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LETTER from the EDITOR

“
Research is formalized curiosity. It is poking and prying with a purpose.
–Zora Neale Hurston”

I am incredibly honored to introduce this year's edition of *Ergo*. I have thoroughly enjoyed working on this journal with my wonderful team; John Cavitt, Erin Kendall, our graphic designer Michaela Funtanilla, and my Assistant Editor Marisa Neil. Without this excellent team behind me, this journal would not have been possible.

Each of these articles contribute something to their field of research, or introduce entirely new information. May these papers inspire you to conduct research and engage within your discipline by sharing knowledge.

It is my hope that this journal will inspire you and spark your curiosity.



Megan Burton

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Call-to-Action Invitations Which Effectively Increase Total Subscribers on YouTube

Author: MATTHEW HAVERTZ

Mentor: DREW TYLER

COMMUNICATIONS

ABSTRACT

Many people are turning to YouTube for a source of entertainment and information. YouTube provides anyone with internet access a chance to share videos with the world. YouTube users can solicit viewers to subscribe to their channel to increase the reach of their videos. A series of YouTube videos were created with different call-to-action invitations to solicit channel subscriptions. The results were analyzed using YouTube Analytics. A simple call to action at the end of the video was the most effective method for gaining new subscribers. Using a call-to-action invitation worked better than not using a call-to-action invitation. The results were analyzed under the lens of the Elaboration Likelihood Model developed by R. Petty and J. Cacioppo; using the central route of persuasion (asking for YouTube subscribