps. Through comparative analysis and other research methods, I aim to make a case for why uncompetitive electoral enclaves throughout the US hurts democracy and why non-partisan redistricting commissions may be the only way to solve that problem.

Key words: political geography; redistricting; electoral geography

Lotka-Volterra Theory: The Mathematics Behind Predator-Prey Interactions

Austin Domeier

Southwest Minnesota State University

Faculty Mentor: Drs. Heather Moreland & Mu-wan Huang, Mathematics

Presentation Type: Poster Presentation

Predator-prey interactions are a vital aspect of population dynamics. Understanding interspecific interactions can help describe past and future relationships between species. In 1925, Alfred J. Lotka and Vita Volterra independently proposed a system of differential equations to model predator-prey interactions. The predator-prey system in northern Minnesota of white-tailed deer (*Odocoileus virginianus*) and gray wolf (*Canis lupus*) populations was studied to help understand the impacts of environmental factors on these species. Data collected by the Minnesota Department of Natural Resources from 2013-2017 was used to determine initial population sizes and growth. Lotka-Volterra theory was used to model predator-prey interactions using standardized interaction rates. Although Lotka-Volterra theory has assumptions that rarely exist in the natural environment, it is essential for simulating effects on population dynamics and can lead to more accurate models of interspecies interactions in the natural environment.

An Everchanging Campus Community: St. Cloud State in the 1980S

John Erickson and Mikhail Jagunich
St. Cloud State University

Faculty Mentor: Dr. Robert Galler, History

Presentation Type: Oral Presentation

During the 1980s St. Cloud State evolved as a campus community in terms of technology, activism, and athletics. Like any university, St. Cloud State has endured many changes during its one hundred and fifty years of existence. While each decade has resulted in change for the university and campus, the 1980s were years of campus and community growth, and the identity of St. Cloud State was changed. From the hockey program's transformation to division one prowess under the leadership of coach Herb Brooks, to the creation of the women's center and various pro-choice protests, the students at St. Cloud State created a new identity for themselves during the decade that expanded outside of academics. Outside of a campus identity and national identity, St. Cloud State also connected further on an international level, in addition to an influx of international students, St. Cloud State adopted a sister university in Japan. This project will demonstrate the ways in which the students adapted into both a new campus identity, as well as various protests involving social movements.

Dominance Assessment of Madagascar Hissing Cockroaches

Cody Friedges and Austin Domeier
Southwest Minnesota State University

Faculty Mentor: Dr. Alyssa Anderson, Biology

Presentation Type: Oral Presentation

Organisms living in groups typically develop social hierarchies. An individual's status in this hierarchy determines access to food, mates, shelter, and other resources. The goal of this study was to observe dominance establishment and male competition in a group of five Madagascar hissing cockroaches (*Gromphadorhina portentosa*) as well as to assess factors that influence competition. Scenarios observed included male interactions without female stimuli, male interactions in the presence of female scent, and male interactions in the presence of a female cockroach. This was accomplished by observing one-on-one male interactions in an enclosed space separated from the group. Initial results indicate that males vigorously compete to establish dominance. Once dominance has been established within a population, aggressive behavior is replaced with submissiveness. However, the reintroduction of females does appear to reinitiate male aggressive behavior. This experiment helps us determine how intraspecific male competition influences the formation of dominance hierarchies.

Laser Production and Characterization of Zinc-Oxide Nanoparticles

Bijaya Ghorasainee and Sanjeev Regmi
St. Cloud State University

Faculty Mentor: Dr. John Sinko, Physics

Presentation Type: Oral Presentation

Zinc Oxide nanoparticles have different physical, electrical, optical and biological properties. The main objective of this project to ablate the Zinc Oxide nanoparticles with the help of YG laser and the size of the nanoparticles should be less than 10 nm. ZnO nanoparticles were obtained in deionized water by laser ablation in liquid. Zinc Oxide Nanoparticles were prepared in neat deionized water by laser ablation on the physical 2D motional micro stage model programmed by Arduino with the addition of surfactant to reduce aggregation and the surface tension of the deionized water. Various purification methods involved in this process is filtration and centrifugation method that reduces the aggregation and strengthen the purity of zinc oxide nanoparticles. The ablated Zinc Oxide nanoparticles are analyzed with the help of Dynamic Light Scattering method (DLS), Scanning Electron Microscopy (SEM) and optical profilometry. The obtained smallest size of zinc oxide nanoparticles through our research is 70 nm which is analyzed with the help of the DLS method. 2 Dimensional and 3 Dimensional properties are shown by the optical profilometry and its special characters are detected by SEM. Various factors affecting the size distribution of ZnO nanoparticles are the type of liquid medium, energy fluence, wavelength, frequency, pulse duration and ablation period.

Thermal Denaturation of MAPK14

Jacalyn Gustavson
Winona State University

Faculty Mentor: Emily Ruff

Presentation Type: Poster Presentation

Kinase domains transfer a phosphate of an ATP molecule to a serine, threonine, or tyrosine residue of a substrate. This phosphorylation can activate or deactivate a protein, meaning that kinases are often important regulators of various cell activities. MAPK14, a mitogen activated protein kinase, is involved in the regulation of the cell cycle in response to environmental stress and proinflammatory cytokines. In experiments performed in Biochemistry I lab in Fall 2019, circular dichroism spectroscopy was used to find the melting temperature of purified mitogen-activated protein kinase 14 (MAPK14) and other purified recombinant protein kinases. However, the melting point for MAPK14 could not be determined as no significant change was observed in the circular dichroism signal when the protein was heated gradually to 95°C. This was surprising as the previously published melting point of the protein is only 46.6°C. Literature research suggests that the 10 mM phosphate buffer or the polyhistidine tag used for protein purification may be stabilizing the structure of the protein, thereby inhibiting the denaturation of MAPK14 during the experiment. To further investigate the thermal stability of MAPK14 and the reason for this unexpected result, circular dichroism was used to determine the melting temperature of this protein kinase under different buffer conditions, as well as in the absence of the His-tag. Trends in these results were also compared to trends in denaturation by guanidinium chloride observed by intrinsic fluorescence spectroscopy.

Application of Ultrasound in Food processing

Rajesh Hamal

Southwest Minnesota State University

Faculty Mentor: Dr. Peiyi Shen, Department of Agriculture, Culinology® and Hospitality Management

Presentation Type: Poster Presentation

Ultrasound has been widely applied in various processes in the food industry. The purpose of Ultrasound in food processing technology is to reduce the processing time, ensure the safety of food, save energy and increase the shelf life and quality of food products, etc. Ultrasound can be applied directly to food product, coupled with device or submerging the food in an ultrasound bath. Based on their ranges of frequency, application of ultrasound can be divided into low intensity with high frequency ultrasound and high intensity with low frequency ultrasound. Several processes such as filtration, deforming, degassing, drying, emulsification, extraction, etc. have been efficiently improved with the assistance of ultrasound in food industry. Moreover, because of its ability to rupture cells and denature enzymes, ultrasound is also one of the new non-thermal technologies in food preservation. All these advantages offer ultrasound a wide application in a variety of food products, including dairy, carbonated drinks, fermented products, dehydrated products, ketchup, mayonnaise, etc. Nowadays, the role of ultrasound as green novel technology in the environment sustainability has attracted the attention in both academic field and food industry. This review will offer a complete picture of theoretical background about ultrasound technology and current knowledge on the application of ultrasound in food processing.

How Do College Students Justify Their Deviant Behavior?

Ryleigh Haynes

Southwest Minnesota State University

Faculty Mentor: Dr. Cindy Aamlid, Sociology

Presentation Type: Poster Presentation

The goal to my project is to determine how college students justify their deviant behavior. I used a convenient sample of college students for my survey. Students were asked to report on past actions that they have engaged in and explain their reasoning behind why they did it. Previous research indicates that people are more likely to engage in deviant behavior if they can neutralize the guilt from committing the action or if they make it appear normal. The student responses will be compared to nine common neutralization techniques. My presentation will share the results of this study.

A Gambling System

Nathan Kuhn

Southwest Minnesota State University

Faculty Mentor: Drs. Heather Moreland & Mu-wan Huang, Mathematics

Presentation Type: Poster Presentation

Gambling is a huge industry in the United States from sports betting to casino games. A few forms of theoretical betting, such as progressive betting, have been developed to beat the casino. However, these are not fool proof. Oscar's System, or Oscar's Grind, is the best approach to beat a casino. This method looks at a bettor who has high probability to win its bet back. In order for this betting system to be successful and to accumulate large profits, lots of hours (grind), is required. This betting system is modeled using Markov Chains which show each bet size and the bet number in each sequence to yield a profit of one unit. It is shown that over the long run, this system will provide increasing profits.

Food Preference and Competition for Food Among *Acheta domesticus* (Orthoptera: Gryllidae)

Louis Lozinski, Baylie Bloomquist, Candace Thomas
Southwest Minnesota State University

Faculty Mentor: Dr. Alyssa Anderson, Biology

Presentation Type: Oral Presentation

The common house cricket (*Acheta domesticus*) is increasingly produced as a human food source. We observed food preferences and foraging behaviors among later instar and adult crickets split between two control and two treatment groups (N = 25 per group). Control groups were fed Fluker's® high-calcium cricket food. Experimental groups were provided choice of cricket food, commercial chicken feed, modified Patton's diet 16, and kitchen scraps. We predicted results would show no difference in food choice, growth, survival, and foraging behaviors between control and treatment groups. Food weight was measured every other day. Data on behaviors, consumption, and preferences were collected by direct observation and video for four weeks. Observations revealed treatment crickets spent more time foraging than control. Treatment groups consumed more food per cricket than control groups ($p < 0.05$), but treatment survival was lower. Given growth in cricket use for human consumption, understanding nutrition for small-scale production is essential.

Reiki and Well-being in Minnesota

Rachel Michl

St. Cloud State University

Faculty Mentor: Dr. Kelly Branam Macauley, Anthropology

Presentation Type: Oral Presentation

Reiki is an example of a holistic healing practice that can be used for the participants overall well-being. Well-being can be seen through mental, emotional, and physical forms with my participants. Some examples include the calming effect Reiki was said to have on my participants, and it's ability to help with pain, in my personal experience it reduced the irritation from my poison ivy and hives. Reiki can be described as a holistic energy healing that focusing on the moving of energy through the body to help realign or balance the recipients energy and help heal ailments. Previous research shows that Reiki and other forms of holistic healing have been used for well-being for a number of years. Julie Hahn, Patricia M. Reilly, & Teresa Buchanan discuss the use of Reiki is helping hospital patients deal with their pain and anxiety. Through the use of participant observation I was able to experience how and why Reiki is used and directly see it's influence on the recipients well being. This paper will discuss my research's suggestion that Reiki is used as a method of well-being, in comparison to other previous works focusing on methods such as yoga, massage, and meditation. Mark S. Rosenbaum, & Jane Van de Velde discuss their research and describe that Reiki is shown to have more of an effect on reducing pain in cancer patients compared to other methods such as massage and yoga. I argue that Reiki is used for the participants well being both mentally and physically in a formate that can reduce stress, anxiety, and pain as seen in Julie Hahn, Patricia M. Reilly, & Teresa Buchanan discussion of the use of Reiki is helping hospital patients deal with their pain and anxiety, and Mark S. Rosenbaum, & Jane Van de Velde discussion of pain reduction in cancer patients.

Anti-diabetic Properties of Sodium Bicarbonate in a Mouse Model of Type 1 Diabetes

Jenna Nelson, Jace Engelmann, Logan Olson, Amira Zaher
St. Cloud State University

Faculty Mentor: Dr. Marina Cetkovic-Cvrlje, Biology

Presentation Type: Oral Presentation

Type 1 diabetes (T1D) is a chronic inflammatory autoimmune disease in which T cells destroy insulin-producing β -cells in the pancreas, leading to hyperglycemia. Some T cells directly kill β -cells, such as T-cytotoxic (Tc), or indirectly such as T-helper (Th), while others, like regulatory T cells, actually protect them. A recent study showed that sodium bicarbonate (SB) exhibited anti-inflammatory activity by affecting immune cells other than T cells, speculating its potential for the treatment of autoimmune diseases. Since SB has never been tested in an experimental mouse model for autoimmunity, we studied the effects of SB treatment on the development and severity of T1D, as well as on T cell subsets and T cell function. It was hypothesized that SB administration (200 mM, administered via drinking water) would decrease the incidence and severity of streptozotocin-induced T1D in 8-week-old C57BL/6 mice by its action on T cells. Glucose and body weight measurements were taken biweekly until mice were sacrificed four weeks later, and their spleens obtained for analysis of cell counts, viability, T cell proliferation, and quantification of T cell subsets by flow cytometry. There were no differences in splenic lymphocyte counts and viability between SB-treated and control mice. Although results showed that SB significantly decreased glucose levels and delayed diabetes development, it does not seem to affect the frequency of T cell populations nor their proliferation capacity. Our results suggest beneficial effects of SB in the prevention of mouse autoimmune T1D and highlight the need for further studies on its mechanism of action.

Math In Balance

Victoria Pounder
St. Cloud State University

Faculty Mentor: Drs. Melissa Hanzsek-Brill, Patty Waletzko, Bruce Klemz
Presentation Type: Poster Presentation

Math In Balance is an educational app created to help anyone who struggles solving single variable equations. Users can select from one of three characters to follow a unique path to solving equations. This app is formatted so the user is presented with a linear equation and asked to solve for x . Using the interactive scale, users balance the equation as a visual reminder that what is done to one side must also be done to the other. Once the problem is solved correctly, the user gets a stamp and can move onto the next equation. Each path has 10 equations and can be completed multiple times with different problems appearing each time.

“This Is What Community Should Look Like”: an Ethnographic Study of Community Building Within a Local Nonprofit Organization

Maggie Powers
St. Cloud State University

Faculty Mentor: Dr. Kelly Branam Macauley, Anthropology

Presentation Type: Oral Presentation

This ethnographic study is based off of six weeks of participant observation and ethnographic research with Neighbors to Friends, a local grassroots organization in Central Minnesota that facilitates a free laundry program and runs a mobile shower vehicle that provides showers to those experiencing homelessness. By fully participating in the day-to-day operations of Neighbors to Friends, the purpose of this project is to gain a holistic understanding of how this unique nonprofit organization creates a sense of community for those experiencing homelessness and poverty. Nancy Dyson, the director of Neighbors to Friends, has a leadership style that allows for volunteers, community partners, and the people they serve to take ownership in the program and creates a sense of community where all are welcome. In a capitalistic society, people are often seen as commodities and value is often placed on a person based on what they can contribute to society financially. Neighbors to Friends rejects this ideal and finds value in people just because they are human. By comparing my observations to scholarly research about community and grassroots leadership styles, I argue that Neighbors to Friends not only meets the physical needs of marginalized individuals experiencing homelessness and poverty, but fosters an environment where community is created and the need to belong is met as well.

Oppression and Resistance: Chinese Litigation in the Late Nineteenth Century

Sonya Smetana
St. Cloud State University

Faculty Mentor: Dr. Robert Galler, History

Presentation Type: Oral Presentation

Chinese immigrants began to steadily enter the United States starting in 1849, and were almost immediately seen as a threat by white Americans. Fears of white racial purity, jobs, and change to culture prompted lawmakers to pass discriminatory laws against Chinese immigrants throughout the nineteenth century. These oppressive measures culminated in the Chinese Exclusion Act of 1882, which banned the entry of Chinese laborers. A common misconception is that Chinese immigrants did not fight back against oppression; however they did resist their mistreatment, mainly through litigation. The Chinese Consolidated Benevolent Association of San Francisco and the Chinese Consulate in San Francisco were two organizations that provided leadership and financial support that made it possible for hundreds of Chinese immigrants to go to court. Wong Kim Ark, Chew Heong, Chan Yong, and Lin Sing were among the many Chinese people to challenge oppressive American laws at state and federal levels before the turn of the century. The legal battles of Chinese organizations and individuals highlight agency and persistence in their fight for equality.

David Davis: How One Decision By A State Legislature Decided the 1876 Presidential Election

Jennifer Sonterre
St. Cloud State University

Faculty Mentor: Dr. Robert Galler

Presentation Type: Oral Presentation

Reconstruction following the Civil War was a long and arduous task which left the country unsure of what was next for the country. In the years following the Civil War the powers of the federal government had devolved, which put much of that power and influence into the hands of the states. The election of 1876 pitted Republican Rutherford B. Hayes against Democrat Samuel J. Tilden, neither of who were powerful choices. When the votes were tallied in November 1876, there still wasn't a winner. After much debate, it was decided that an Election Commission should be formed. The Commission would be made up of five U.S. Senators, five U.S. Representatives, and five Supreme Court Justices. Supreme Court Justice David Davis had been tapped to head up the Commission. In the hopes of swaying the decision of the newly appointed Election Commission, the Democrats in the Illinois Legislature abruptly nominated Supreme Justice David Davis to fill a Senate seat that had been sitting vacant for weeks. Davis accepted the nomination but surprised the country but resigning his seat on the Election Commission. Supreme Court Justice, and Republican, Joseph Bradley was named as the new head of the Commission. Bradley cast his vote for the Republican and gave the election to Hayes and the Republicans. This strange case of backroom deals, compromises, and uncertainty shows how important the role of the state legislature can be, not only in their home state, but also on a national level.

Laboratory Simulated Supernova Shockwaves

Elatia Zaffke

St. Cloud State University

Faculty Mentor: Dr. John Sinko, Physics

Presentation Type: Oral Presentation

Supernovae are some of the most powerful explosions that occur in our universe. These explosions generate massive shock waves that span over tens of light years in distance. They are responsible for atomic fusion that creates the denser elements, needed for the creation of planets such as our own. The goal of this project is to simulate one of these on a small scale, to study the resultant shock waves and their effects upon dust in the interstellar medium. This research can improve understandings of the impact these explosions have on the formation of solar systems and the composition of the interstellar medium itself. In order to simulate this type of event, two electrodes were fashioned from sputter-coated aluminum and affixed within a scientific vacuum chamber. The vacuum chamber was pumped down, then re-pressurized, with pure argon gas. A 13.56 MHz radio frequency argon plasma was sparked and maintained using a 20 Watt RF generator and matching network. Dust with a chemical composition similar to interstellar dust (e.g., coronene and silicon carbide) will be introduced into the plasma and a pulsed Nd:YAG laser will be used to spark a detonation. Shock wave pressure will be measured using a piezoelectric pressure sensor. A high-speed camera will record shock wave motion, at up to 200,000 frames per second, via schlieren imaging. The dust particles will be measured before and after the test, using a scanning electron microscope, to determine if the explosion affected the size or composition of the particles.

List of Opt-In Virtual Presentation Participants

Presented Online as Oral Presentations

| Presenters | Title of Presentation | Institution | Faculty Mentor |
|--|--|-------------|----------------------------|
| Sariah Cheadle | Underestimating Children's Literature: The War That Saved My Life | SMSU | Dr. Ruthe Thompson |
| Jenna Nelson Jace Engelmann Logan Olson Amira Zaher | Anti-diabetic Properties of Sodium Bicarbonate in a Mouse Model of Type 1 Diabetes | SCSU | Dr. Marina Cetkovic-Cvrlje |
| Elatia Zaffke | Laboratory Simulated Supernova Shockwaves | SCSU | Dr. John Sinko |

Presented Online as Poster

| Presenters | Title of Presentation | Institution | Faculty Mentor |
|------------------|--|-------------|--|
| Austin Domeier | Lotka-Volterra Theory: The Mathematics Behind Predator-Prey Interactions | SMSU | Dr. Heather Moreland Dr. Mu-wan Huang |
| Rajesh Hamal | Application of Ultrasound in Food processing | SMSU | Dr. Peiyi Shen |
| Ryleigh Haynes | How Do College Students Justify Their Deviant Behavior? | SMSU | Dr. Cindy Aamlid |
| Nathan Kuhn | A Gambling System | SMSU | Dr. Heather Moreland Dr. Mu-wan Huang |
| Victoria Pounder | Math In Balance | SCSU | Dr. Melissa Hanzsek-Brill Dr. Patty Waletzko Dr. Bruce Klemz |
| Maggie Powers | "This Is What Community Should Look Like": an Ethnographic Study of Community Building Within a Local Nonprofit Organization | SCSU | Dr. Kelly Branam Macauley |
| Sonya Smetana | Oppression and Resistance: Chinese Litigation in the Late Nineteenth Century | SCSU | Dr. Robert Galler |

Presented Online as Scholarly Paper

| | | | |
|-------------------------------------|---|------|----------------|
| Bijaya Ghorasainee Sanjeev Regmi | Laser Production and Characterization of Zinc-Oxide Nanoparticles | SCSU | Dr. John Sinko |
|-------------------------------------|---|------|----------------|

Scholarly Presentation Awards

About the Awards

Due to the COVID-19 pandemic, all presentations were in digital format this year, and submissions were made in three categories: oral, poster, and written. Based on the number of submissions of each type, “Best in Category” awards were issued for oral and poster presentation categories this year. There was a single high quality submission of a scientific paper which was very highly reviewed by the scholarly paper judge and reviewer; however, it was decided that issuing a “best of category” award would not be meaningful in that there were no other submissions in that category for comparison. Since the largest number of submissions were in the form of posters, it was decided to split the poster awards into STEM (science, technology, engineering, and mathematics) and liberal arts / social science categories.

Judging of the submissions was performed using a predetermined rubric by volunteers from the St. Cloud State University faculty, who were intentionally chosen to represent a variety of disciplines and research interests. Care was taken to eliminate conflicts of interest in the judging process, and in particular, no one involved with a project presentation was permitted to judge any submissions in that category. Every submission received constructive criticism from the conference chairs. Each student participant with a winning presentation received a \$ 200 cash award from the St. Cloud State University Foundation, a laser-etched plaque created by the Husky Make-It Space, and a certificate.

Best Oral Presentation

Anti-diabetic Properties of Sodium Bicarbonate in a Mouse Model of Type 1 Diabetes

St. Cloud State University

Jenna Nelson

Jace Engelmann

Logan Olson

Amira Zaher

Mentor: Dr. Marina Cetkovic-Cvrlje

Best Poster Presentation – Science, Technology, Engineering, and Mathematics Category

Lotka-Volterra Theory: The Mathematics Behind Predator-Prey Interactions

Southwest Minnesota State University

Austin Domeier

Mentors: Dr. Heather Moreland & Dr. Mu-Wan Huang

Best Poster Presentation – Liberal Arts and Social Sciences Category

“This is What Community Should Look Like”: An Ethnographic Study of a Local Nonprofit Organization

St. Cloud State University

Maggie Powers

Mentor: Dr. Kelly Branam Macauley

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Laser Production and Characterization of Zinc Oxide Nanoparticles

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Abstract

ZnO nanoparticles exhibit attractive optical properties that are important in the realm of catalysis and nanotechnology involving the developments of solar cells, chemical sensors and other optoelectronic devices. The main objective of this project was to create zinc oxide nanoparticles of less than 10 nm size by using an Nd: YAG laser and characterize the particle diameter. Zinc oxide nanoparticles were prepared by vaporizing zinc in neat deionized water by laser ablation, aided by a physical 2D-motional micro-stage programmed by Arduino. The addition of surfactant was explored to reduce aggregation of the nanoparticles. Various purification methods were applied to this process, including filtration and centrifugation, to reduce aggregation and improve the purity of zinc oxide nanoparticles. The ablated zinc oxide nanoparticles were analyzed with Dynamic Light Scattering (DLS), Scanning Electron Microscopy (SEM) with Energy Dispersal Spectroscopy (SEM/EDS) and Optical Profilometry (OP). The measured diameter of the nanoparticles is found at around 30-100 nm, with a peak around 35 nm, as analyzed by DLS method. Optical Profilometry allows estimation of thickness of ZnO films, while the elemental composition and large particle sizes can be detected by SEM/ EDS. We tested energy intensity, spot size, spot size overlap, and laser focusing setup of ZnO nanoparticles. Future research will mainly focus on creating smaller Zinc Oxide nanoparticles i.e. (10±1) nm by the effective use of surfactant and purification methods.

Introduction

Nanoparticles – particles of less than 100nm diameter – have interesting chemical, biological and optical properties that change as their size approaches the atomic level, compared to bulk material with the same composition. Such particles have widespread potential in medical applications, as well as for food packaging materials in order to inhibit the growth of food pathogens. In choosing a specific nanoparticle species, toxicity is a strong factor for consideration.

For this study, we chose to produce zinc oxide nanoparticles, which are nontoxic for humans, but toxic for aquatic organisms. Bulk ZnO is a stable material, with a melting point of 2248 K [1(a)]. Zinc oxide nanoparticles have been widely investigated as a photo-emissive material because nanocrystallization can enhance the optical and electrical properties of wide band gap semiconductors by the quantum confinement effect [2]. Zinc oxide nanoparticles are transparent in the visible range of the electromagnetic spectrum but can act as a physical filter for solar ultraviolet (UV) radiation. Photochemically, ZnO has a relatively low band energy of 3.37eV and an even lower excitation energy of 60meV, which has triggered

extensive research on the properties of ZnO and the production of nanoparticles using physical and chemical methods [3]. The ultimate purpose of this project is to produce nanoparticles of <10nm in order to permit an experimental test of a theory of Dr. Christofer Nelson, Department of Physics & Astronomy, St. Cloud State University, related to quantum effects on the glass transition in semiconductors [4].

One method under development for production of nanoparticles is laser ablation: violent removal of material by intensely irradiating a surface with a laser beam [5]. One method for creating nanoparticles, described in the literature, is laser ablation of metallic zinc immersed in deionized water [6,7]. This approach has several advantages including technical simplicity and chemical pureness, compared to other methods such as plasma-enhanced chemical vapor deposition or ball milling [3]. The most important advantage of the laser ablation method is that nanoparticles can be prepared directly from a pure zinc surface. In principle, production of a narrow size distribution of particles at atmospheric pressure and without post processing is possible. However, steps to limit excessive coalescence and aggregation of nanoparticles were often undertaken in the literature, including the use of surfactant molecules such as Tween 80, because nanoparticles prepared in deionized water evinced a wide size distribution [8].

Direct vaporization- or plasma-based ablation is described by Stafe as indicated:

$$F_{th} = 2H_v \sqrt{\frac{\rho \kappa \tau}{C_p}}, \quad (1)$$

where H_v is the latent heat of vaporization, ρ is the material density, C_p is the heat capacity at constant pressure, κ is the thermal conductivity, and τ is the laser pulse duration.

The threshold for melting-based laser ablation of metallic samples was described by Stafe as a fluence, meaning energy per area: [5]

$$F_{th} = \frac{2(T_m - T_0)\sqrt{\rho C_p \kappa \tau}}{1 - R}, \quad (2)$$

where T_m is the melting point, T_0 is the ambient temperature, and R is the surface reflectance.

Surface reflectance can be calculated at normal incidence (beam perpendicular to the surface) in air using the Fresnel equation for metals, with a complex index of refraction $n = n_r + in_i$ [9]:

$$R = \frac{(1 - n_r)^2 + n_i^2}{(1 + n_r)^2 + n_i^2} \quad (3)$$

Relevant optical constant values are organized in Table 1, including theoretical density functional theory (DFT) predictions and experimental reflection electron energy loss spectroscopy (REELS) data for the optical constants of zinc metal, as well as power reflectance R , which was calculated from these values using Equation (3) [10]:

Table 1: Optical constants and reflectance of zinc at 1064nm [10]

| n_r | | n_i | | R | |
|--------|------------|--------|------------|--------|------------|
| Theory | Experiment | Theory | Experiment | Theory | Experiment |
| 4.230 | 2.885 | 4.657 | 6.289 | 0.655 | 0.789 |

These theoretical and experimental data will allow us to predict the ablation threshold for zinc. The necessary thermal data from the literature is organized in Table 2, where m is molar mass:

Table 2: Thermodynamic parameters of zinc metal

| Parameter: | m | T_m | T_b | ρ , 298 K | C_p , 298 K, avg. | H_v | κ , 298 K |
|------------|--------|--------|--------|-------------------|---------------------|--------------------|------------------|
| Units: | g/mol | K | K | kg/m ³ | J/(kg K) | J/kg | W/(K m) |
| Value: | 65.38 | 693 | 1180 | 7133 | 386 | 1.99×10^6 | 116 |
| Source: | [1(b)] | [1(b)] | [1(b)] | [1(b)] | [1(c)] | [11] | [1(d)] |

The maximum achievable fluence is determined from the diffraction-limited minimum spot size for a stigmatic Gaussian beam:

$$d = \frac{2.44 f \lambda}{D}, \quad (4)$$

where d is the spot diameter, f is the focal length of the lens, λ is the wavelength, and D is the effective collimated beam diameter that is focused by the lens.

Next, the equipment and methods of the experiment will be described.

Experiment and Methods

I. Creation of ZnO Nanoparticles

In order to produce zinc oxide nanoparticles, a 500 μm -thick 99.95% pure zinc foil was constrained at the bottom of a beaker filled with deionized water until the metal rested 16mm below the surface. A 2-axis motional stage was built by the first two authors using two CD-ROM motors and was controlled by an Arduino program using code designed and created by the same authors. A 1 mW Helium-Neon laser beam with a wavelength of 633nm was used to illuminate the target spot on the sample. Then a Nd:YAG laser (Continuum YG-660) operating at $\lambda = 1064$ nm, with frequency of 10 Hz, 100 mJ pulse energy, and pulse duration of 90 μs , was used to ablate the sample. The high energy laser beam was passed through a lens with focal length 250mm and then focused onto the piece of zinc metal.

We first estimated the threshold for ablation, assuming a vaporization-driven process. Using the data from Table 2 in Equation (1), that vaporization threshold is predicted to be $F_{th} \approx 175$ J/cm². On the other hand, if the process is dependent on only melting the zinc surface, we can use Equation (2) with $T_0 = 295$ K, the average ambient temperature in our laboratory. In that case, we calculate $F_{th} \approx 39$ J/cm² if the DFT calculation is to be trusted, or $F_{th} \approx 64$ J/cm² if the experimental REELS data is accurate. The next step is to see if these fluence limits are achievable. Using Equation (3) with input values of $D = 8$ mm, $f = 250$ mm, and $\lambda = 1064$ nm, we predict a minimum spot diameter of around 80 μm , or for which the beam fluence could reach up to 1934 J/cm², well in excess of the ablation threshold. Based on the lowest estimate of F_{th} (39 J/cm²), we would expect the maximum spot diameter where ablation could still be achieved to be around 570 μm .

As a result of the irradiation of the Nd:YAG laser beam onto the zinc surface, the high energy laser pulse vaporizes the zinc into a plasma. In Fig. 1(c), this process is further illuminated by a second, 1 mW

HeNe laser. The zinc in the plasma reacts with water to form $\text{Zn}(\text{OH})_2$, which chemically decays into ZnO nanoparticles. By changing the laser wavelength, number of laser shots and laser intensity, different morphologies of particles can be formed.

To monitor the precision of the ablation process, white light interferometric (WLI) optical profilometry (Filmetrics, Profilm3D) and optical microscopy (Leica, MC205) were used to perform quality assurance steps to monitor the zinc metal samples post-ablation, specifically to document the quality of crater formation and regularity of crater spacing on the sample.

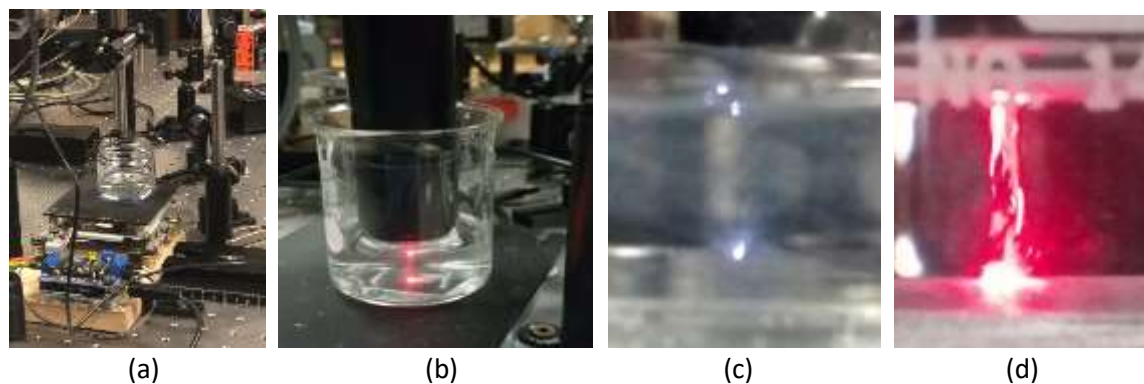


Figure 1: Experiment: (a) overall setup, (b) detail of ablation setup, (c) detail of plasma on zinc, (d) same process, illuminated by HeNe laser to illustrate particle plume

II. Nanoparticle Analysis

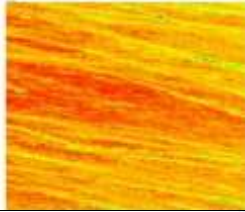
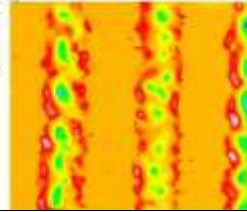
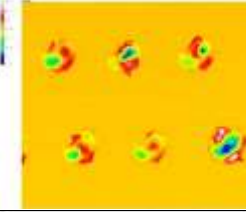
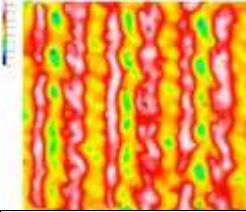
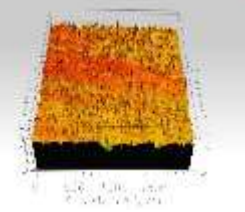
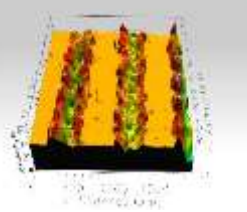

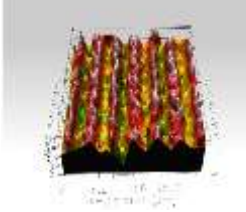
The obtained nanoparticle suspension was concentrated, filtrated, ultra-sonicated, and centrifuged to attempt to reduce the aggregation and average diameter of zinc oxide nanoparticles. The diameter of particles in suspension was measured using the Dynamic Light Scattering (DLS) method (Malvern, ZEN3690). In DLS, the Brownian motion of suspended particles or molecules causes time-dependent scattering of laser light; analysis of these intensity fluctuations yields the velocity of the Brownian motion and hence the particle size using the Stokes-Einstein relationship. As a second method of confirmation of particle size, ZnO particles were transferred onto a polished aluminum stub by casting a drop of suspension over the stub and heating to dryness. Particles on the surface were imaged using Scanning Electron Microscopy (SEM) (JEOL, JSM-6060LV). Particle elemental composition (namely, zinc and oxygen) was confirmed during imaging using Energy Dispersal Spectroscopy (EDS) (Thermo Scientific, PF-NS6-UPG-C).

Results

I. Ablation and Quality Control

The ablated surfaces were analyzed using optical microscopy and WLI optical profilometry for better assurance of crater sizes and to provide quality control feedback for setting the parameters of the laser 2D stage. As shown in Table 3, the Arduino programming with $50 \times 50 \times 2$ (steps) 10 rpm and 20 Hz produced good coverage of the surface during repetitive ablation. So, for further experiments, the same algorithm was used to get similar size particles and nanoparticles.


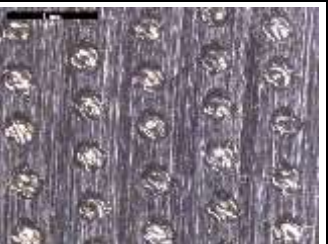




Table 3: Quality Control of the Scanned Repetitive Ablation Process (Optical Profilometry)

| Steps | N/A | 50×50×5 | 200×200×5 | 50×50×2 |
|-------|---|---|--|---|
| Laser | N/A | 20 Hz | 13 Hz | 20 Hz |
| Motor | N/A | 10rpm | 15rpm | 10rpm |
| 2D |  |  |  |  |
| 3D |  |  |  |  |

In the above 2D optical profilometry with 50×50×5 with 10 rpm, in each column of ablated zinc, the crater diameter is overlapped and there are no gaps but the gap between the columns is so large which reduces the probability of ablating more zinc oxide nanoparticles. For the steps in 200×200×5 with 15 rpm, the gaps between the rows and column are large, so less zinc is ablated, and less zinc oxide nanoparticles are produced. Hence, 50×50×2 steps at 10 rpm turn out to be the best because there is no gap in the rows and columns and crater diameter is not overlapped. In the 3D image the peaks and valleys can be easily seen.

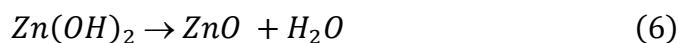
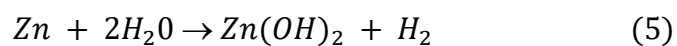
The surface was also recorded via optical microscopy, as shown in Table 4:

Table 4: Quality Control of the Scanned Repetitive Ablation Process (Microscopic Images)

| Stage, $N_x \times N_y$ | 50×50 | 200×200 | 50×50 |
|--|---|--|---|
| Stage, # steps | 5 | 5 | 2 |
| Stage, motor set | 10 rpm | 15 rpm | 10 rpm |
| Laser pulse rate | 20 Hz | 13 Hz | 20 Hz |
| Low Microscope Magnification (bar = 1 mm) |  |  |  |
| High Microscope Magnification (bar = 200 μm) |  |  |  |

By looking into the crater size and surface quality of the microscopic images shown in Table 4, the Arduino algorithm was generated and refined. The ablated surface was inspected at both low and high magnifications (200 μm and 1 mm scale bars) as illustrated. The ablated pattern and surface using the parameters (50 \times 50 \times 2, 10rpm, 20 Hz) was best for use, since the ablated craters were not overlapped with each other, which we believe would result in maximizing the number and uniformity of particles ablated from the surface.

Our working hypothesis is that when the laser beam ablates the zinc metal surface, a dense zinc plasma region is produced at the liquid-solid interface. The presence of liquid medium surrounding the plasma, which is deionized water in this project, creates extra pressure on the plasma and restricts the expansion of plasma hence making it denser when compared to the plasma produced by conventional laser ablation (i.e., in air, without liquid). The plasma expands adiabatically at high velocity until it extinguishes when its temperature becomes too low to sustain its ionized state. After the disappearance of plasma, a cavitation bubble remains. As it continues to cool, its pressure drops. It may initially continue growing in size, driven by remnant pressure, but eventually it reaches a maximum size, then quickly collapses. The collapse of a cavitation bubble is a violent process that produces high temperature and pressure; hence it is possible that this phenomenon may contribute to the formation of ZnO nanoparticles. The relative importance of the initial plasma-water interaction vs. the cavitation collapse in producing ZnO nanoparticles is presently unclear. In any event, zinc clusters produced in these events react with the water medium to form zinc hydroxide, Zn(OH)₂, and Zn(OH)₂ further decomposes to ZnO, following the reactions in Equations (5) and (6), respectively. [12,13]



Eventually, we would like to confirm the ratio of zinc to zinc oxide in our particle samples. That work is ongoing and has not yet been completed.

II. *Analysis of Nanoparticles via SEM and SEM-EDS*

The obtained nanoparticles were heated, concentrated, filtrated, ultra-sonicated, and centrifuged to attempt to reduce aggregation. Following casting of the suspension across an aluminum stub, and heating to dryness, SEM imaging with EDS was applied. SEM images of the raw zinc surface, and of the suspected ZnO nanoparticles, are shown in Figure 2. The particle size scale of produced nanoparticles was not yet analyzed in detail using SEM but appears to range from approximately 100-2000nm diameter.

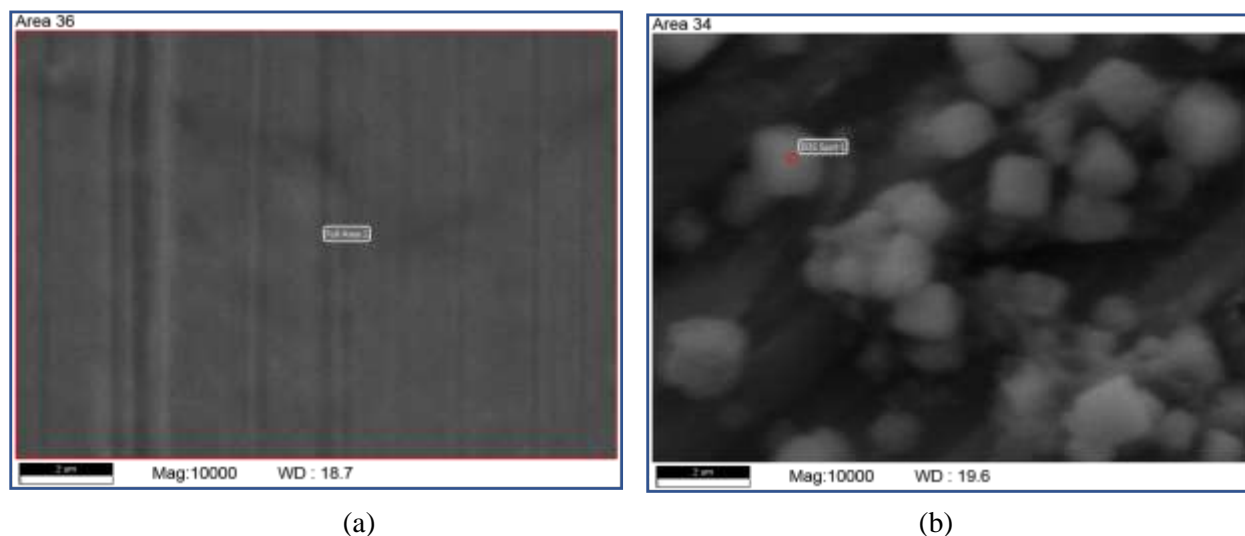


Figure 2: SEM images of (a) unablated zinc surface and (b) ablated ZnO particles

Next, EDS analysis was performed on the raw zinc surface as a full area scan, as well as for selected points in the center of five ZnO particles, as shown in Fig. 3. Detailed results from the ZnO scans are shown in Table 3. While it is inadvisable and imprudent to rely on EDS for molecular identification, the data do support the claim that the particle composition includes zinc oxide and not merely zinc. The presence of aluminum in these data arises from the SEM sample stub upon which the particles were cast and dried.

Table 3: SEM-EDS Results for ZnO particles on an aluminum stub

| Element | Weight % | Atomic % | Error % | Net Int. |
|---------|----------|----------|---------|----------|
| O K | 23.97 | 37.25 | 10.41 | 14.60 |
| Zn L | 13.54 | 5.15 | 11.47 | 4.48 |
| Al K | 62.49 | 57.60 | 5.75 | 39.84 |

The EDS scan of zinc is shown in Fig. 3(a), and for ZnO particles is shown in Fig. 3(b).

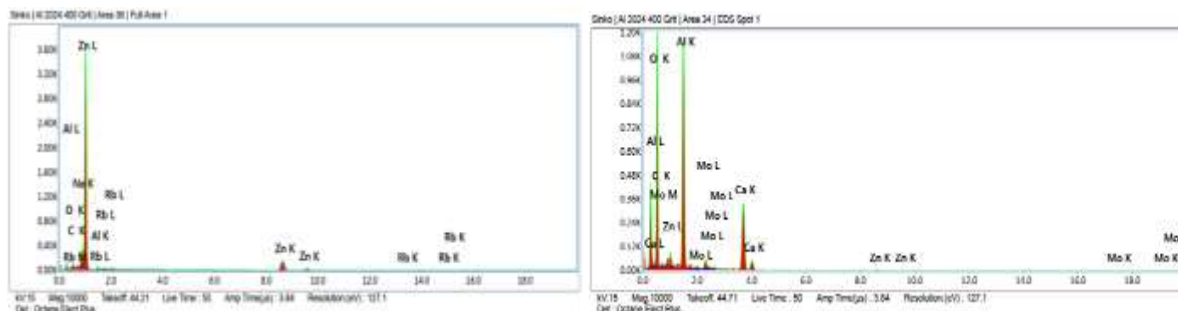


Figure 3: SEM-EDS data illustrating unablated zinc (a) and ablated particles (b)

Most worthwhile to note is the presence of oxygen in the ZnO particle data.

III. Analysis of Nanoparticle Size via DLS

As a separate experiment, the size (diameter) of zinc oxide nanoparticles was measured in a water suspension by the DLS method. Fig. 4 shows the size distribution of the zinc-oxide particles with and without the addition of a surfactant over a range from 1-10000nm diameter. The vertical units are arbitrary, but indicate the frequency at which particles of a given size range are detected.

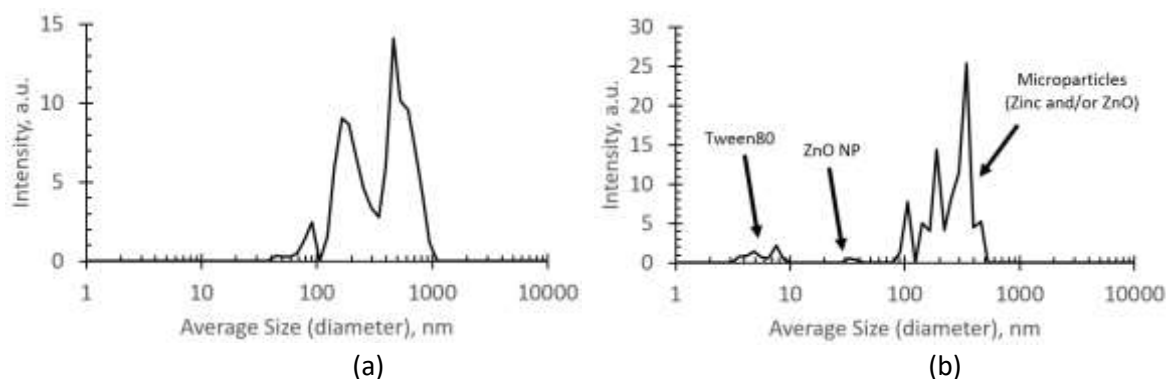


Figure 4: DLS size distribution data: averages of 10 measurements, 10 scans each, each scan 300s length: (a) ZnO suspension with no surfactant, (b) ZnO suspension with Tween80 surfactant.

The polydispersity index (PDI) is a parameter which represents how wide the range of particle sizes extends. In these experiments, PDI increased from 0.73 to 0.93 with the addition of Tween80 surfactant. Most of this change is likely to arise from the introduction of the ~10 nm surfactant molecule into a suspension of generally 10-100 \times larger particles. The presence of ZnO nanoparticles can be assumptively discerned in the raw suspension between 40-100 nm in Fig. 4(a). The process was error-checked using separate DLS runs of water only (which yielded no usable data) and a suspension of Tween80 only (which is not shown, but confirmed the ~10nm size of this surfactant). With the addition of surfactant to the ablatant suspension, the ablated particles became resolvable at a smaller size range of roughly 30-100 nm as shown in Fig 4(b), with an apparent small peak around 35 nm, which may indicate the minimum size of ZnO particles achieved from this particular laser ablation method. While larger particles are present in both suspensions, it may be pointed out that the peaks of nearly 1 μ m size are almost entirely removed in the presence of Tween80. Both features support our hypothesis that particle aggregation was distorting the initial results. Finally, we note that the ~10 nm Tween80 peak in Fig. 4(b) and in our control test with surfactant only (not shown) are consistent with the literature [8].

In looking ahead from these results, various factors affect ZnO nanoparticles; e.g., liquid medium, laser fluence (energy/area), pulse duration, laser power, ablation time and particle aggregation with respect to time. The higher the laser fluence, the more mass will be ablated, and we have some expectation that using a laser with a shorter pulse duration, lower wavelength, and higher energy per pulse could yield more monodisperse nanoparticles. One additional lesson learned from these experiments was that when the ablated zinc oxide particles are stored for long periods of time in suspension, they aggregate to form micrometer-scale clumps. The use of a surfactant such as Tween80 is likely to be necessary to achieve resolution of nanoparticles, but with our goal of achieving nanoparticles of <10 nm diameter, a surfactant significantly larger or smaller than Tween80 is likely needed to avoid masking such particles within the DLS peak of the surfactant. Future work on this project will surely include adjusting the laser focus to

determine if operation at higher or lower fluence will be better for production of small, monodisperse particles. If available, we hope to also explore using a laser with a much shorter pulse duration than 90 μ s, as well as extend the experimentation into a lower wavelength, which would support a more vaporization-driven ablation process.

Conclusions

In this study, a 2D motional stage was designed, built, and used to support pulsed laser ablative processing of a zinc plate immersed in water in an effort to generate zinc oxide nanoparticles. Ablated particles were collected and analyzed mainly using SEM imaging and SEM-EDS for dried particles, and the DLS method for an aqueous suspension of the ablatants. These efforts confirmed the presence of zinc oxide in the ablatants and measured the diameter of the nanoparticles at around 30-100 nm, with a peak around 35 nm. In our experiments, aggregation is one reason for not achieving particle size, less than (10 \pm 1) nm. Tween80 surfactant was used to attempt to disaggregate the suspended particles, and our DLS results suggest this approach met with success, although we did not produce significant numbers of ablated particles below 30nm in size. Hence, future work and technique on this research will strive to continue reducing the particle size, while reducing the range of ablated particle sizes.

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How Do College Students Justify Their Deviant Behavior?

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Abstract

The goal of my project is to determine how college students justify their deviant behavior. I used a convenient sample of college students for my survey. Students were asked to report on past actions that they have engaged in and explain their reasoning behind why they did it. Previous research indicates that people are more likely to engage in deviant behavior if they can neutralize the guilt from committing the action or if they make it appear normal. The student responses will be compared to nine common neutralization techniques. My presentation will share the results of this study.

Introduction

The start of my research began after I took the class Sociology of Deviance. I thought about how all the material that we went over was intriguing and brought out an interest to me. I noticed that there are different levels of beliefs on what is “deviant.” In the deviance class we were talking about how people think believing in aliens can be a controversial topic to talk about, in times people will think that is more of an abnormal belief. However, people still believe that those who have a bountiful number of tattoos would be classified as bad people, just because they do not have clear skin of tattoos. I think the concept of being wronged for different beliefs is ridiculous, because the different meanings and beliefs on what is seen as “deviant” have changed drastically though out time. The idea of deviance is different for each person, that is how the idea of my research started. While going through and sending the survey out to students from all over Minnesota, I wanted to have a wide variety of participants that range from college students but of all ages. The research questions that I have are how do college students justify and normalize deviant behavior? Along with which techniques were reported most frequently? The last of the few questions I have is, are the justifications similar for men and women? The few questions make what we were looking for throughout the research easier to find and to see if there really are any other qualifying factors that play a role in how people perceive deviant behavior. While these questions are to see how students react to the same issues but with different justifications. It is normal to know that most people will make up an excuse to help them get past what they did and make them feel better about the overall situation. Each of the questions bring new knowledge towards the topic of my research project. I believe that the questions are important for understanding different ways around neutralization techniques. Before people may wonder if men or women tend to feel less or more guilty based on gender. I talk about that in the results sections, but it is whether or not the person needed to do it or if they felt like they should be able to do it due to everyone else around them doing it as well.

Experiment and Methods

When I started this project, I got the survey questions from a survey that we had done in my deviance class a few years ago and was put together by Cindy Aamlid. When that was worded and put into the survey it consisted of seven different questions, to start it was asking age, year in school and then the participant had engaged in and explain what their initial thoughts were when doing so. I had 31 college students participate, 7 Males, and 24 Females. The participants were from several different classes at SMSU and a few different Universities. I had asked friends from all over to help with my survey and that is how I got the majority to help participate. Participants completed a survey and responded to questions about their behavior on seven different choices and check all that had applied to them. The survey was crafted on Microsoft 365 in the forms section of the app. The few questions that students were asked are the following, “Choose one of the acts you reported engaging in to answer the questions below. Which act did you choose?”, “Think back to the first time you committed the act, describe what you felt, and what you were thinking while doing it.”, “Do you think engaging in this act is wrong, if yes then why did you do it anyway, if no why do you think it’s wrong?” Next was coding the data, that came along with the instance of going through each statement that the students left and put them in a word document and go through my list of nine neutralization techniques. When I went through and made sure each statement had a code labeled next to it, I then added up each response to the correct label. Once that was done, I could find the best response for each technique to share.

| Neutralization Technique |
|----------------------------|
| Denial of Injury |
| Claim of Normality |
| Denial of Responsibility |
| Claim of Entitlement |
| Appeal to Higher Loyalties |
| Defense of Necessity |

Results

Each student was asked to check all the choices that applied to them for what was deemed as deviant behavior. The highest and most used option was cheating in school with 24 out of 31 students. The second most common choice was smoking marijuana, with 14 of the 31 students reporting this. The most used justification response was Claim of Normality, which means that the students are claiming to an area where they see as something that is done in the normal day world frequently. It has no background history on why it shouldn’t be allowed, because of the fact that people have always partaken in that activity. The questions that referred to how students justify their actions was an area where they were allowed to write in and explain why they decided to do whatever actions they checked off. That is how I answered my first research question which was how do college students justify their deviant behavior? That clearly answers how they do, since claim of normality is the most used, we see that students think that there is a way around feeling fully guilty and that is through making it normal that they are doing it. They would justify their actions through the role of saying it was done because it had to have been done for them to pass the class, along with that it is normal because everyone else does it, so why can’t I? I think this is a very normal response for people when they are trying to save face. It is something that people have done since they were little, and I find that intriguing. The fact that it has been found so normalized is what makes it seem less deviant in some people’s eyes. The coding was meant to find out how people justified each action, it brought reason behind why and what people think about when they make decisions. The nine different neutralization techniques that I had brought more understanding for what people can choose to respond with. Appeal to higher loyalties is normalizing behavior or beliefs by insisting the interests of a higher principle are being served. Denial of injury is acknowledging responsibility by insisting that there

is permissible because no one is injured or harmed. Claim of normality is that they want to be successful like all those others who do it. Denial of responsibility blames social conditions or bad advice from coworkers. Condemning the condemners is characterized as hypocritical. Claim of entitlement is them saying they worked hard all their life and they deserve this extra benefit. Denial of victim is to reconceptualize the victim as having deserved it or brought on the behavior. Defense of necessity is that they had no choice, and they need to fulfill their self-centered needs. Those are the nine different techniques and I had five for denial of injury and those covered the moment where they claimed they didn't hurt anyone, and it was not going to affect anyone if they were just going from point A to point B. Claim of normality had fourteen people use that as their justification process and that is the most common way of making yourself feel better about the choices that you make. Denial of responsibility had one person use that as how they chose to act out in what they wanted to. Claim of entitlement had three people use that term. Only one person used appeal to higher loyalties. Lastly for what people used as an option was defense of necessity with five people. My other research question was do males and females justify their actions similarly? After seeing the difference in answers regarding what they responded to. I saw that men seemed to feel less guilty and more okay with how their decision played out. For females, I saw that they felt worse about the decision that they had made. I think that the two differences show how people think about how they make a decision.

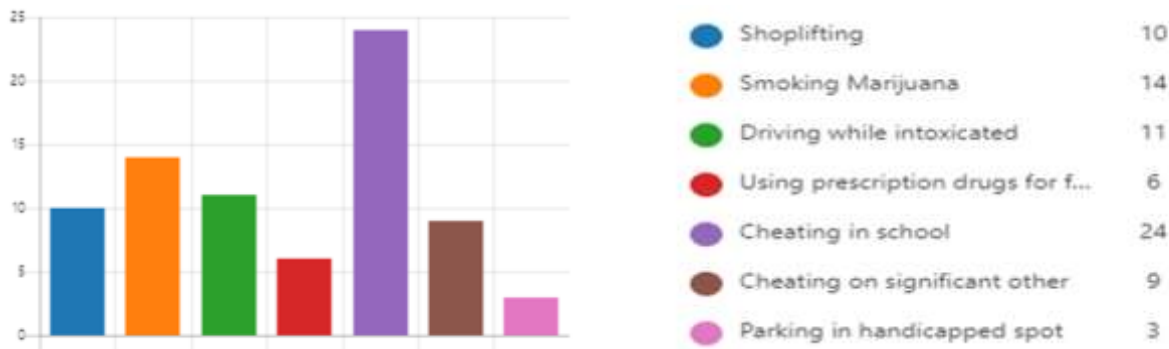


Figure 1: Which of the following acts have you ever engaged in? (Check all that apply)

Conclusions

After conducting this research project, I had learned that there are many different ways to justify why you do something and I find that to be the most interesting. The way that mostly everyone who had participated in my study had different responses towards what they had done was intriguing as well. I had a feeling that cheating in school would be one of the most common choices, that is because it is less deviant than let's say driving while intoxicated. That is because there are more serious consequences for driving while intoxicated rather than cheating on a test or a homework assignment. That is more likely the reason I hadn't had that many results that were in that category. I have the feeling that people wanted the easy option so they would not have to explain something that may make them uncomfortable or feel more guilty about said decision. College students normalized their behavior to account for their actions and the techniques used for normalizing behavior were claim of normality, denial of victim, claim to entitlement,

appeal to higher loyalties, denial of injury, denial of responsibility, and defense of necessity. The most common neutralization for their actions is that college students tend to back up their justification with why they made the decision to follow through with an action. Each technique that was chosen went along the lines of why people normalize their decisions and the way they act on them. The most common neutralization technique that was used was claim to normality, or everyone else is doing it. Everyone seems to find a way to make themselves feel better about their choices by backing them up with either "everyone else does it", or "no one got hurt." Many students did feel guilty for their actions after they did it. Students had mentioned that they had felt guilty of their actions, most of those had to do with cheating in school, another had to do with being nervous about smoking marijuana, a few others were also nervous about being pulled over while driving intoxicated. The differences between college men and women in responses are that men and women had the same justifications for how they acted on an urge. However, more men felt okay with their decisions, but did feel little guilt. Women tend to feel more upset about how they acted on their response to why they did what, many felt anxious when doing whatever it was that they were doing. A few final comments and ideas that I have on this topic is that I noticed most out of the justifications that students used for their actions were about how they felt after and for how they could have found other ways to go around a decision. Another idea I had was that if I were to change anything or go further into this topic it would be to survey people outside of college and get other opinions on what they find to be deviant. This would be an interesting way to get opinions of all ages to really see how people determine someone may seem deviant or not. I think by also asking all ages these questions, it could give us insight into what acts they had engaged in and see what their responses would be. Otherwise, the way that the research turned out for the presentation was a success.

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I would like to thank my Professor, Cindy Aamlid for all of her guidance and her help with this research project. Everything that she did for me was very beneficial for the outcome of the research and with the making and findings for the questions for the survey that asked college students from all over the state. She had done a wonderful job being my mentor and guiding me into scholarly success.

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Reiki and Well-Being in Minnesota

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Abstract:

Reiki is an example of a holistic healing practice that can be used for the participants overall well-being. Well-being can be seen through mental, emotional, and physical forms with my participants. Some examples include the calming effect Reiki was said to have on my participants, and its ability to help with pain, in my personal experience it reduced the irritation from my poison ivy and hives. Reiki can be described as a holistic energy healing that focuses on moving of energy through the body to help realign or balance the recipient's energy and help heal ailments. Previous research shows that Reiki and other forms of holistic healing have been used for well-being for a number of years. Hahn, Reilly, & Buchanan(2014) discuss the use of Reiki in helping hospital patients cope with their pain and anxiety. Through the use of participant observation I was able to experience how and why Reiki is used and directly see it's influence on the recipients well-being. In this paper, I argue that Reiki is used as a method of well-being, in similar ways that yoga, massage, and meditation. Rosenbaum, & Van de Velde (2016) discuss their research and describe that Reiki is even more effective in reducing pain in cancer patients compared to other methods such as massage and yoga.

Introduction:

It was a warm Wednesday evening in Hackensack Minnesota, I was standing in a small room with a singular massage table strategically placed in the middle of the room. N was laying down with a pillow placed under her head and knees. All of my participants did an energy scan. Starting at her arms and shoulders I held my hands gently on her imaging myself sending loving energy through me to her. I eventually made my way to her feet to ground her and soon be done. While making my way down to her feet Karlene told me to ground her and pointed at a picture of tree roots on the wall. With my hands placed gently on top of N's feet I imagined her as a tree with roots digging deep into the ground. Karlene then told me to call my grandma Rose and make the connection to Nicole through her (this connection is referring to Nicole being Native and my unknown Native ancestors through my grandma). Immediately I lost all strength in my body and slumped to the ground. Hands still on top of her feet I became overwhelmed and began crying. Karlene locked eyes with me and told me to ground this energy. I calmed myself and shortly after we were done. I chose to share this experience because this was the first moment I was able to truly feel the power behind Reiki that I had heard about. In this paper I will begin by discussing the methods used for this ethnographic study, I will continue with a discussion of my field notes, and end with a literature review connecting my work to previous work done with Reiki and well being. I argue that Reiki is used for the participants well-being both mentally and physically in a format

that can reduce stress, anxiety, and pain as seen in Hahn, Reilly, & Buchanan(2014) discussion of the use of Reiki is helping hospital patients deal with their pain and anxiety, and Rosenbaum, & Van de Velde(2016) discussion of pain reduction in cancer patients.

Methods:

For my research I focused on a method called participant observation. Schultz and Lavenda, discuss participant observation is a technique of field research were “fieldworkers gain insight into another culture by participating with members in social activities as outsiders”(2018, pg.43). This method is the most effective way to gather an understanding of why and how people do what they do. I believe that when researching Reiki I was only able to truly understand this practice when embodying it the way my participants did. DeWalt and DeWalt explain this experience as “tacit” understanding stating, “tacit aspects of culture largely remain outside of our awareness or consciousness. It is the feeling of discomfort we have for example, when someone stands too close to us or touches us in a way that seems too familiar”(2011, pg. 1-2). I utilized this method while having conversation with my participants about Reiki as well. Some of the things I participated in included the procedures that lead up to Reiki sessions and the Reiki sessions themselves, referred to as Reiki share when working with a group. Reiki as described by my participants, is an energy practice that creates balance or realigns the recipients energy facilitating in healing, or returning their bodies back to harmony. The practitioners are a vessel through which the Reiki energy flows and goes wherever it is needed.

I went to my field site once a week for two to four days at a time to meet with with my participants over a period of six weeks. My field site was located in and around Hackensack, MN which is a two hour drive north from my home. I worked out of my Aunt’s shop which is a two room building which is shared with a chiropractic clinic in Walker, MN. Once in awhile I worked at a participants house and when needed I worked on myself at my own home in Waite Park, MN. The drive allowed for me to have separation from my site and give me time to experience the authentic feeling of going to a field site. I was expecting to be spending more time outside and at participants’ homes but instead I spent a lot of time at my Aunt’s shop.

I think it is also important to mention my positionality, and use of participant observation as situated knowledge in this research. Schultz and Lavenda (2018, pg. 51) describe situated knowledge as making explicit what your nationality is, class background, gender, and why you chose your research influences and effects of your research. I am a middle class white female from a college educated family who grew up in central Minnesota. I chose to work with my Aunt which gave me an in into the community. Karlene has been practicing Reiki for around twenty years and has worked her way up from a practitioner to a master/teacher in these years. All of my participants which I met through my aunt know her because they were reaching out to her for assistance in receiving or learning how to do Reiki. All of my participants are Minnesotan women who found Reiki when looking to expand on their belief system. Based on this information we all seemed to have similar backgrounds and a connection through my Aunt making it easy for me to communicate and work with them. It is within this context that my research is uniquely situated within time and space.

Week one

I began my fieldwork on Sunday June 30th, 2019. The two hour drive up to Hackensack, MN was filled with conversation with my older sister who was joining me. We arrived at our family cabin around 12:15pm and got unpacked before heading to Karlene’s house which is about five miles away. After catching up and eating our chicken salads we headed over to the town Nevis for a singing bowl meditation

where I hoped to make some contacts for my research. At 3:00 we arrived at an art gallery that had blue walls and painted chairs hanging upside down on the ceiling. Paintings lined the walls all the same size about a foot apart. The large rectangular room had the meditation leader sitting up against the middle of the wall with different sized bronze bowls scattered around in a semi circle. About thirty women of different ages lay in front of her on yoga mats on the floor in a semicircular shape. We placed ourselves in the back of the room. The meditation lasted about an hour. We all closed our eyes and listened to the meditation leader create a song using the tones from ringing the bowls. When we were done around 4:30 I introduced myself to the group and explained my project asking if anyone was interested in discussing and practicing Reiki with me. I was informed that this practice of using Reiki on each other is called a Reiki share. I received three business cards from women interested in meeting with me and practicing Reiki.

That evening I did my first personal Reiki session on myself at 8:00 it lasted about 40 minutes. I laid in my bed placed my hands on my head then my throat, my heart, and then on my stomach. I spent about 10 minutes holding each position slowing my breathing down with my eyes closed. The lights were off making the room very dark. This process felt like a very deep relaxation. I found my body becoming more relaxed and my muscles feeling looser. My thoughts became more contained and I felt very calm. My hands felt warm and tingly like when your arm starts to fall asleep. The decision to start a reiki session felt more like a decision but when I was done I just knew I was done. After this session I noticed that I slept really well I didn't wake up at all the entire night.

10:00 am I headed to the beach at Leech lake in Walker. I reviewed the folder of notes I have about reiki. This includes hand positions, a few examples of people using reiki and then some notes about reiki with animals. I was focusing on reiki with people this day because I was going to go work on a client with my aunt. I reviewed these notes for 45 minutes at the lake. It was windy and you could hear the waves hitting the rocks. This is not a sandy beach but a rocky one with benches to sit on.

At 10:45 Karlene picked me up so we can head to the clients session. We arrive for the session at 11:15 at the clients home in Walker. Karlene asks me about any concerns I have and I state that I'm worried about doing it wrong, she told me to just trust the process and let what ever happens happen. To prepare for this session we first wash our hands to prepare our hands as conduits for the reiki energy to flow through. The client laid at the foot of her bed giving us direct access to three sides of her body. She laid under a white sheet with a pillow below her head and feet. The temperature was set at a cool 70 degrees for the clients comfort. The only scent was that of the lemon soap I had used when washing my hands. Time seemed to go rather slowly during this hour and thirty minute session.

Karlene had me choose to start at her head or feet. I choose feet. Placing one hand above and below each foot I went into a slow meditation like breathing and paid attention to the clients reaction. During this session I would feel a pressure in my body until I went to that area on the client. My throat began to feel heavy and sore like when you are holding back tears. When this happened I went to her throat and placed my hands on either side eventually the pressure dissipated in my throat and she said wow I really felt that. I did this same process from head to toe. At the end I went to her feet and my aunt placed herself at the head. We then pushed the energy towards each other through the clients body by placing my hands on her feet and my aunts hands on her head. We ended the session at 12:37pm. This client mentioned that she would be interested in doing a weekly session with me. Once we were done we again washed our hands to cleanse the leftover energy off of us.

As soon as we walked outside I immediately noticed that everything was louder and brighter. The sun was almost unbearable and the birds sounded like they were yelling. We stopped at the gas station and the smell of the gas was obnoxiously strong. This sensitivity diminished throughout the day. I did another personal Reiki session in my bed in the dark around 9:00 this night to avoid the light sensitivity I followed

the same process as the night before but it only lasted about thirty minutes this night. I again slept very well. This first week was a very overwhelming experience for me. It was filled with lots of observation and learning all of which were good and interesting things.

Week Two

8:40 am I began the twentyish mile drive from my cabin to Karlene's shop in Walker to do a Reiki session on one of the women she connected me with. This woman is in her mid to late twenties and is pregnant with her second child. My car was running on empty so I had to make a stop to fill up on the way cutting my time line pretty close. This made me anxious making it harder to focus. When I arrived the client was lying on a massage table in the center of a small white room with a pillow below her knees and head. The temperature wasn't too hot or cold and a small fan in the corner helped keep me cool off as well. Karlene said hello when I walked in and asked me to do an energy scan. Not knowing exactly what this meant and not wanting to interrupt the session in some way I followed Karlene's lead and walked alongside the client hands at my side trying to see if I could feel anything different when I did so. I didn't notice anything when I walked alongside of her other than the desire to start this session up by her head. Karlene then asked where I wanted to start and I said at her head. I made my way over to her head starting there after about five minutes I then placed my hands above either shoulder staying there for about ten minutes. I then felt the need to move above her heart. I lastly worked on the baby after Karlene asked if I would like to, I worked on the baby for about ten minutes. This meant using Reiki on N's stomach focusing the energy towards the baby through her. After about thirty minutes Karlene told the client to take a deep breath and come back slowly and told her that she was very balanced and handling her pregnancy very well. The client and I then went into the hall and made plans for doing a weekly session together.

On Friday I sat down and reviewed all my notes that I have on Reiki with animals. The notes stated that when doing Reiki your goal is never to diagnose or know exactly the ailment to properly perform Reiki. Animals are said to respond intuitively and will move to receive the Reiki where they need it. We become an empty vessel for Reiki to pass through and create healing possibilities to exist. Most sessions last 30-60 minutes depending on what the animal decides. First ask the animal if they would like to participate. My understanding is that you just verbally ask the animal if they want to participate and they will leave if they don't want to, or use other body language to sure their unwillingness to participate. You are to then set intention of being an open vessel. Cup small animals in your hands without pressure, if animal is asleep do not use hands on. I finished reviewing around 1:15 and then reviewed the easy twenty minute nine step self Reiki session for thirty minutes.

1. Ground and protect yourself
2. Set intention
3. Check your energy centers
4. Start at your head and work down
5. Put yourself in bubble of color
6. Say prayer and thanks to your healing team
7. Recheck energy
8. Ensure your session is complete
9. Bring yourself back and drink some water

I have notes to ask Karlene about this because this did not all make sense. I finished reviewing these at 1:45. At 2:00 I attempted to do a Reiki session on my cat Charlie. He is a five year old orange domestic short hair. He walked into my room heading towards my window I stopped him and gently pet him from head to tail for about five minutes before he got up and walked away. Before bed I noticed that I had developed hives due to an allergic reaction from Anchovies.

On Saturday around 9:00 am I decided to do a quick 9 step session on my self before work following the notes that I took on Friday. Starting above eyes, I move above the cheeks, than above the occipital, then on the throat, next above the heart, above the rib cage, next above the pubic bone, and lastly on the upper thighs. I stay at each position for about two minutes. This session lasted for about twenty minutes. Because of my hives I found it hard to focus but noticed that afterwards I felt wide awake and ready for the day.

Sunday I started my day working on other homework. Also made note that my hives have spread to my legs and ears making it almost impossible to ignore them. I intended to do Reiki on animals at work but something came up with the owner and we were not able to meet. At 9:20ish pm I decided to do another nine step session on myself. The order once again was eyes, cheeks, occipital, throat, heart, rib cage, pubic bone, and upper thighs. Each position was held about three minutes making the session about twenty minutes long. My hands became warm and tingly as they hovered above each step. This session was interesting because my hives were not itchy at all and I was very relaxed afterwards. I headed straight to bed after this session.

Week Three

Wednesday July 10th, began with me and my friend Liz heading up to my cabin at 10:00am. We arrived in town around 12:00 stopping to eat and met my aunt at the flea market confirming a meeting time for the Reiki refresh at 4:45 at Karlene's shop in Walker. We then picked up a few snacks around 3:30 and got to Karlene's shop around 4:10. She was still with a client and popped her head out of the door to ask us if we would set up the food on a small table with the food in the fridge. We set up the food and the client was done and left around 4:30. I asked if it would be alright if Liz stayed and Karlene said yes. While waiting for the other three women to arrive Karlene asked about my poison Ivy and noticed my hives. I was really itchy all day from my hives which I knew was going to affect my Reiki for the day. At about 4:45 two older women maybe in their sixties arrived. When the first two women arrived I was a bit nervous to meet them but they were just as open and willing to learn as me which was helpful. We had created a semi circle of chairs in the entry way of the shop for all of us to sit. Around 5 the last woman arrived. While waiting and before introducing ourselves we snacked on veggies and chips. Karlene sat down and asked who wanted to introduce themselves first. I volunteered myself to go since I was part of the reason why this meeting was created. I explained my project and my previous contact with Reiki.

One of the older women went next. We will call the first woman J, and the second woman, T. J was in a blue top and T was in white. Woman one introduced herself next explaining that she has a background in multiple healing energies and uses Reiki alongside them. Woman two talked about using other healing energies alongside Reiki as well, she also mentioned the recent loss of her mother and how Reiki seemed to help her mother pass on. My friend Liz was next explaining that she was there because she was interested in what I was doing and had no idea what Reiki was. N was next explaining that she is excited to bring her baby into the world with Reiki, and she discussed how she has been working to break cultural barriers combining Reiki with her Native traditions.

Karlene then told us to focus on our energy. When asked to find my energy and hone into it I imagined a bubble of energy around me growing stronger, and noticed I didn't itch anymore. I did this because I didn't know what else that would mean and it seemed inappropriate to ask because everyone else seemed to know. She then continued by explaining the history of Reiki. It began with a monk in Japan named Dr. Usui. He went to a mountain top to meditate and fast where he was enlightened with the knowledge of Reiki. He then spent time turning this knowledge into words so he could teach others. His first student was a man named Dr. Nayashi who travelled to Hawaii and taught a woman named Dr. Takata. This then lead to people being taught in the U.S.. Karlene then asked how our hands felt we all

agreed they felt warm and kind of tingly, J said she felt nothing, and how she hasn't done any energy work in a year. Karlene then tells a story about my great Aunt Marietta who is a Benedictine sister. She learned Reiki and never felt a thing but made it apparent that that doesn't mean it's not working, and that you must trust the process. I never knew this about my great aunt and was surprised to hear the story. Karlene then led the conversation to ask us how we scan others energy. There as a general consensus that you walk next to them trying to feel what each area feels like. T however stated that she stands still scanning each area in her head.

We then discussed who wanted to be worked on first and if we wanted everyone to work on us at the same time. I was first on the table. My session lasted about twenty minutes. We were all moved into a small room with a massage table in the middle, essential oils on shelves around the room gave it an earthy aroma and a wooden fan hung on the ceiling. There was a pillow under my head and knees and I took my shoes off just because it was more comfortable. When I was on the table I began focusing on my breathing and soon noticed I was seeing blue green and purple under my eyelids. I also was hyper aware when someone touched my arm and it felt like a buzzing all over that area that stayed their until the end of the session. There were no words saying we're done we just knew when we were done. Sometimes seemingly taking cues from others letting go and backing away. At one point during my session I also noticed that my head felt really small and a beam of light was shining down on me my eyes were still closed though. Once open I noticed that the fan blades seemed orange instead of brown and that I felt more awake. Discussing my session Karlene explained that the colors I say were my upper three chakras opening. Everyone washed their hands and drank water after each session to hydrate and as Karlene says to clear the energy from one person so you are ready for the next.

N was next, her session was also about twenty minutes she positioned the same as me on the table and everyone washed their hands and drank water after. We all did an energy scan and I felt like I wanted to start at her head but I started where there was room which was her arms and shoulders. I held my hands gently on her imaging myself sending loving energy through me to her. I eventually made my way to her feet to ground her and soon be done. My aunt then told me to ground her and pointed at a picture of tree roots on the wall. I thought this was interesting because I was already doing this and imaging her as a tree. Karlene then told me to call on my ancestors for help, I said okay in my head and thought nothing of. Next, Karlene told me to call my grandma Rose and make the connection to N through her (this connection is referring to N being an indigenous woman and my unknown Native ancestors through my grandma). Immediately I lost all strength in my body and slouched over hands still on top of her feet, I was overwhelmed and began crying. Karlene looked at me and told me to ground it I calmed myself and shortly after we were done. My body felt weak and shaky after. I shared what happened and how it was like I was consumed and had no control over what happened. Karlene told me that my grandma didn't know her ancestors when she was alive but now knows them in spirit and brought them to me. N then said she would be interested in teaching me some Native traditions to help me connect to my cultural heritage more. I was super excited but also amazed at what had happened. After this session I couldn't focus on the others I tried to get into it but I couldn't.

T was after her same position on the table, same washing and drinking after about twenty minutes. I was sitting out of the room for this session so I don't have notes on her response. Then it went woman one and lastly my friend Liz all in the same position and the same washing hands and drinking water after. J was next and seemed very calm, she didn't cry and she barely moved at all on the table. I did the same for her going where there was space and observing the others because now I was getting tired. Karlene half way through placed an orange dragon made from stone on the J's chest and I imagined it blowing fire across her body. We were done shortly after. Interestingly J sat up and said she wanted to scream and yell the whole time, that she hasn't released that much anger in a long time, and that she felt like she had let

something big go. Karlene then informed the rest of us that J is a medium and was carrying around energy from the individuals who connect with her and she had finally let all of them go. She said she felt like a new person.

My friend Liz was last and she was really excited. I held her hands for part of her session and wanted to make sure she felt comfortable so focusing on thinking about very calm things. Karlene placed a rock with a bee painted on it on her forehead and when she removed Liz opened her eyes and started laughing uncontrollably. This continued for about ten minutes. At one point Liz said she couldn't help it. That she didn't know why she was laughing. Karlene explained it as spiritual laughter, and said it happens a lot when people experience an energy surge for the first time because it raises their energy levels so high. Liz said surge was the right word and that she didn't expect to feel a thing but once the rock was set on her forehead she felt this buzz all the way through her body almost making her pee her pants. After this we discussed a bit more, Liz was still shocked she felt something and continued giggling on and off for another hour or so. She was also amazed that I cried saying after seven years of friendship she's never seen me cry. I was also shocked, excited, and a bit overwhelmed. When my friend Liz was done we concluded the night by scheduling a level two attunement which was explained as an opening of your energy pathways further so you can receive and be a better vessel for the energy.

Week Four

Tonight I decided to do a short twenty minute session on myself in hopes of relieving a migraine I had. I laid on a pullout couch at the house I was house sitting with an ice pack on my forehead. I placed my hands above my eyes, over my throat, on either side of my head covering my ears, and on the crown of my head. I set the intention of relieving my headache (I did this by saying it in my head). My nausea seemed to abruptly disappear and the constant itch from the hives on my hands was soothed. The practicality of Reiki was made apparent at this moment as I knew I had to get other things done and it helped me to function on better level. There is also an ease when working on myself because there is a lack of judgement and concern about doing it "right".

I began the next day around 10:00 am when I started my drive up north to my cabin. Knowing this is going to be the first time staying alone at the cabin has made me very anxious. Arriving around 12:00pm gave me ample time to get situated as I waited for my meeting with Nicole at 3:30. Before we started, N immediately noted that she could sense my nervousness and reminded me to just trust the process and let my worries fade. She then shared her story of finding my aunt by just walking into her shop after seeing the word Reiki on her business sign. Her story was complex as she explained her struggles with substance abuse and the internal battle to live up to her Indian name Medicine Woman. She also explained how Reiki has helped her overcome these substance abuse problems and create a better life for herself and her children.

After our discussion she then laid down on the table with a pillow under her head and knees. I started at her feet after doing an energy scan (I did this by closing my eyes and walking beside her, hands at my side to try and see if any area felt different then the others). I went from her feet to her knees, hips, shoulders, head, and then back down in the opposite order. My hands weighed down my arms feeling as though there were weights on them. This sensation caught my attention as it was different than the normal warm tingly feeling my hands develop. The image of what I can best describe as a loading symbol kept lingering in my mind as I worked on her, giving me the knowledge to start and end at her feet. The inability to explain what I saw weighed on me after but Nicole explained that it is not my job to know but to deliver the message. She stated that allowing the words to flow out of you after like word vomit is the best way to get everything that needs to be said out.

Before wrapping up our meeting she reminded me to not worry. Something about this triggered a memory of mine about my Reiki 1 attunement years ago, and how that experience lead me to believe I was doing it wrong from the beginning. Karlene told me to go on a path in my head. I was to go on this path and meet my spirit animal at the end. Well I didn't meet one animal I met the entire forest of animals and I really felt I did something wrong. N was able to talk to me about this just being proof that I have a great connection to nature and animals. After this I went and met Karlene to share and return her keys. She agreed with everything N had told me and again reassured me that I wasn't doing anything wrong, and to not be nervous.

Week Five

I started the day hanging out with Liz and going to Karlene's shop to prepare for N to show up. We arrived around 2:30 expecting N to arrive around 3:30 like last week. After waiting to hear from N for twenty minutes I decided to try giving Liz a massage while doing Reiki with her for a bit, to test out my skills and see what other things I could possibly do with this. I worked on her shoulders and neck, then on her legs, all while she laid face down on the massage table. I didn't feel like I was doing anything because my hands weren't warm or tingly, and Liz couldn't focus enough to tell me if she experienced anything. We then traded places and just talked waiting for N to respond. She finally messaged me at 4:00 needing to reschedule because something came up. I decided to just work on Liz some more since we were already there. I mentally set the intention of sending whatever Reiki energy she needed her way. I turned on music in the background. It was a beautiful soothing combination of flutes with birds chirping and the whooshing sound of water flowing. After placing a pillow under her head and knees I did an energy scan breathing deep, with my eyes closed to see where I should start. I felt the desire to start at her head so that's where I went first. I would lightly touch or hover my hands above each area. Beginning at her head, then going to her feet, then back up to her arms.

The familiar warm tingly feeling crept into my hands as I began to imagine Liz and her boyfriend dancing in a field to the music playing in the background. When I was down at her feet I was thinking about how much I'm gonna miss her when she moved in a month, because she is my closest friend. When I was back up by her arms I began thinking about what we were gonna do the rest of the day. Eventually just stopping when I felt like I was done. Liz described her experience and visual. She didn't really feel anything but she said she could see a rainbow of colors moving like a mood ring. When I was thinking of her and Jack dancing the colors were two bubbles moving around each other. When I was at her feet the colors were pouring from the top and pulling down like raindrops, and when I let go of her feet and went back up by her arms, the color went completely red and burst making everything go black for the rest of the time. I noticed that this twenty minute session felt just as long as my hour session with Nicole, and found that interesting.

Today is Liz's birthday! We spent the morning at the farmers market waiting to hear from one of my original contacts we will call C. Liz came with me to C's house at 2:00. We started by looking at her screened in porch where she said she does Reiki with clients. The room was only large enough to have a massage table and her desk in it. We then went outside and sat on a swing under a beautiful oak tree with its branches surrounding us. She told us about her life with Reiki and how she came to find it. Originally she had no contact with energy work at all. She was an EMT in walker and wanted to find something she could use to help patients calm down and find peace when on the way to the hospital. A friend of hers then introduced her to the woman who eventually taught her Reiki. C thought Reiki was a perfect fit to use in the ambulance and decided to then go through all the levels over a six year span. She talked about how it has helped make her jobs easier, and helps calm her daughter down when having panic attacks. She then showed us her barn and told us about her family and a bit about her past before Reiki. I ended up

taking Saturday and Sunday off because I got road rash on my left leg, lower knee and upper left shin and had to clean it which hurt, and was exhausting.

I received a message about preparing for my Reiki 2 class from Karlene today. It includes cutting back on meat, sweets, caffeine, smoking, drinking, and screen time. It also suggests doing self treatments and meditation or going for walks. It says doing this will help detox our body from the chemicals and hormones in these products and help clear your brain (notes from Karlene). I also need to get permission from someone to do a distance Reiki treatment on them (I asked my sister Michaela and she said yes). I did a session on myself focusing on my leg as suggested by Karlene around 1:00. I went around the injury and hovered my hands above it. There was so specific order or time in each spot. I verbally set the intention of healing and took deep breaths before beginning. I then went for a walk as suggested this was about an hour and was just around my neighborhood. This session was interesting because my hands felt cool instead of warm, but they were still tingly. My leg felt a sense of relief while doing this. The throbbing subsided a bit and the tingling also stopped. Once I was done it began to hurt once I stood up, and hurt on my walk.

Week Six

This is my last week and the time to prep for my level two attunement. Karlene told me we were meeting at 10:00 am the next morning and to bring some fruit to share, a chair, water, a notebook, and anything else I needed to be comfortable. She shared the number of a woman I would be carpooling with in the morning and I messaged her to check on a time to meet. I was also supposed to get permission from someone to do a long distance reiki session on them sometime the next day. I asked my sister, she said yes. I would also need a picture of her with me which was easy to find.

The next day at 9:15am I met with N and one other woman to carpool to T's house which is where the attunement was being held. On the way we talked about our busy schedules and I explained how I got the road rash on my leg. When we arrived at 10:00 we pulled up to a beautiful two story log home situated on the lake with trees surrounding it. In total there were six women there. There was an abundance of fruit and other food covering the counter available for us to eat throughout the day. We began by introducing ourselves to the one woman we did not know there which goes by K. After grabbing some food we all headed down to the lake to sit on the pontoon. We sat in an oval with Karlene on one end and a make shift alter on the other. The alter was made of a chair with a baby blanket, lots of stones, and any personal items we wanted blessed on it. This was to be blessed and given to N after the attunement was done so she could carry the Reiki energy with her. Karlene gave each of us a packet filled with notes to keep. The first couple pages include breathing exercises for meditation. With Karlene leading us we all starting breathing together eyes closed. The sun was very hot and you could hear the bugs and the fish smacking the water around us. We breathed in and out our noses holding the breath in and focusing, holding it behind our belly buttons. We did this for awhile before Karlene told us to add the sound. This was done as we exhaled saying ohhh ahhh mmmm. She said this is supposed to help move the energy.

After doing the breathing exercises for awhile for N lead us in a traditional Anishinabe prayer. This began with lighting sage in large rainbow colored shell and pouring the smoke over your body with an eagle feather, each of us did this once. N said this is done to cleanse your soul. Next she took out her pipe. She did not explain everything she was doing but said she would point to all four directions starting from the east, and this was done to thank all the parts of the universe. We were then to smoke a tobacco pipe she was given as a baby around in a circle until the tobacco was gone (I was extremely excited and thankful to be able to participate in this). I knew I didn't have the right words but the only way I could express my gratitude and excitement of this experience was that it felt like being at the right church for me, and the combination of practices was truly comforting.

After this was done we then headed back into the yard and congregated in a screened in tent to do the attunement. Karlene told us to take our chairs and put them in a circle with enough room that she could walk around each one of us. The attunement process as explained by Karlene is the placing of the Reiki symbols into our energy field giving us the ability to use them. When we started Karlene asked us to close our eyes. I sat in my chair and was able to hear Karlene walking around us. When she reached me she placed my hands into the prayer position in front of my chest for awhile I could tell she was standing next to me but could not see what she was doing. She then unfolded my hands and drew symbols in my palms. A light blue and green fluttered under my eyelids during this process. Once done she folded them back together and moved them in front of my forehead then back down to my chest. I stayed like that until she was done with everyone else. My body felt like it was almost buzzing as I sat and waited for the others to be done.

Once we were all done Karlene told us to open our eyes and go spend some time by ourselves, eat, and drink some water. I went and laid in the house with my leg elevated because it was swollen. When I looked at the clock it was already 1:30. Around 2:00 everyone gathered in the living room. Karlene had us flip to the page with symbols on it and had us practice drawing them. It was made very clear that these are sacred symbols not to be shared with people who are not attuned so they can't be used for ill intentions. Once we had done this we then were supposed to pull up a picture of the person we wanted to practice long distance Reiki on. We were to practice the breathing from earlier and imagine this persons laying down as one would for a session and draw these symbols over their picture. I didn't feel anything during this and later found out that my sister had no awareness of anything happening to her.

We continued by going over the notes about sending Reiki into the future or past and even to the dead. You do this by imagining the person, place, or thing in that time and performing a session on it. When talking about distance Reiki and sending it to the deceased or through time K brought up that the previous day a friend who had passed came to her when she thought about this idea. This stood out to me because right before the feast K left to take a phone call and returned to tell us that her good friend had committed suicide. It was his sister who had come to K the day before and she told us that she came to her to tell her this was going to happen. We all sent her our love and best wishes before she left.

After this we all stretched and decided to start preparing the feast. We had Salmon, wild rice salad, bread, and fruit. We were told by N this was a traditional feast done by her people and she wanted to share that with us as we shared a very special journey together. We all brought a dish to share. It was about 5:30 when we started the feast. I note the time because this day seemed to fly by. Each new thing we did seemed to last only a short time, but in reality lasted hours. At dinner we discussed N's pregnancy and other things going on in life. This was my last day of field research and as everything came to a close. We all made it apparent that we would see each other again, and I expressed my gratitude to the women who let me share in this experience with them.

Literature Review:

As stated before I argue that Reiki is used for the participants well-being both mentally and physically in a format that can reduce stress, anxiety and pain. For the purpose of this research well-being is defined as mental and emotional happiness, and physical health as the absence of illness or pain. My literature review consists of multiple previous studies and discussions of how Reiki can be beneficial to those who receive and provide it's power for their well-being, along with the connection to Reiki being used alongside other methods of health and well-being such as yoga and meditation. I found it interesting to mention that almost all of my sources were journal articles discussing the use of Reiki in formal medical

settings. Although my research was situated uniquely and separately from previous research there was a similar understanding of the definition of well-being, and Reiki's use and importance in achieving that.

As stated by Burden, Herron-Marx, and Clifford "Anecdotal evidence suggests that through its profound relaxation effect, reiki alleviates anxiety, stress, perception of pain, and promotes a feeling of wellbeing"(2005, pg. 250). This directly connects to my findings postulating that Reiki can be used on yourself or others for well-being through the form of stress, pain, and anxiety relief. Referring back to week three of my research I would like to focus on the effects of Reiki being used on my participant T. She states during this Reiki share that her experience was one of relaxation, stress relief and release. I found this to show just how similar my participants experience was to previous research.

Many articles mention how Reiki is used in a hospital setting, more specifically with cancer patients and their treatments, focusing on it's use in relaxation, and pain reduction. The article I am going to focus on is by Hahn, Reilly, & Buchanan (2014). Because this article specifically discusses the use of Reiki in pain reduction, I would like to reference back to week two of my field notes when I first developed my poison ivy and hives. Similar to the patients in this article I was able to use Reiki to reduce the pain and uncomfotability from my own personal ailments during that time. There were also a number of articles discussing the use of Reiki in hospital settings put into use for the staff. (Tang, Tegeler, Larrimore, Cowgill, & Kemper 2010; Mangione, Swengros, & Anderson 2017) have an interesting discussion of the use of Reiki's benefits in a hospital setting similar to my previous articles. The difference is that this article focuses on the use of Reiki for the staff and not the patients in forms of anxiety and stress reduction. The connection I found most relevant was to that of my participant N's experience. Throughout the research setting she talked about the use of Reiki helping her to feel calm and less anxious or stressed about giving birth, which I felt directly connected to the use of Reiki being used to reduce stress and anxiety.

(Rubik, Brooks, & Schwartz, 2006; Garrett , 2001; Rosenbaum, & Van de Velde, 2016; and Haines 2016) have very interesting discussions about the effectiveness of Reiki alongside other forms of well-being including yoga, meditation, and medication. In these articles it is concluded by the participants that Reiki was seen as more effective compared to the other methods used to achieve well-being. This was an important discovery in my literature review because I was not able to compare multiple different healing methods to document effectiveness. During my healing process specifically with road rash I was able to make a small connection to this discovery. When using antibacterial ointment or other western medicine forms of treatment my road rash made no improvement. With Reiki I was able to see more drastic improvement including less redness, itching, and pain.

Beeler (2018, pg. 82-86) has a discussion about the experience of Reiki and what it feels like. Describing an instance where the practitioner felt a warm tingling sensation in their hands. I found this research interesting because it was the only one I could find describing the physical experiences I had. In my participation I was able to feel a warm tingling sensation in my hands as well when using Reiki. Karlene noted that this was a normal and often common sensation.

Conclusion:

To conclude, I used participant observation to collect research on Reiki finding that this form of energy healing was most often used for my participants well-being. I argue that Reiki is used for the participants well-being both mentally and physically in a format that can reduce stress, anxiety, and pain. For my research I focused on a method called participant observation. This method was the most effective way to gather an understanding of why and how people do what they do. I believe that when researching Reiki I was only able to truly understand this practice when embodying it the way my participants did. I utilized this method while simultaneously having conversation with my participants about Reiki. Some of

the things I participated in included the procedures that lead up to Reiki sessions and the Reiki sessions themselves, referred to as Reiki share when working with a group. Reiki as described by my participants, is an energy practice that creates balance or realigns the recipients energy facilitating in healing, or returning their bodies back to harmony. The practitioners are a vessel through which the Reiki energy flows and goes wherever it is needed.

I went to my field site once a week for two to four days at a time to meet with with my participants over a period of six weeks. My field site was located in and around Hackensack, MN. I worked out of my Aunt's shop which is located in a two room building which is shared with a chiropractic clinic in Walker, MN. Once in awhile I worked at a participants house and when needed I worked on myself at my own home in Waite Park, MN. The drive allowed for me to have separation from my site and give me time to experience the authentic feeling of going to a field site.

My literature review has shown that my research is a continuation of previous findings that Reiki can be used for the recipients well-being in solidarity or alongside other methods of well-being such as yoga and meditation. I was able to see this in my own personal healing process with poison ivy, hives and road rash. Along with the mental and physical healing my participants experienced as well.

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Anti-diabetic Properties of Sodium Bicarbonate in a Mouse Model of Type 1 Diabetes

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Abstract

Type 1 diabetes (T1D) is a chronic inflammatory autoimmune disease in which T cells destroy insulin-producing β cells in the pancreas, leading to hyperglycemia. Some T cells directly kill β cells, such as T-cytotoxic, or indirectly such as T-helper, while others, like regulatory T cells, actually protect them. A recent study showed that sodium bicarbonate (SB) exhibited anti-inflammatory activity by affecting immune cells other than T cells, implying its potential for the treatment of autoimmune diseases. Since SB has never been tested in an experimental mouse model for autoimmunity, we studied the effects of SB treatment on the development and severity of T1D, as well as on T cell subsets and T cell function. It was hypothesized that SB administration (200 mM, administered via drinking water) would decrease the incidence and severity of streptozotocin-induced T1D in 8-week-old C57BL/6 mice by its action on T cells. Glucose and body weight measurements were taken biweekly until mice were sacrificed four weeks later, and their spleens obtained for analysis of cell counts, viability, T cell proliferation, and quantification of T cell subsets by flow cytometry. There were no differences in splenic lymphocyte counts and viability between SB-treated and control mice. Although results showed that SB significantly decreased glucose levels and delayed diabetes development, it does not seem to affect the frequency of T cell populations nor their proliferation capacity. Our results suggest beneficial effects of SB in the prevention of mouse autoimmune T1D and highlight the need for further studies on its mechanism of action.

Introduction

Type 1 diabetes (T1D) is an autoimmune disease that occurs when inflammatory T cells attack insulin-producing β cells in the pancreas, which produces a halt in the body's production of insulin, leading to increased blood glucose levels (hyperglycemia). T1D is the second most common autoimmune disease among children (Jamshidi et al., 2019). The onset of this disease typically occurs during childhood and generates many complications throughout the life of a patient. Early symptoms include polydipsia (increased thirst), polyphagia (increased appetite), polyuria (increased urination), weight loss, and fatigue (Kahanovitz, Sluss, & Russell, 2017). If untreated, ketoacidosis is likely to occur and more serious

symptoms can follow, including cerebral edema, mental confusion, unconsciousness, coma, and death (Kahanovitz et al., 2017).

The incidence of T1D increased at varying rates throughout the 20th century and the same trends are being discerned now (Egro, 2013). Egro (2013) stated several hypotheses affirming that an increase in T1D incidence could be an implication of increased hygiene over the past decades, viral infections, vitamin D deficiency, and even a lack of breastfeeding. The only definitive answer that scientists have come up with on T1D etiopathogenesis is that it is a matter of both genetics and environment (Knip & Simell, 2012). Without knowing the exact cause of disease, the efforts that have been made toward prevention of disease have been futile. Since T1D depends on the over-reactivity of T cells, many preventative immunosuppressive approaches are aimed at the destruction of these immune cells (Chatenoud, Warncke, & Ziegler, 2012). However, these efforts did not provide expected results. Often times the treatments had an overwhelming effect on the immune system, eliminating the cells necessary to fight infections and tumors (Chatenoud et al., 2012). The only current treatment, once T1D is diagnosed, is insulin injections, leaving a great need for investigating alternative intervention methods for T1D.

Sodium bicarbonate (SB) has been used for decades to treat minor health issues, including dyspepsia and reflux. It is also implemented in the treatment of serious health complications, including metabolic acidosis which may occur in severe renal disease, uncontrolled diabetes, circulatory insufficiency due to shock or severe dehydration, extracorporeal circulation of blood, cardiac arrest and severe primary lactic acidosis (NCBI, n.d.). In a recent study, SB was shown to have *in vitro* anti-inflammatory properties, through its action on macrophages (Ray et al., 2018). One can assume that SB's anti-inflammatory effects on macrophages might also be observed on T cells as well. The same study speculated about SB's potential in prevention of autoimmune diseases, however it had never been tested *in vivo* in an experimental model of autoimmune disease. With T1D being a T cell-mediated autoimmune disease, and there being a lack of knowledge on the effects of SB on T cells, further research in this area is imperative.

When studying T cells in T1D, several types of T cells must be considered, as they are crucial in the disease's mechanism of action. Cytotoxic T cells (T_C), helper T cells (T_{H1} , T_{H2} , T_{H17}), and regulatory T cells (T_{reg}), each of which can be characterized by their particular cell markers (immunophenotypes) and the cytokines they release, and can be described as protective or destructive during disease development (Cetkovic-Cvrlje, Thinamany, & Bruner., 2017). Contradictory to their names, T_{H1} , T_{H2} , and T_{H17} are not all helpful, nor do they play the same roles in T1D. T_{H1} release the cytokines interleukin (IL)-2 and interferon (IFN)- γ , which are considered to be pathogenic, while T_{H2} release protective cytokines, IL-4 and IL-10 (Kuiper, Moran, Cetkovic-Cvrlje., 2016). T_{H17} release IL-17, which is also considered destructive (Kuiper et al., 2016). T_{reg} do their implied job in regulating the immune system and are said to have protective qualities during disease development (Kuiper et al., 2016). C57BL/6J (BL6) mice injected by chemical streptozotocin (STZ, Sigma-Aldrich) and NOD/LtJ (NOD) are both acceptable model organisms for T1D research. NOD mice spontaneously generate T1D, while BL6 mice must be chemically-induced, using 5 low-doses of STZ. Both models exhibit immunological changes during the development of T1D, comparable to humans (Cetkovic-Cvrlje et al., 2017).

The aim of this study was to illuminate antidiabetic properties of SB using a STZ-induced T1D mouse model. Since T1D is a T cell-mediated disease, the effects of SB treatment on T cells were closely examined. It was hypothesized that SB administration would decrease the incidence and severity of STZ-induced T1D by its action on T cells in a BL6 mouse model.

Methods

Mice. BL6 breeding pairs were purchased from Jackson Laboratory in Bar Harbor, ME for continued breeding at St. Cloud State University. Mice were housed in NexGen Lo-Profile caging systems in temperature- and relative humidity- controlled rooms with a 12-hour light/dark cycle. All mice had constant access to casein-based phytosterol-gen-free food and filtered water. St. Cloud State University Institutional Animal Care and Use Committee approved all protocols/procedures before experimentation began (protocol 5-113).

Sodium Bicarbonate Preparation. 200 mM concentration of SB (Sigma-Aldrich) drinking water was prepared by mixing SB powder with deionized water (Ray et al., 2018). The solution was then autoclaved along with non-treated, deionized (control) water. The water solutions were distributed to the appropriate cages via glass bottles with rubber sips when the mice were 7 weeks old. For the remainder of the experiment, the water bottles and sips were changed weekly.

Type 1 Diabetes Induction by Streptozotocin Injections. On 5 consecutive days, STZ was injected at 40 mg/kg/day, intraperitoneally (i.p.), to control and SB-treated 8-week-old, male mice (Cetkovic-Cvrlje et al., 2017). Prior to injections each day, STZ was dissolved in 0.05 M citrate buffer (pH 4.5, Sigma-Aldrich), vortexed, and within 30 minutes i.p. injected at 6.52 μ l/g (ter Veld et al., 2008).

Blood Glucose and Body Weight Measurements. At pre-decided time points, a lateral tail vein puncture was performed in a mouse to produce a small drop of blood that was then placed onto an Accu-Chek Aviva blood glucose meter strip to determine blood glucose levels. Glucose testing, along with body weight (g) measuring, was performed biweekly, starting 8 days after the initial STZ injection, until the experiment end. A mouse was considered diabetic after two consecutive readings of ≥ 250 mg glucose/dL (Cetkovic-Cvrlje et al., 2017).

Euthanasia. At 12 weeks of age, mice were euthanized via CO₂ asphyxiation. The mice were placed into an empty, clean 10-gallon plastic box. A stainless-steel lid was placed on top of the box, which is attached to the CO₂ tank by flexible polyvinyl tubing. The CO₂ tank was opened, allowing CO₂ (at ≥ 200 psi) to fill the tank. The mice remained in the tank for at least 10 minutes; during this time, their heartbeats stopped, and the mice were considered deceased.

Single Cell Suspension. Spleens were harvested from euthanized 12-week-old SB-treated and control mice and were smashed using a 10 cc syringe plunger and a 70 mm nylon mesh strainer with the addition of phosphate-buffered salt solution (PBS, Sigma-Aldrich). This process produced single (spleen) cell suspensions (SCS). The SCSs were put into a centrifuge and spun for 5 minutes at 1200 rpm 4°C. The supernatants decanted, and the pellets were resuspended in 0.75 ml of ACK lysing buffer (Lonza-BioWhittaker) which was used to lyse the erythrocytes. The SCSs were washed three more times using PBS. A small portion of each SCS was mixed with Trypan blue (Lonza BioWhittaker), which stains dead cells blue. 20 μ l of the mixtures were inserted into a hemocytometer for cell counting with a light microscope. Alive and dead cells were counted separately; this allowed for conclusions to be drawn, not only about how many cells there were in each sample, but also what percentage of those cells were living. This procedure has been described in more detail in the Cetkovic-Cvrlje et al. (1997) manuscript.

T-cell Proliferation. Proliferation assays were performed according to Cetkovic-Cvrlje et al. (2016). To summarize, splenocytes from SB-treated and control mice were suspended in complete media (CM), which contained RPMI-1640 medium, 1 U penicillin/ml, 100 µg streptomycin/ml and 10% fetal calf serum (FCS) (all purchased from Sigma-Aldrich). The CM-suspended cells were cultured in triplicates in a 96-well-plate with and without the addition of 3 µg/ml Concanavalin A (ConA, Sigma-Aldrich) for 72 hours at 37°C and 5% CO₂. ConA is T cell mitogen, which means it is used to induce proliferation (mitosis) of T cells (Dwyer & Johnson, 1981). After 72 hours, 10 µl of Alamar blue (Invitrogen), which is used to measure the reducing capacity of cells, was added to each well, and the plate was incubated for an additional 4-6 hours. Optical densities were then measured, at 570nm, with an ELISA plate reader (GeneMate).

Immunophenotyping. Splenocytes were analyzed in order to detect particular types of immune cells (immunophenotypes) by flow cytometry (Cetkovic-Cvrlje et al., 2016). Aliquots of 10⁶ splenocytes were obtained from the SCS of each mouse. Aliquots were spun down via centrifugation, the supernatants were decanted, and the pellets were resuspended in FACS buffer (0.1%NaN₃, 1% FCS in PBS). Each sample was stained with a particular antibody mixture, incubated in the dark at 4°C for 45 minutes, washed, and analyzed using a FACSCalibur (BD Biosciences) flow cytometer. The antibodies against particular cell markers were purchased from BD Biosciences; these immune cell markers and their associated fluorochromes can be found in Table 1. A minimum of 10,000 cells were acquired for each analysis. Immunophenotype analysis was performed using CellQuest Prosoftware (BD Biosciences).

Table 1. Cell types, cell markers, and antibody-associated fluorochromes, used for the flow cytometry. The fluorochrome column displays abbreviations of the following fluorochromes: peridinin chlorophyll-a protein (PerCP), fluorescein isothio-cyanate (FITC), allophycocyanin (APC), and phycoerythrin (PE).

| Cell Type | Cell Marker | Fluorochrome |
|---------------------|-------------|--------------|
| T cell (all types) | CD3 | PE |
| T-cytotoxic | CD8 | FITC |
| T-helper | CD4 | PerCP |
| T-regulatory | CD4 & CD25 | APC |
| B cell | CD45RB220 | APC |
| Natural Killer Cell | CD335 | FITC |
| Macrophage | CD11b | PerCP |

Statistical Analysis. For each of the statistical analyses, a p-value of < 0.05 was considered significant. Differences in diabetes incidence among experimental groups were determined using a life-table analysis, specifically looking at the log-rank test, using JMP Pro 14 statistical analysis software. For blood glucose levels and body weight data, Microsoft Excel was used to run a one-way analysis of variance with repeated measures, otherwise known as an ANOVA test. For immunophenotyping, T cell proliferation, cell counts, and cell viability a Student t test was performed using Microsoft Excel.

Experimental Timeline. The mice were divided into two groups, control and treatment, and treatment began at 7 weeks of age (Day -7). Initial blood glucose and body weight measurements were also taken at that time. At 8 weeks of age (Day 0), STZ injections began. Between 9 and 12 weeks of age (Day 7 to

Day 28), blood glucose and body weight measurements were taken biweekly. At 12 weeks of age (Day 30), all T cell-related experimental analyses were performed (SCS preparation, cell counting, the initiation of the T cell proliferation assay, and immunophenotyping).

Results

Effect of Sodium Bicarbonate on the Development and Severity of T1D. To test the effect of SB treatment on the development and severity of T1D in a STZ-induced BL6 mouse model of disease, mice were treated with 200 mM SB from 7 to 12 weeks of age. One week after the initiation of treatment, each mouse, control and SB-treatment, received a daily low-dose of STZ for a period of 5 days to induce T1D. Prior to the induction to T1D (Day -7) there were no differences in glucose levels observed between the control and treatment groups (Figure 2). At 9 weeks of age, biweekly glucose measurements were taken until the end of the experiment (Day 7 to Day 28). As illustrated in Figure 1, 200 mM SB treatment significantly ($p = 0.0444$) decelerated T1D diabetes development and decreased diabetes incidence compared to control group. On Day 14, 47.6% of SB-treated mice were diabetes-free while only 14.3% of control mice were diabetes-free; at the end of experimental period, 33.3% of SB-treated mice were diabetes-free, while 9.5% of control mice were diabetes-free (Figure 1).

Throughout the aforementioned time period, on average, the SB-treated group had lower blood glucose levels than the control group, though no statistical significance was reached ($p = 0.1819$) (Figure 2).

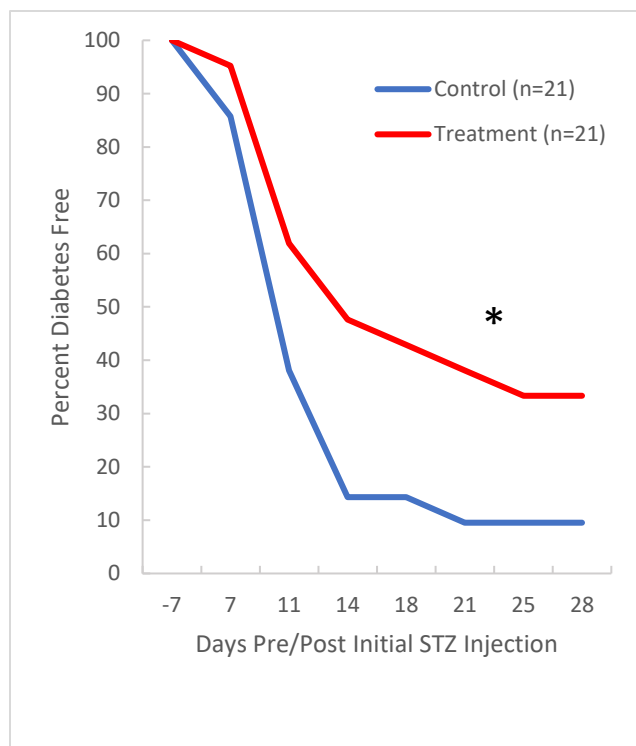


Figure 1. Incidence of diabetes in STZ-administered mice treated by 200 mM SB vs control group. Statistical significance was observed for incidence of diabetes in treated vs control mice; $p = 0.0444$.

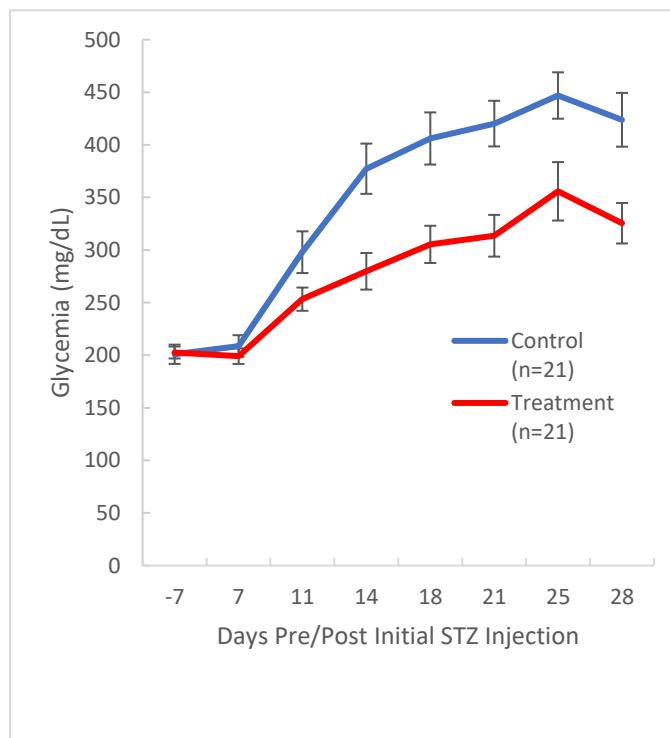


Figure 2. Average blood glucose levels (mg/dL) +/- standard error of the mean (SEM) for 200 mM treatment vs control group of mice. No statistical significance was observed ($p > 0.05$).

Sodium Bicarbonate and Immunotoxicity. The main focus of this project was to test SB's potential in decreasing the incidence and severity of T1D, but it was also vital to observe whether a 200 mM dose of SB exhibited toxic effects. Thus, certain parameters were monitored *in vivo* and *ex vivo*. *In vivo*, an initial body weight measurement was collected for each mouse at 7 weeks of age (Day -7). Following 5 low doses of STZ given to induce T1D, body weight measurements were recorded biweekly (Day 7 to Day 28) until the mice reached 12 weeks of age. During this time, there was no significant difference found between the 200 mM SB-treated group and the control group ($p = 0.2706$) (data not shown). A Trypan blue exclusion test was performed *ex vivo* after the preparation of the SCS. A small portion of the SCS was mixed with Trypan blue and splenocytes were counted. When comparing 200 mM SB-treated and control mice, there were no significant differences found in the context of total cell counts ($p = 0.5288$) (Figure 3), nor in the cell viability ($p = 0.3681$) (Figure 4).

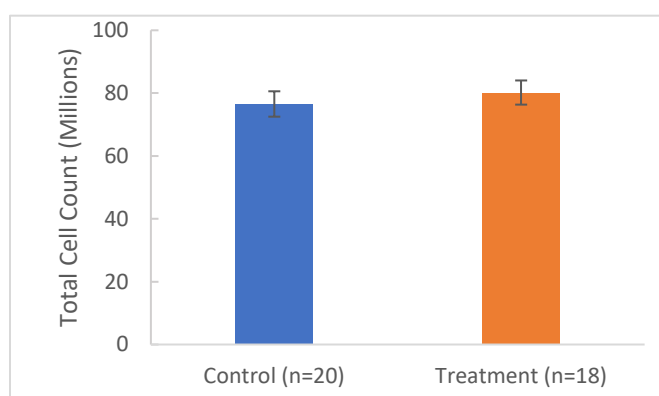


Figure 3. Splenic cell counts (millions) +/- standard error of the mean (SEM) for treatment vs control group of mice. No statistical significance was observed ($p > 0.05$).

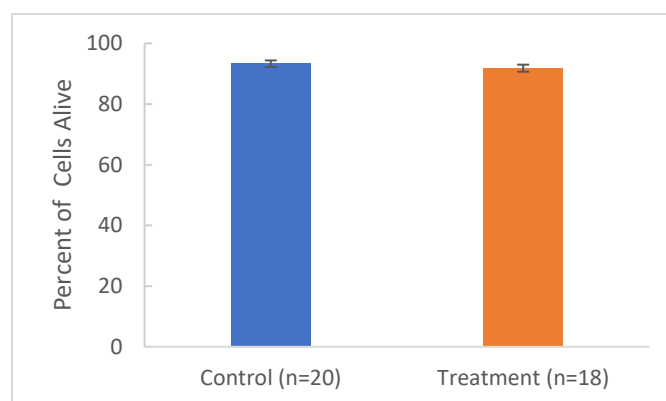


Figure 4. Splenic cell viability +/- standard error of the mean (SEM) for treatment vs control group of mice. No statistical significance was observed ($p > 0.05$).

Effect of Sodium Bicarbonate on T cell Function. If SB had the potential to decrease the incidence and severity of T1D, which is a T cell mediated autoimmune disease, one would expect to observe SB-mediated effects on T cell function. Thus, a T cell proliferation assay was performed. A portion of each SCS was plated with and without the addition of ConA and was stained with Alamar blue after the 3-day-culture period and was analyzed via spectrophotometry. When comparing T cell proliferation levels, in stimulated and non-stimulated conditions, there was no significant difference for non-stimulated ($p = 0.3614$), as well as stimulated conditions ($p = 0.6287$) between the 200 mM SB-treated group and the control group (Figure 5).

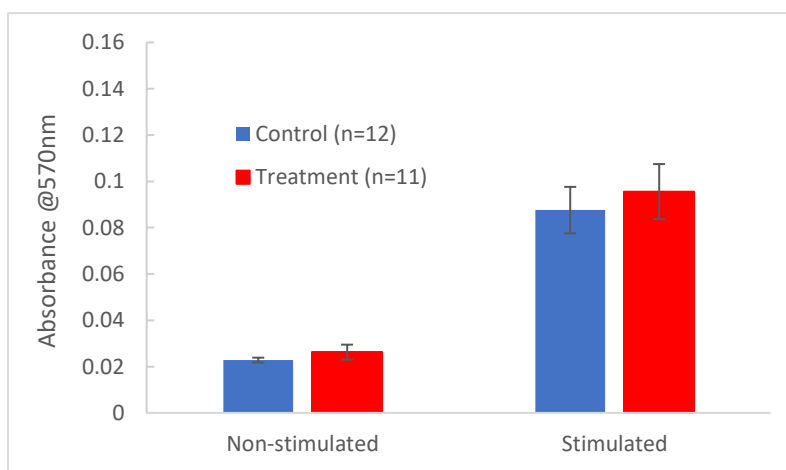


Figure 5. Proliferation levels +/- standard error of the mean (SEM) for 200 mM treatment vs control group of mice. No statistical significance was observed ($p > 0.05$).

Effect of 200 mM Sodium Bicarbonate on Immune Cell Subpopulations. To shed light on SB's mechanism of action in the context of immune cells, quantification of immune cell populations and subpopulations was performed. Thus, mouse splenocyte samples were stained with fluorochrome-labeled antibodies and a flow cytometer was used to quantify the immune cell types/subtypes. The percent of T_C, T_H, and T_{reg} cells was slightly lower in the 200 mM SB-treated mice compared to the control, while there was a trend of slight increase in the percent of B cells, natural killer (NK) cells, and macrophages in the SB-treated group. However, comparing the SB-treated against the control group, across all immune parameters, no significant differences were observed (Figure 6). The p-values for the 200 mM SB-treated group versus the control group are as follows: CD3⁺ (p = 0.4697), CD4⁺ (p = 0.3958), CD8⁺ (p = 0.4718), Treg (p = 0.4739), B cell (p = 0.4218), NK cells (p = 0.1696), and macrophages (p = 0.5460). The cell types that coincide with these cell markers can be found in Table 1.

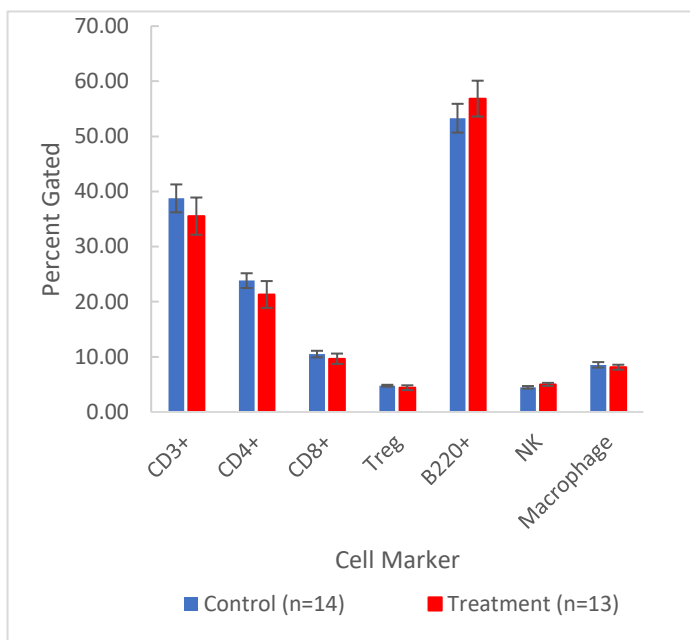


Figure 6. Splenic cell immunophenotypes +/- standard error of the mean (SEM) for 200 mM treatment vs control group of mice. No statistical significance was observed (p > 0.05).

Conclusions

This study showed for the first-time effects of SB treatment in an *in vivo* T1D mouse model. The results imply that SB has the potential to reduce the incidence and severity of the disease, as SB treatment significantly delayed the onset of disease, while simultaneously lowering glycemia levels. SB did not show toxic effects; this was confirmed with no changes in the body weights during the treatment period, as well as with intact splenic cell counts and viability. Interestingly, SB did not affect T cell function nor the frequency of T cell populations/subpopulations. Thus, further research into SB's mechanism of action, in the context of T cells, needs to be performed. Cytokine secretion will be studied to elucidate how SB affects particular T cell subpopulations regardless of not affecting their numbers. Overall, whereas these results are not conclusive about the mechanism of action of SB in T1D, they serve as a promising first step towards retardation of T1D onset and potential preventative efforts for autoimmunity in general.

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“This is What Community Should Look Like”: an Ethnographic Study of a Local Nonprofit Organization

(Originally submitted for ANTH 470: Anthropological Analysis and Interpretation)

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Abstract

This ethnographic study is based off of six weeks of participant observation and ethnographic research with Neighbors to Friends, a local grassroots organization in Central Minnesota that facilitates a free laundry program and runs a mobile shower vehicle that provides showers to those experiencing homelessness. By fully participating in the day-to-day operations of Neighbors to Friends, the purpose of this project is to gain a holistic understanding of how this unique nonprofit organization creates a sense of community for those experiencing homelessness and poverty. Nancy Dyson, the director of Neighbors to Friends, has a leadership style that allows for volunteers, community partners, and the people they serve to take ownership in the program and creates a sense of community where all are welcome. In a capitalistic society, people are often seen as commodities and value is often placed on a person based on what they can contribute to society financially. Neighbors to Friends rejects this ideal and finds value in people just because they are human. By comparing my observations to scholarly research about community and grassroots leadership styles, I argue that Neighbors to Friends not only meets the physical needs of marginalized individuals experiencing homelessness and poverty, but fosters an environment where community is created and the need to belong is met as well.

Introduction

Neighbors to Friends is a not-for-profit organization established by Nancy Dyson and Jason Jaques, along with the other volunteers they work with. Before the organization had a name, it started off as a small laundry program at Kip’s Laundry in St. Cloud, Minnesota. Nancy had spent some time at Lake George, bringing coffee and breakfast food to some homeless men that had been living around the lake. As time passed, she began to form a friendship with them and developed trust. She found out that these men had a great need for their clothes to be washed and Nancy wanted to do something about it. Five years ago, Nancy and the men from Lake George worked together to start a program called Laundry Love. They collected quarters and laundry soap and anyone in need was welcome to come and do their laundry for free on the first, third, and fifth Tuesday of every month. Laundry Love is a nationwide program that

offers laundry services and supplies to those in need. Nancy does not take credit for starting Laundry Love in St. Cloud, but says the men from Lake George helped too. Over the years, the program has grown quite large and there is now a second location in a neighboring city where families can go to get their laundry done. Over the years, Nancy has developed relationships with the homeless community in St. Cloud and has become aware of what their needs are and the lack of community resources that are able to meet those basic needs.

A few years ago, Nancy and Jason were walking in a parking lot outside of a store and ran into one of their friends. She was a middle aged woman experiencing homelessness and when Nancy leaned in to give her a hug (as she does with nearly everyone she talks to), the woman pulled away and tearfully said she hasn't showered in days. She asked Nancy and Jason if they knew of any place where she could take a shower, and Nancy and Jason said no. In St. Cloud, the homeless population has grown increasingly over the years but shelters have not grown to accommodate. Shelters are almost always full and there is no place that is easily accessible for people experiencing homelessness to shower. Nancy and Jason knew they had to do something about it and began looking at small busses to transform into a mobile shower vehicle. As they were about to purchase a 15-passenger bus, they looked at each other and wondered if this was too crazy of an idea. They had no idea what they were getting themselves into, but had faith in their idea and felt compelled to do something about this growing issue in their community. Jason and their friend Brian watched countless YouTube videos and became amateur carpenters and plumbers and transformed the gutted bus into a fully functioning mobile shower vehicle which they call "Shower the People," named after the James Taylor song of the same name. Nancy, Jason, and Brian started bringing the truck out in the summer of 2019 and now take it out to a local rest stop and the public library parking lot multiple days in a week.

Neighbors to Friends is in the process of becoming a 501(c)(3) and has three branches to the organization. Laundry Love, Shower the People, and a project addressing housing for the homeless that is currently in the works make up the larger non-profit of Neighbors to Friends.

Experiment and Methods

During my field research between 6/25/2019 and 8/6/2019, my primary method of research was participant observation. Participant observation is the foundation of ethnographic research and involves the researcher actively participating in the day-to-day lives of a people group. Essentially, it is learning by doing. This method gives the researcher a tacit and more holistic understanding of a cultural group. This method allowed me to learn about how Neighbors to Friends operates by participating in what Nancy and Jason were doing. The boundaries and limits to participant observation depend on the circumstances, however I was heavily involved with the operations at Neighbors to Friends. I went to numerous Laundry Love events, went out with the Shower the People truck, worked with Nancy during her office hours, and attended various meetings with Nancy to obtain a holistic view of how Neighbors to Friends is run. During these various activities, I took extensive field notes to make sense of all that was happening. Using participant observation allowed me to have a first-hand view of what went on and also allowed me to physically feel what it was like to be involved with Neighbors to Friends. These viewpoints could not be obtained had I not used participant observation as my primary research method.

I will be using the terms "homeless person/people" and "people experiencing homelessness" interchangeably. Throughout my fieldwork, I have heard both terms being used. Nancy Dyson uses the phrase "people experiencing homelessness" because she believes that "homelessness is something you are

living and experiencing, it isn't who you are." She also stated that she doesn't think there is one right way to say it. Because of this, I will use both.

In this ethnographic essay, I argue that Neighbors to Friends is an organization that was created to meet the basic physical needs of marginalized individuals experiencing homelessness and poverty, but serves a larger purpose of creating community between the individuals it serves, their volunteers, and community partners. Through analyzing the definition of "sense of community" (McMillan 1986), the use of food in creating community, and grassroots leadership styles, I argue that Neighbors to Friends brings people together to create a "beloved community," a term made popular by Martin Luther King Jr.

Results

"Sense of community"

David McMillan defines the "sense of community" as "a feeling that members have of belonging, a feeling that members matter to one another and to the group, and a shared faith that members' needs will be met through their commitment to be together" (1978:9). McMillan's definition has four elements: membership, influence, integration and fulfillment of needs, and shared emotional connection. Membership is when one feels like they belong to the group and have a shared connections with other members. Membership also means that boundaries are set about who is and is not included in a group. Influence is the sense that one can make a difference to the group and that the group matters to its members. Integration and fulfillment of needs is the feeling that a members' needs will be met through resources available to those that are members of the group. Finally, shared emotional connection is the idea that members have and will share a history, similar experiences, and time together (McMillan 1986:9). Neighbors to Friends is composed of all four of these elements which can create a strong "sense of community" for those involved.

Nancy, Jason and the other volunteers at Neighbors to Friends are adamant in the fact that anyone and everyone is welcome to participate in the programs that they offer. There are no income requirements or proof necessary to be able to use the laundry services or mobile shower. People can simply show up to the locations and utilize the services. Membership in any group means that there are boundaries, meaning that there are people who belong to the group and people who do not. These boundaries can vary greatly depending on the type of group. These boundaries that are set "provide members with the emotional safety necessary for needs and feelings to be exposed and for intimacy to develop" (McMillan 1986:9). Even though Neighbors to Friends is extremely inclusive and will always welcome anyone who desires to be a part of the community, there are a few requirements that are put in place in order to allow everyone to feel comfortable in the group. They have guidelines as to what kind of behavior is unacceptable and will not be tolerated. Many that attend Neighbors to Friends events are often going through difficult circumstances and tensions can run high. Nancy created guidelines that state that anyone is free to express their frustrations in however way they need to, as long as they are not harming others verbally or physically.

According to McMillan, groups often use deviants to establish boundaries (1986:9). For example, at Laundry Love, one young man had escalating aggressive behavior and was swearing and yelling at Nancy. She asked him many times to end that behavior or he would be asked to leave or the police would be called. Because he did not stop the aggressive behavior, she unfortunately had to call the police and he was banned from the laundromat. Nancy said he would be welcomed back to Laundry Love if he would behave appropriately. Nancy said that she doesn't care how people express their anger or frustrations as long as they are not hurting others. Because this man's behavior was violent towards others, he was asked to leave the group. The basic rule that Neighbors to Friends has of not hurting others allows for members

to feel safe to expose their emotions and needs and develop intimacy with one another. Members of the Neighbors to Friends community have a shared connection through events they attend together, such as Laundry Love and Shower the People. Over time these shared connections create intimacy and foster a “sense of community”.

Influence, the second element of the “sense of community”, is the sense that one can make a difference to the group. The group at large also has influence on members of the group. These two ideas working together make influence a bidirectional concept. “In one direction, there is the notion that for a member to be attracted to a group, he or she must have some influence over what the group does. On the other hand, cohesiveness is contingent on a group’s ability to influence its members” (McMillan 1986:11). This idea does not mean a loss of personal choice because many people would try to escape the conformity of a tight-knit community in order to express their own ideas and values. This shows the need to develop communities that appreciate everyone’s differences so that an individual believes they can exert some sort of control over the community (McMillan 1986:11).

Nancy and her team fully embrace each individual’s uniqueness and encourages anyone involved in Neighbors to Friends to use their gifts and talents to have ownership and a sense control over their community. Anybody is welcomed and encouraged to volunteer in whatever capacity they feel comfortable with. Nancy has the belief that everyone has a unique gift or talent and if someone has an idea of how they can use those skills to contribute to the community at Neighbors to Friends, they are strongly encouraged to do so. For example, a woman approached Nancy with an idea of how she wants to contribute to Laundry Love. She wishes to create a children’s program and provide activities to keep kids occupied while the adults they are with do laundry. She was excited about this and felt that is how she could best use her skills to contribute to the Neighbors to Friends community. Nancy and Jason do not try to control each individual’s ideas, but allow them to fully take control and utilize their skills in a way that only that individual could do.

Nancy also allows for individual agency within Neighbors to Friends by not forcing her religious beliefs on anyone. Nancy belongs to a local religious community and those religious principles guide her beliefs, but she does not hint towards any sort of religious affiliation within Neighbors to Friends. During my fieldwork, I heard many people ask if Neighbors to Friends is a religious group, and I believe this is because many charity organizations will help people in need only if they listen or be involved in their religious practices. Because Nancy does not advertise her religious beliefs or only provide services if an individual participates in those beliefs, people are able to hold on to their individual freedom while still getting their basic needs met.

The third element of the definition of the “sense of community” is integration and fulfillment of needs or in other words, reinforcement. McMillan states that “it is obvious for any group to maintain a positive sense of togetherness, the individual-group associate must be rewarding for its members” (1986:12). This theory of the “sense of community” can be applied to all different types of community, but Neighbors to Friends has shown to be rewarding to all different types of people. People experiencing poverty or homelessness get a need met through a hot meal, a shower, or free laundry services and for many this is very rewarding. Along with that, being able to spend time with others and make intimate connections is also rewarding. Many people that came to the Shower the People truck often never took a shower, but spent time with the group socializing and sharing a meal with others. Even though they weren’t utilizing the shower, it was rewarding to them to have time to socialize with others.

McMillan goes on to state that groups work to find a way to fit people together so that people meet the needs of others while also meeting their own needs. This is evident in Neighbors to Friends about just how often Nancy and Jason talk about boundaries. Nancy always says, “if you can’t do it with joy,

don't do it at all." For example, some volunteers asked what to do at Laundry Love if someone arrives after the cut off time. Nancy explained that if they feel comfortable and are willing to stay a little bit longer and still have joy, then they can feel free to let someone start washing their clothes late. If they don't feel comfortable and would be disgruntled about staying later, then tell the person they cannot start washing. Nancy encourages everyone to have this mindset because she believes that they are present to serve others, but also to have personal boundaries as well. She wants the volunteers to feel good about the work they do and not feel like it is a burden. Another way Nancy and Jason develop boundaries is by calling all volunteers at the beginning of the year to ask if they want to continue volunteering. They do this so people are able to say no if they want to back out and not continue volunteering with Neighbors to Friends because sometimes it can be difficult for people to quit and to set boundaries themselves. Nancy and Jason make sure to set boundaries to make sure the community at Neighbors to Friends is rewarding for everyone.

The fourth and final element of the definition of the "sense of community" is a shared emotional connection which is based, in part, on a shared history. It is not necessary for members of a group to have participated in the history of the group, but must identify with it in order to share it. McMillan states that "the interactions of members in shared events and the specific attributes of the events may facilitate or inhibit the strength of the community" (1986:13). For example, "the more people interact, the more likely they are to become close...and the more positive the experience and the relationships, the greater the bond" (McMillan 1986:13). Food definitely helps facilitate positive experiences and interactions between group members. In a way, serving food at Neighbors to Friends allows people to set aside their status and make positive connections and have meaningful conversations.

A shared emotional connection also involves what McMillan calls a "spiritual bond" (1986:14). This is present in varying degrees in all communities but is difficult to describe. I believe this is what Nancy and Dr. King call the "beloved community," a place where great love for one another is fostered. I also believe this is the kind of bond Nancy is talking about when she says it is difficult to describe to news outlets what goes on at Laundry Love because all the media wants is numbers and statistics. She cannot put into words what it means to have meaningful connections with one another at Neighbors to Friends. I believe this spiritual bond is what an individual that attended Shower the People was referring to when they said, "this is what community should look like." I don't believe they were talking about sitting outside a renovated bus in the summer heat, but were talking about the welcoming and loving environment that is created at Neighbors to Friends. All four elements that McMillan describes (membership, influence, integration and fulfillment of needs, and shared emotional connection) work together to create a community at Neighbors to Friends that is based on love, tolerance, and acceptance.

Food at Neighbors to Friends

Every week at Laundry Love, a homecooked meal was always provided for everyone attending. Various groups would volunteer to provide the meal, including church volunteers from St. John's Episcopal Church (the church Nancy attends), volunteers from other churches in the area, and employees at the local credit union. Volunteers and people using the Laundry Love services would also bring food to contribute. Salvation Army would donate meat to be used at Laundry Love since many of the people staying at the shelter would also come to Laundry Love to get their laundry done. One of the long tables at the laundromat would be cleared off and transformed into a buffet. There would be hot dishes, soups, chips, juices, milk, pie and other desserts. Crock pots would be plugged into power strips and flimsy metal trays would be filled with ice to keep beverages cool. Nancy always had a board listing the names of everyone who brought food to acknowledge and thank them for their contribution. Everyone who came to the laundromat would be invited to eat and people who brought food seemed to take pride in the things

that they made. The laundromat at the St. Cloud location was small and every washer and dryer would be used, and having an elaborate buffet seemed to add to the chaos, but I observed people connecting over the food that was provided and it allowed for people to stay awhile and enjoy the meal and each other's company.

Throughout my fieldwork with Neighbors to Friends, I observed that food was an integral element of both Shower the People and Laundry Love. At every single event I attended with Nancy, there was always some sort of food that was provided. Whether it be a box of a dozen doughnuts from Walmart at Shower the People or an elaborate homecooked meal provided by local church ladies including a main dish, sides, and desserts served at Laundry Love, food was consistently provided to those attending. In many different cultures, food is used as a tool to bring people together. Church potlucks, inviting your new neighbor over for dinner, or having party food at a Superbowl party are just a few of the countless ways people use food as a means to support a gathering of people. This is the same way food is used at both Shower the People and Laundry Love.

Having a sit-down meal with others has been shown to have a positive impact on psychological well-being and emotional stability, along with many other physical and emotional benefits (Purnell and Jenkins 2013). Food has had a long connection with human intimacy. The word "companion" is derived from a Latin word that means "with" and "bread." Originally, a companion is someone that one broke bread with (Purnell and Jenkins 2013). In 2013, David Purnell and J. Jacob Jenkins conducted a study on the phenomenon of "Family Dinner Nights," a weekly dinner put on by the Seminole Heights neighborhood. For the past twelve years, neighbors and members of the surrounding community have come together to share a potluck style meal, talk about significant events in their lives, and enjoy each other's company. Purnell and Jenkins argue that the weekly gathering to eat together transforms an "otherwise disconnected group of residents into a strong network of friends and an even stronger community" (2013:74). This transformation is done through open invitation to the meals and shared storytelling during them. Neighbors to Friends does just that. Sharing a meal together is a means for them to turn disconnected neighbors into friends.

Whenever I went out to the Shower the People truck, Nancy made sure to always provide some sort of food. Sometimes it would be as simple as a few boxes of \$5 pizzas and pop, and sometimes it would be something more like fried chicken, potatoes, and corn dogs. Anyone was invited to eat the food and there was no limit on how much you could take. If you were hungry, Nancy wanted to make sure you would be full. Leftover food would be given to whoever needed it. One afternoon at the rest stop with the shower truck, Nancy brought pizzas and pop for people to eat. Myself, Nancy, Jason, Brian and some of the people that were living in their cars at the rest stop were sitting outside of the shower truck chatting and eating. A rest stop employee in his all green uniform and cap walked over to say hello and ask how things were going. Nancy invited him to sit and eat with us since there was plenty of pizza to share. He agreed and sat with us for quite some time and told us about his job at the rest stop. Having food out at the truck allowed for a means to get to know this man and spend time with him, which I believe is the goal of having food at all of these events. People are more likely to stay awhile and get to know each other if they have a reason to do so, and here sharing a meal is that reason. Similar to the attendees at the "Family Dinner Nights," people from all different backgrounds were welcome to eat the meal at both Shower the People and Laundry Love. I observed volunteers, people experiencing homelessness, rest stop employees, and even people stopping by to check out what the shower truck was all about stop and share the meal with others.

Purnell and Jenkins also argue that sharing a meal builds community through shared storytelling. At "Family Dinner Nights," Purnell and Jenkins state that "in contrast to "report-talk" which is indicative

of formal conversation, the sharing of food was shown to create a casual atmosphere in which participants were less interested in impressing one another and more interested in knowing one another” (2013:79). Conversation arose spontaneously and there was never a pre-determined agenda. In a sense, food appeared to level the playing field by allowing conversation to flow naturally without status and power looming overhead. Purnell and Jenkins state that these conversations emerge from the “immediacy of presence” and builds community by “deconstructing personal boundary structures.” At both Laundry Love and Shower the People, I heard conversations about people’s days, the ups and downs in their lives, and stories that made everyone laugh. For example, during one evening at Shower the People, a man that regularly used the mobile shower shared a meal of sandwiches and pop with everyone and told us all stories of pranks he would pull on his teachers and principals in high school. He was making big gestures and acting out the pranks he pulled, making everyone laugh. Many people that are not experiencing homelessness often view themselves as being drastically different than those that are experiencing homelessness. Sharing stories during a meal with those that we believe are very different makes those differences fade away and it is easy to see just how much you have in common, which is the goal of Neighbors to Friends. Nancy explained numerous times that the shower truck is not about “efficiency,” but it is all about creating a special community and loving people.

One element of community is a shared emotional connection between group members that is based, in part, on a shared history. This does not mean that community members need to be a part of the history of the group to share in it, but they must identify with it (McMillan 1986, 13). This can come from interactions between members that strengthen the community, like sharing a meal together. In David McMillan’s analysis of the “sense of community”, he states that “the more people interact, the more likely they are to become close...and the more positive the experience and the relationships, the greater the bond” (1986, 13). Based off of Purnell and Jenkins’ study on weekly neighborhood meals and my observations about sharing food and conversation at Laundry Love and Shower the People, I believe that food helps facilitate positive interactions and experiences between individuals and that fosters a “sense of community”.

Grassroots leadership styles

Since I spent a large majority of my fieldwork doing participant observation with Nancy Dyson, one of the founders of Neighbors to Friends, I will be highlighting her leadership styles and how they compare to other grassroots leadership styles. Nancy makes it very clear that the work she does isn’t about her and that Neighbors to Friends could not be possible without the contributions of everyone involved. While this is true, Nancy does possess characteristics and leadership styles that set the stage for how Neighbors to Friends operates. Through analyzing my field notes and contextualizing them within larger studies of leadership styles, I argue that Nancy has numerous qualities that classify her as a successful grassroots leader.

Before analyzing leadership traits or grassroots organizations, it is important to define what a grassroots innovation is. According to Mari Martiskainen, grassroots innovations are “networks of activists and organisations [sic] generating novel bottom-up solutions for sustainable development; solutions that respond to the local situation and the interests and values of the communities involved” (2016:78). By definition, Neighbors to Friends would be considered a grassroots innovation because they have developed solutions (like Laundry Love and the mobile shower truck) that respond to the local issue of homelessness and poverty. A grassroots innovation is different than other types of organizations because its goal is to create social good rather than monetary profit. This goal can allow for unique innovations and ideas that would not have been developed in an organization driven by profit (Martiskainen 2016:78).

The complexity theory is one way to analyze adaptive systems and “how system-level order spontaneously arises from the action and repeated interaction of lower level system components without intervention by a central controller” (Onyx 2011:494). It was originally used to analyze the effects of relationships within non-human systems but can be used to analyze human systems as well. There are a few dynamics within the complexity theory that may explain the process of the self-organizing emergence of networks, like Neighbors to Friends. First, a social network emerges out of a state of disequilibrium or a tension between disequilibrium and equilibrium in a wider context (Onyx 2011:494). For example, there was tension between the disequilibrium of a lack of places to shower for people experiencing homelessness in the St. Cloud area and the equilibrium of everyone else in the community having access to showers. The second dynamic in the complexity theory is that the state of disequilibrium draws agents (individuals, organizations or both) together to explore options for action (Onyx 2011:495). Nancy and Jason came together to explore solutions to the problem of the lack of showers when they met a woman experiencing homelessness in a parking lot that hadn’t showered in days. Nancy and Jason sought to respond to the disequilibrium that was occurring in their community. The third dynamic of the complexity theory states that positive feedback loops are necessary and that actions that are both big and small produce an effect. The effects can be positive or negative (Onyx 2011:495). For example, the shower truck that Nancy and Jason created received media attention which garnered them more support from the community. The final dynamic to the complexity theory states that these forms of actions are full of uncertainty and although disequilibrium occurs, there are forces working against it and towards equilibrium (Onyx 2011:495). It is important to note that “leadership should not be viewed as individuals operating in isolation as they influence their followers, or in terms of individual traits. Leadership is seen as an emergent phenomenon that arises from interactions and events” (Onyx 2011:496). Nancy and Jason do not operate in isolation and they have become leaders through reacting to the disequilibrium of poverty and homelessness that exists in their community.

In Onyx and Leonard’s case study of traits in leaders of community development in small communities around the world, they discovered that community leaders have a broad vision for what is possible in the future and a clear path of how to get there (2011:504). Although Nancy did not have a clear idea of how to develop Laundry Love over the years and did not try to plan for every single problem they could run into, she did see a problem in her community and knew the kind of steps she wanted to take to address this problem. Nancy entered into this endeavor knowing full well that she did not have all of the answers but was willing to adjust her plan as necessary. She knew that it would be possible to have a community that would strive to meet everyone’s basic needs and took action to work towards that goal.

In Mari Martiskainen’s case studies of community leadership in the development of community energy projects, she found that leaders voiced their expectations. This helps provide direction to work towards the group’s goals along with attracting potential support and resources from external partners (2016:83). Regardless of the motive, the case studies showed that there is always someone, either an individual or a group, who sees an opportunity or a need and decides to act on it. Nancy and the group of homeless men at Lake George saw an opportunity to meet a need (assistance with laundry) and decided to act on it. They did not wait around or ask someone else to do it. In Martiskainen’s case studies, the community leaders were clear from the beginning that they wanted to create projects that would benefit their local community. They had the confidence needed to voice those expectations and had trust in their group’s ability to deliver their idea.

In Onyx’s and Leonard’s case studies of community development leaders, they found that the identified leader or leadership group was strongly embedded in both the formal and informal networks of the community. They were not in a position of formal authority, but they took an active initiating role in

establishing the project. The leaders had integrity, cared about the public interest, and were trusted by the community (2011:503). Nancy has belonged to the St. Cloud area for decades and has gained trust from the community. Martiskainen's case studies also showed that community leaders were people that were well known in their community and active in them (2016:84). Being visible and active in the community helps leaders voice their ideas to a wider audience. Being engaged in the community helps build connections and access to other community organizations and funding sources. Nancy has been an active member of her community for many years. She attends city council meetings and other community organization's meetings to make herself and her ideas known. This then helps gain support and aids for development of her projects. Because community leaders are working with open systems, they need to engage with other systems and groups. Community leaders bridge links between these other groups to fill identified gaps in their knowledge, skills and material resources. Leaders fill "structural holes" between their community and outside networks and these connections were used for public, not private, gain (Onyx 2011:504).

Community energy groups in Martiskainen's case studies relied on volunteers that brought a mix of skills and resources. The leaders of the group were able to identify and bring people with a variety of skills together to build a bank of useful skills for their project (2016:85). In Nancy's case, she did not have the technology skills needed to develop a website for Neighbors to Friends. Because of her presence in the community and the fact that she voiced her needs and goals to the community, someone offered to assist her in creating a website.

Community leaders also need to have an understanding of practical management processes to enable the project to move forward. Establishing basic procedures and creating a division of labor is necessary in order for a project to grow. This must be done with coordination and good communication between the participants (Onyx 2011:504). Nancy is organized and able to coordinate with many different people to fill all of the roles that Neighbors to Friends has in order to run smoothly.

Both Onyx and Martiskainen identified the need for leaders to have a plan for potential successors. No case in Martiskainen's study had a plan in place but this shows how grassroots innovations can be vulnerable if they solely rely on one person or a small group of people to see the project through. Nancy explained to me that if she ever steps away from her role, she wants the group to continue as if nothing ever happened. This shows the importance of the volunteers of Neighbors to Friends and how they are the driving force of the group while Nancy directs the vision.

Overall, in Neighbors to Friends there is no sign of a hierarchy or anyone relying on the dominance of the leader to command and control the organization. Volunteers share in the decision making and draw on the knowledge and ideas of many different kinds of people. There is no central controlling authority figure, but that does not mean that there is no leadership. Nancy nurtures the group and enables it but does not try to command. The group itself has the power and is the driving force of Neighbors to Friends, not one individual leader.

"Beloved community"

The term "beloved community," made popular by Dr. Martin Luther King Jr., was the single and organizing principle of King's life and thought. According to Kipton Jensen, the "beloved community" is a community ordered by love. It involves empathy for the oppressed and a dissatisfaction with all forms of injustice (2016:254). King believed that this kind of radical love is needed to break down the barriers that separate us from one another. Smith and Zepp state that King thought that this notion of a community would be the ideal expression of the Christian faith (1974). Human existence is social in nature, and King believed that all humans should be united as one. Because all humans are interconnected, an injustice to

one is an injustice to all. A community like that at Neighbors to Friends strives to connect those that have been divided by classism. It strives to unite neighbors and treat everyone with love, kindness and acceptance. Neighbors to Friends meets the basic human needs of those suffering in the community, but a community driven by love and acceptance is open and inviting and draws people together.

Conclusions

Through participating with and observing Neighbors to Friends, I have gained a holistic understanding of how they operate and argue that while this organization meets the basic physical needs of individuals experiencing homelessness and poverty, they serve a larger purpose of creating a “sense of community” between the individuals they serve, their volunteers, and community partners. By the definition of “sense of community,” the use of food in creating community, and grassroots leadership styles, I have shown that Neighbors to Friends brings people together to create a “beloved community.”

People experiencing homelessness and poverty are often ignored and excluded from the greater society. Neighbors to Friends sees these individuals as fully human and deserving to be treated as an equally valuable part of the community. This organization seeks to turn strangers into familiar faces and transform neighbors into friends. Neighbors to Friends has shown that giving love and compassion to those that have been left on the fringes of society can transform a divisive community into one that is welcoming and accepting to everyone.

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Laboratory Plasma Tests towards the Production of Simulated Supernova Shock Waves

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Abstract

Supernovae are some of the most powerful explosions that occur in our universe. These explosions generate massive shock waves that span tens of light years in distance. They are responsible for atomic fusion that creates the denser elements, needed for the creation of planets such as our own. The goal of this project was to simulate a supernova on a small scale, in order to study the resultant shock waves and their effects upon the interstellar medium. This research can improve understanding of the impact these events have upon the formation of solar systems and the composition of the interstellar medium itself. In order to simulate a supernova in the lab, two electrodes were fashioned from sputter-coated aluminum and affixed within a scientific vacuum chamber. The vacuum chamber was pumped down, then re-pressurized with helium or argon gas. A 13.56 MHz radio frequency plasma was sparked and maintained using a 120-Watt RF generator and matching network. Characteristic UV-Vis-NIR spectra for argon and helium were recorded as functions of pressure, power, and position in the chamber. An attempt was made to capture high speed images of shock waves during vaporization of a graphite rod in the plasma chamber, but was ultimately unsuccessful.

Introduction

Supernovae are phenomenally energetic events resulting from the death of a high mass star, or the nuclear detonation and complete destruction of a white dwarf within a binary system. The energy released in the well-studied Supernova 1987A was more than 10^{46} Joules; equivalent to the simultaneous explosion of about 10^{32} atomic bombs. Many elements are made by the process of nuclear fusion in the core of a star. As a star reaches the end of its lifetime its mass begins to flow into the core. When the star has exhausted its nuclear fuel and can no longer withstand its own gravitational force, the core collapses and results in a supernova explosion. This explosion sends shock waves outward into interstellar space, carrying heavier elements and debris with them. These elements take part in the formation of new stars, planets and more. By simulating these supernovae, albeit on a much smaller scale in the laboratory and well below the pressure and temperature required for nuclear fusion, we can nevertheless study how the shock waves travel through and impact the interstellar medium.

These cosmic explosions link both the death and birth of stars and planets.[1] A shock wave from a supernova explosion likely initiated the collapse of the cloud of gas and dust from which our Sun and the

Earth formed.[2] Based on this idea, shock waves can also change the chemical characteristics and morphology of dust that they encounter and seed it with trace elements.

Although the attempt to mimic a supernova at the laboratory scale may seem a bit limiting, the results can still explain observations on a much grander scale. During a supernova, large fluxes of high energy particles are emitted with energies dependent on the supernova shock wave itself. The finite lifetime and the curvature of the shock front are determining factors on the maximum allowable energy of emitted cosmic rays. The effects of these shock waves also affect the observations of interstellar space, where turbulence caused by supernova shocks can cause fluctuations in observed spectra.[3] Energy deposition, shock expansion rate, and the duration of the supernova event also have a large effect on the flow of matter within the supernova event. This flow of matter is profoundly important for astronomical observations long after the event has taken place. Large inhomogeneities in the expanding shell of debris from a supernova event are the result of this flow of matter and determine the composition of stars and planets that form from the material long after it has been ejected.[4] The heavy element abundances in the subsequent generation of stars can be used to determine the age of stellar bodies and how many generations of supernova events preceded their formation. The traces of past supernova events can even be seen in isotopic anomalies in meteorites within our own Solar System [2] Our work with RF discharge plasmas in a laboratory environment will provide key insight to what happens inside of a supernova event.

Radio frequency (RF) glow discharge plasmas have found frequent use in industrial and scientific lab environments due to their stability and utility. In an RF capacitive coupled plasma (CCP), an RF generator (AC in the diagram) delivers electromagnetic power to a load. [5] In our case, the load is a plasma tuned by a matching network MN, portrayed conceptually in Figure 1.

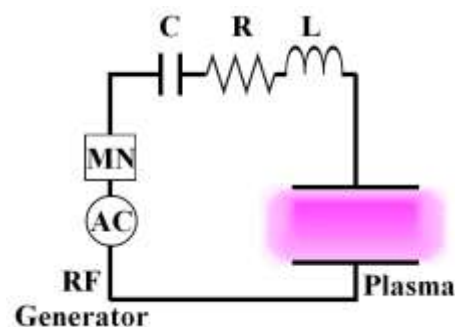


Figure 1: Conceptual Electrical Diagram for a Capacitive RF Plasma

The system is characterized by values of resistance R, inductance L, and capacitance C, which are endemic to the components (wiring, connectors, vacuum chamber), as well as to the state of the plasma and RF generator output. Tuning of impedance via capacitive adjustment within the matching network maximizes power delivery to and absorption by the plasma.

When a plasma is ignited from a gas, a significant number of gas particles are ionized. A plasma is quasi-neutral, meaning its composition includes roughly equal numbers of positive and negative charges. The plasma shields electrical information to about one Debye length, given by:

$$\Lambda_D = \sqrt{\frac{e_0 k_B T_e}{ne_c^2}}, \quad (1)$$

where ϵ_0 is the dielectric permittivity of free space, k_B is the Boltzman constant, T_e is the electron temperature, n is particle number density, and e_c is the electric charge constant [6(a)].

The mean free path of a particle in a gas describes the average distance the particle travels before colliding with another particle. Its value is given by [6(b),7]:

$$\Lambda = \frac{1}{n\sigma} = \frac{k_B T}{p \frac{\pi}{4} (d_1^2 + d_2^2)}, \quad (2)$$

where σ is the collision cross section, T is thermal temperature, p is pressure, and d_1 and d_2 are the effective diameters of the particles participating in the collision, under the assumption of spherical particles. This path length can influence the behavior of a plasma in a scientific vacuum chamber, in particular, determining whether the gas particles collide more with the wall (molecular flow) or with each other (collisional flow).

According to the Schrödinger equation, electrons in an atom can only exist at discrete energy states within an atom, which are dependent upon a set of quantum numbers [6]. These numbers include n (energy quantum number), m_l (magnetic quantum number), l (orbital angular momentum quantum number) and s (spin quantum number). A set of rules governs these fundamental quantum numbers, which are expressed in Table 1:

Table 1: Basic Rules Governing Quantum Numbers

| Quantum number | Description | Allowed values |
|----------------|--------------------------|-----------------------------|
| n | Energy | 1, 2, 3, ... |
| l | Orbital Angular Momentum | 0, 1, ..., $n-1$ |
| m_l | Magnetic | -1, -1+1, ..., 1-1, 1 |
| s | Spin | $-\frac{1}{2}, \frac{1}{2}$ |

In chemistry, values of l are assigned letters (s,p,d,...) that designate “subshells,” e.g., $l = 0$ (s), $l = 1$ (p), and $l = 2$ (d). These can be structured to express the electronic state of an atom; for example, atomic helium with 2 protons, has 2 electrons in the 1st shell, would have electronic state $1s^2$. Argon, with 18 protons, has complete electronic state: $1s^2 2s^2 2p^6 3s^2 3p^6$. Collisions with particles and exchange of photons can result in transitions of electrons between states, including those at higher energies.

Ionization energies are the energy values necessary to completely remove an electron from an atom or ion. These are important in setting threshold behaviors for plasma, and values for Argon and Helium are organized in Table 2 [9]:

Table 2: Ionization Energies of Argon and Helium [9]

| | Units | Argon | Helium |
|-----------------------------------|-------|------------|-------------|
| 1 st Ionization Energy | eV | 15.7596117 | 24.58738880 |
| 2 nd Ionization Energy | eV | 27.62967 | 54.4177650 |

Argon is characterized by a significantly lower energy first threshold to ionization compared to helium, and thus might be expected to be easier to ignite as a plasma. The values are stated to significant digits matching the precision currently accepted by NIST.

An electron moving from a higher energy state to a lower state within an atom or ion emits a photon with a precisely defined energy. Since frequency and energy of a photon are proportional, these photons have frequency values that are fundamentally determined by the set of quantum numbers of the source. This is the basis for optical spectroscopy. A characteristic and unique set of energy levels and emission lines exists for each element. We can use these emission lines to identify constituents of the plasma. The ten strongest spectral lines of argon and helium from 300-1000nm wavelength are collected in Table 3(a) and Table 3(b). [9]

Some past literature work also addressed spectroscopy of helium and argon plasmas.[10] Some studies included the practical step of calculating plasma temperature from spectroscopic data.[11] We have not yet completed this analysis on our own data as of the writing of the present work.

Table 3(a): Strong Lines of (a) Argon [9]

| Argon | | |
|-----------------|-----------|-------------|
| Wavelength [nm] | Intensity | Attribution |
| 750.4 | 600 | Ar I* |
| 763.5 | 700 | Ar I |
| 794.8 | 600 | Ar I |
| 800.6 | 600 | Ar I* |
| 801.5 | 700 | Ar I |
| 810.4 | 600 | Ar I* |
| 811.5 | 1000 | Ar I* |
| 842.5 | 600 | Ar I* |
| 912.3 | 1000 | Ar I* |
| 965.8 | 700 | Ar I |

Table 3(b): Strong Lines of Helium [9]

| Helium | | |
|-----------------|-----------|-------------|
| Wavelength [nm] | Intensity | Attribution |
| 301.4 | 40 | He I |
| 388.9 | 500 | He I* |
| 402.6 | 50 | He I |
| 447.1 | 200 | He I |
| 471.3 | 34 | He I |
| 501.6 | 100 | He I* |
| 587.6 | 870 | He I* |
| 667.8 | 200 | He I* |
| 706.5 | 180 | He I* |
| 728.1 | 50 | He I |

*These lines had the strongest intensity in our experimental observations

Other past efforts simulated a supernova explosion in the laboratory, include a simulation of the collision of shock waves with ring nebula material.[12]

One major objective of this set of experiments was to ignite a laser-driven detonation wave, or shock wave, within the plasma. To achieve such a detonation requires extremely concentrated energy per volume within a material. To produce such concentration with a laser in turn requires significant energy to be forced into a tiny space. The smallest achievable laser spot diameter is called the diffraction limited spot diameter, d , and it is given for a focused, Gaussian, stigmatic laser beam by:

$$d = \frac{2.44 f \lambda}{D} \quad (3)$$

where f is the focal length of the lens, λ is the laser wavelength, and D is the effective beam diameter focused onto the target by the lens [13].

Next, we will present the experimental equipment and methods used in this study.

Experiment and Methods

For the main experiment setup shown in Figure 2, two electrodes were fashioned from 6061 aluminum and each was plasma sputter coated (Quorum, SC7620) with gold-palladium alloy for 60 seconds on one face. Each electrode was held within a separately fashioned polyvinyl chloride insulating shield and supported by polycarbonate rods, then affixed within a scientific vacuum chamber of approximate volume 0.003 m^3 . The vacuum chamber was pumped down to approximately 0.8 Pa using a rotary vane pump (Ulvac Kiko, GLD136C).

Following evacuation, the chamber was re-pressurized with a test gas (argon or helium) to a specified pressure within a chosen range from 5-270 Pa, measured with a Pirani gauge (Kurt J. Lesker, 275i). A 13.56 MHz, 120-Watt radio frequency (RF) generator (T&C Power, AG 0113) and matching network (T&C Power, AIT-600-03) sparked and maintained a glow discharge RF plasma for the experiments. Plasma voltage and RF power reflection was monitored by the matching network.

For all parts of the experiments, plasma spectroscopy was performed using a UV-Vis-NIR spectrometer (Ocean Optics, Flame) using the setup shown in Figure 3, with irises and collimating optics used to restrict the field of view to a column within the plasma of about 1 cm diameter.

For the power tests, the power delivered to the plasma was incremented using the RF generator and matching network including specific settings at 1 W and 2 W, and incremental steps of power from 5-100 W using intervals of 5 W. A dark spectrum (room lights and plasma off) was subtracted from each measurement. An integration time of 100 ms was used, with each spectrum comprising an average of 11 scans, with spectral binning using a size 3 boxcar window.

For the laser ignition tests, a pulsed Nd:YAG laser (Continuum, YG-660) delivered 1064nm wavelength, 0.1 J per pulse into the plasma by directing the beam from a series of mirrors and finally into the vacuum chamber through a lens. For a secondary part of this effort, a graphite rod was inserted into the chamber at the focus of the laser beam and ablated.

Results

The experimental results are divided between three main areas: first, a test of dependence upon power, a second test probing the spatial distribution of temperature in the plasma, and third, a test to attempt to ignite the plasma using laser energy deposition. Finally, we will report details of an unsuccessful attempt to capture images of shock waves during vaporization of a graphite rod.

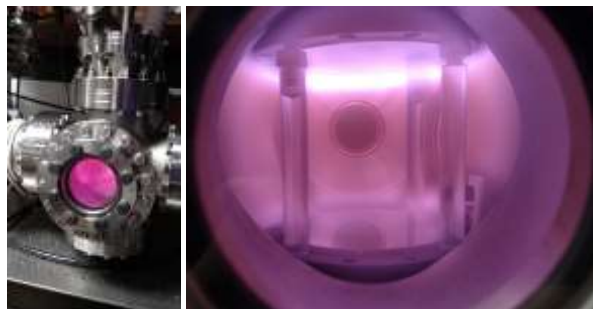


Figure 2: General Experiment Setup



Figure 3: Spectroscopy Experiment Setup

I. Power Tests

In this series of tests, argon or helium was added to the chamber continuously with the roughing pump running, to maintain the pressure at $80. \pm 1$ Pa. Meanwhile, the RF forward power to chamber was adjusted from 1-100. W. At each power setting (1 W, 2 W, and 5-100. W in 5 W intervals), the plasma voltage was noted and a set of three UV-Vis-NIR spectra recorded. Whereas helium plasma was produced across the entire range of power settings, argon could only be ignited above 2 W. This lower limit in power to produce an argon plasma was observed in other plasma physics studies and was attributed to argon exhibiting higher resistance than helium.[7] Three-measurement averages for plasma voltage are shown as a function of power in Figure 4.

Following the ignition of plasma, spectra of RF-sustained helium and argon plasmas were measured by UV-Vis-NIR spectroscopy. The line spectra of the two gases are of course distinct. The measurements are presented in Figure 5.

Noting the broader peaks common to both plots, there is clearly a significant background, which we believe may arise from one or more of four possible sources: (1) hydrogen and/or oil contamination in the chamber from the rough vacuum pump, (2) chlorine outgassing from the PVC insulating shields, (3) air (nitrogen/oxygen) leak in the gas line, or (4) sputtering of aluminum from the electrodes. Regardless of the source of the background features, each spectrum includes several lines that are clearly present for one gas and not the other, and these generally align with expected strong lines of argon or helium.

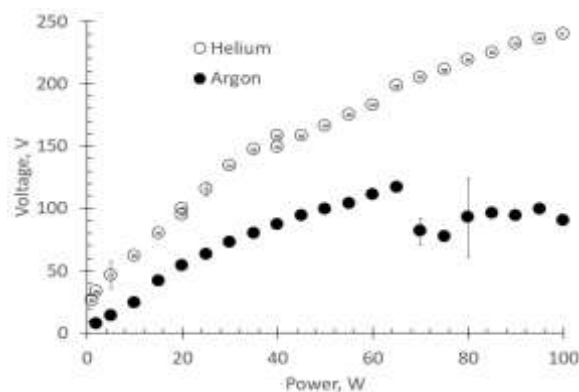


Figure 4: Plasma voltage as a function of RF power

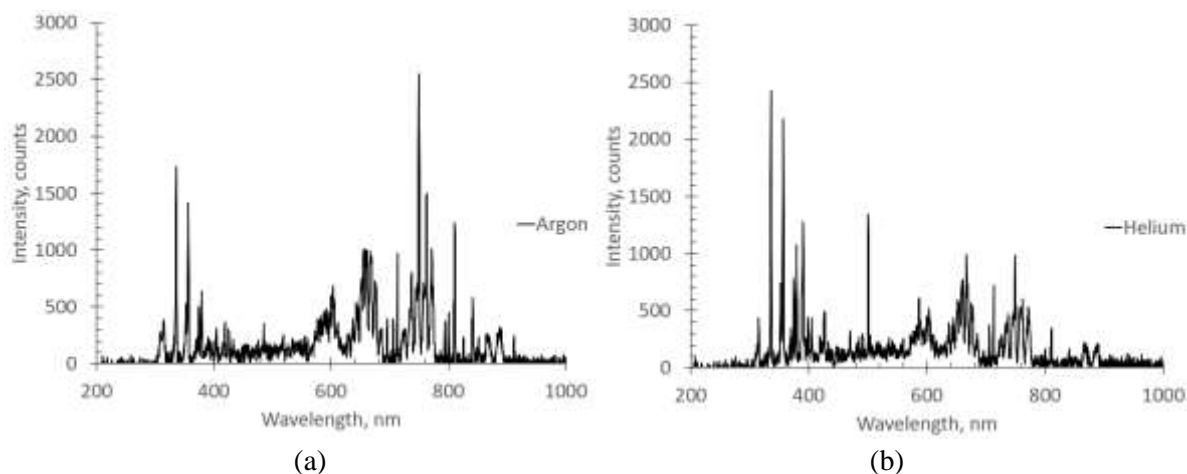


Figure 5: Experimental (a) argon and (b) helium spectra

For helium, the 501 nm line was particularly visible, and deemed to be of analytical importance. Its intensity dependence upon power is illustrated in Figure 6(a).

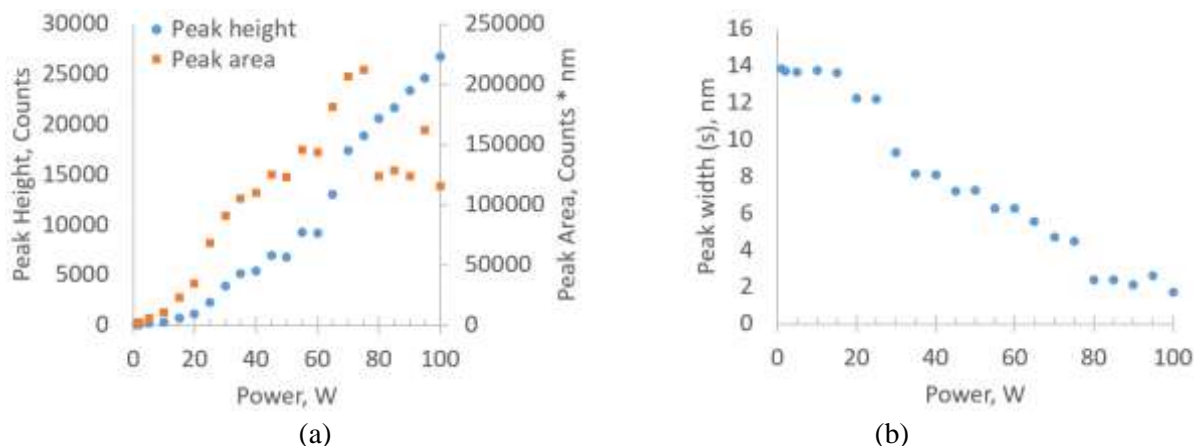


Figure 6: Helium 501nm line spectral output with power: (a) Peak height and area, (b) Peak width

As demonstrated in Fig. 6(a), the data seem to evince a power law increase in peak height up to about 75 W, which was followed by an approximately linear increase to 100 W. Over the entire range, peak width decreases approximately linearly with increasing RF power, as shown in Fig. 6(b).

II. Pressure Tests

In this series of experiments, the pressure in the chamber was varied from 5-270 Pa for argon or helium flowing through the system, with a constant forward power setting of 20. W, and with the vacuum pump running. At each pressure, plasma voltage was recorded, and three UV-Vis-NIR spectra were collected and averaged. Results are shown in Figure 7(a) for argon and 7(b) for helium.

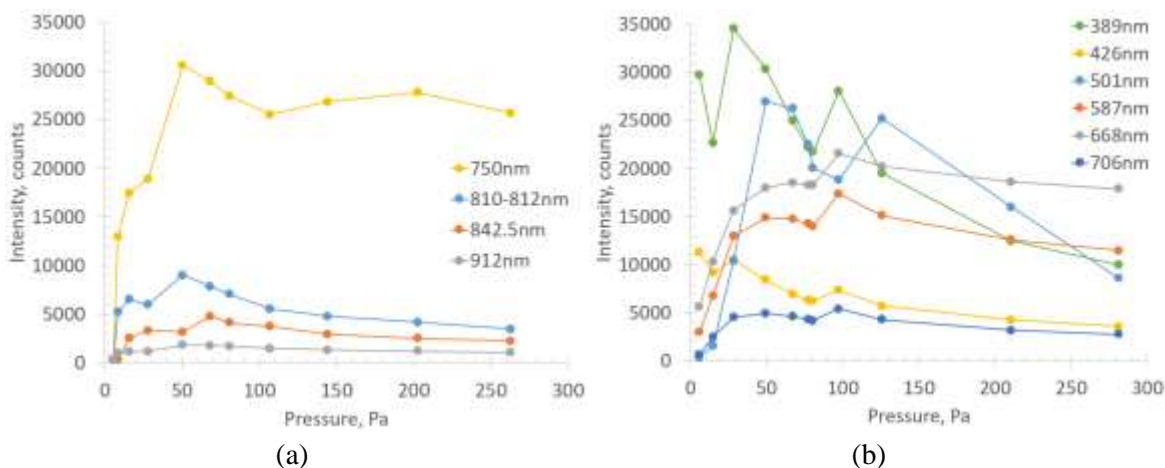


Figure 7: Spectral intensity of strong lines with increasing pressure: (a) argon, (b) helium. The lines connecting data points are for clarity in identification, and are not intended to indicate trend lines.

In general, the intensity of the lines in both plots rapidly rises as pressure increases from our system baseline of around 40 mTorr (5 Pa) up to a few hundred mTorr, then slowly falls off as the pressure is further increased. It may be noted that our RF device failed to ignite argon above 2 Torr (270 Pa). This is likely due to collisional interference in the RF electron acceleration mechanism, in conjunction with decreasing mean free path as pressure increases. The interesting exceptions to the general behavior are the

357nm and 389nm lines for helium, which seemed only to decrease in intensity with increasing pressure. The existence of the observed helium lines points to significant population of various energy states around 23 eV, which it may be noted is quite close to the ionization energy for helium.

III. Vertical Translation Test

In this experiment, the vertical position of the UV-Vis-NIR spectrometer was adjusted in steps of 11 mm. The spectrometer input was carefully tuned using a set of irises and lenses to permit entry of light from a region of only around 11 mm diameter. This repositioning allowed creation of a vertical map of spectral output within the plasma by taking successive vertical steps of 11 mm, which is shown in Figure 8(a); the plasma in the chamber is shown in Figure 8(b).

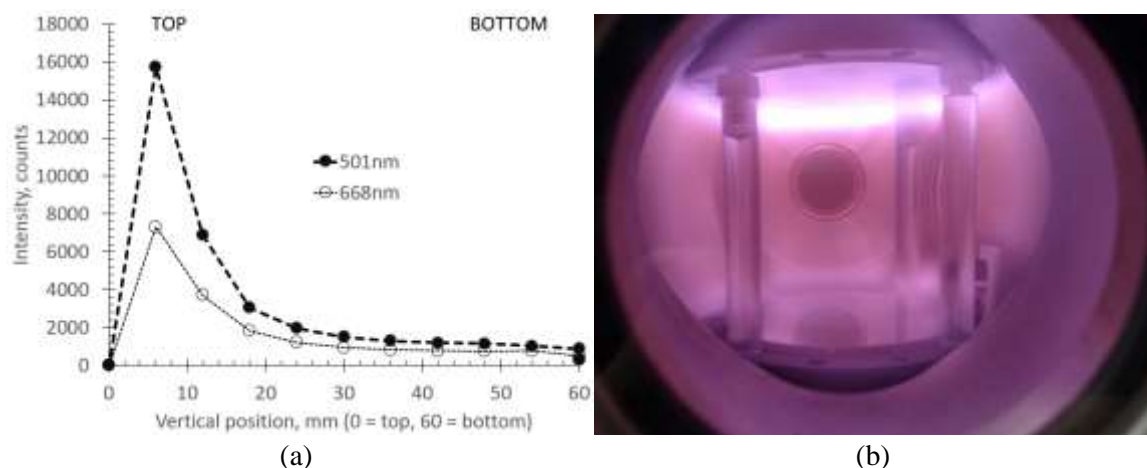


Figure 8: Plasma emission between the electrodes: (a) plotted emission intensity for 501nm, 668nm helium lines; (b) corresponding digital photograph of visible light output for the same plasma.

Because the lines are strongest closest to the top electrode (at left in the plot in Fig. 8(a)), the results support the idea that most of the RF energy is deposited near the top electrode. This idea is also borne out by visual inspection of the plasma in the chamber as in Fig. 8(b), since a brighter glowing area can be distinguished adjacent to the top electrode.

IV. Graphite-Triggered Laser Vaporization Test

This aspect of the experimental work did not produce the desired result; namely, deposition of laser energy directly into the plasma did not initiate a laser spark. However, in further review of the literature, it appears that this result is consistent with expectation since the threshold to ignite a plasma from the diffuse gas is significantly higher than our laser can produce. As an effort to bypass this difficulty, a graphite rod of 0.5 mm diameter was inserted into the experimental chamber so that its position coincided with the laser focus, with the idea that vaporization of the rod would lower the threshold to spark a plasma. Results from this test are displayed in Figure 9, including a high-speed image of the ablation event, and 2D and 3D diagrams of the optical profilometry of the aftermath.

Although material was certainly vaporized from the rod, the amount of material removed strongly suggests that our laser intensity is too low to generate strong shock waves. Theoretically, in order to

vaporize carbon, at least the bare minimum of energy must be supplied to heat the material to its vaporization point. In practice, for rapid surface heating, the latent heat of vaporization is generally much greater than the energy needed to heat or melt the material. Thus, the threshold laser energy per area for vaporization to occur can be estimated as:

$$F_{th} = 2L_v \sqrt{\frac{\rho \kappa \tau}{c}}, \quad (4)$$

where L_v is the latent heat of vaporization (sublimation enthalpy), ρ is density, κ is the thermal conductivity, τ is laser pulse duration, and c is the specific heat of the material.[14]

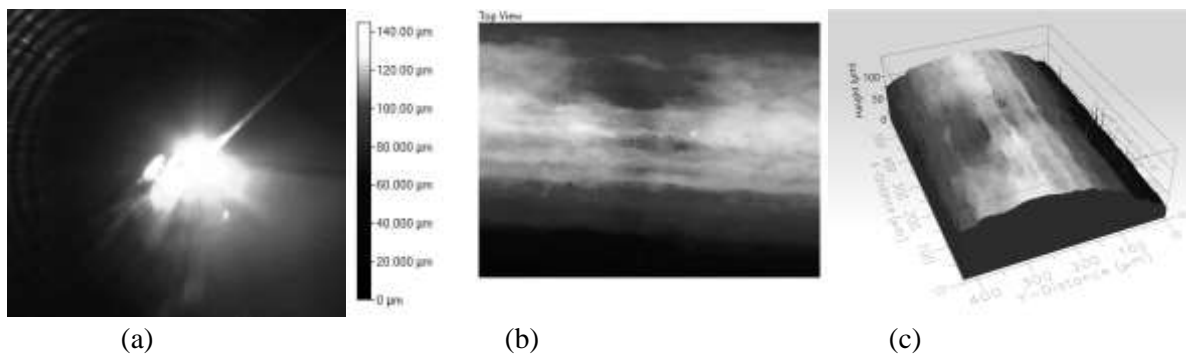


Figure 9: Laser vaporization of carbon rod: (a) high-speed camera image of laser vaporizing carbon, (b) WLI optical profilometry 2D view, (c) WLI optical profilometry 3D view

For graphitic carbon, literature data with associated uncertainties [15(a),15(b),15(c),16] are shown in Table 4.

Table 4: Thermophysical Literature Data for Carbon

| Parameter | T_v | ρ | κ | c | L_v |
|-----------|---------------|-------------------|--------------|-------------|-----------------------------|
| Units | K | kg/m ³ | W/(m K) | J/(kg K) | J/kg |
| Value | 3640 ± 25 | 2100 ± 200 | 140 ± 10 | 715 ± 4 | $(6.9 \pm 0.2) \times 10^7$ |
| Source | [15(a)] | [15(a)] | [15(b)] | [15(c)] | [16] |

Based on the data in Table 4, the threshold would be predicted to lie around $2650 \pm 230 \text{ J/cm}^2$, which is near the upper end of our presently achievable fluence using our laboratory's Nd:YAG laser focused to the smallest possible spot area, following equation (3) and accounting for reasonable beam losses before the beam reaches the target. Although limited vaporization of the graphite certainly is achievable, very little energy remains above that threshold to energize a plasma from the vapor, and so it is not surprising that no shock waves were observed. To overcome this obstacle, future experiments could make use of a different plasma seeding material with a much lower vaporization threshold, or use a laser with significantly higher pulse energy or significantly shorter laser pulse duration.

V. Future Work

Regarding future work, dust with a chemical composition similar to interstellar dust (e.g., coronene and silicon carbide) will be introduced into the plasma and a pulsed Nd:YAG laser will be used to spark a detonation. Shock wave pressure will be measured using a piezoelectric pressure sensor. A high-speed camera will record shock wave motion, at up to 200,000 frames per second, via schlieren imaging. The chemical composition and physical conformation of the dust particles will be measured before and after the test, using a scanning electron microscope, to determine if the explosion affected the size or composition of the particles.

Conclusions

This work reports the creation and initial testing of a radio frequency (RF) plasma chamber. A pair of aluminum electrodes were machined and connected to an RF source within a vacuum chamber to form capacitive RF plasmas. Spectroscopic data from 300-1000 nm, roughly consistent with literature spectra, were collected for argon and helium plasmas while the pressure of the chamber was varied from 5-270 Pa and power delivered to the plasma was varied from 1-100 W. Separately, the vertical position of the spectrometer was varied across the capacitive distance of 11 cm as a first step to collection information about the plasma temperature between the electrodes. Finally, a carbon rod was used in an unsuccessful attempt to initiate shock waves within the plasma.

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Acknowledgments

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The Minnesota State Undergraduate Scholars Consortium

The Minnesota Undergraduate Scholars Consortium is a collaboration between faculty and staff across the Minnesota State Colleges and Universities system to support research, scholarly works and creative activity of undergraduate students. The consortium principally organizes and supports the Posters in St. Paul event in the Minnesota state capitol which brings exceptional student posters highlighting research work across the state system into view of legislators, as well as the prestigious annual Minnesota State Conference on Undergraduate and Scholarly Activity, the location of which regularly moves from school to school.

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This is a welcoming consortium. All faculty and staff who support undergraduate student research are highly encouraged to get involved, and all students in the Minnesota State Colleges and Universities System are welcome to submit their research, scholarly or creative works to the state conference. To get involved, please contact one of the campus representatives above.

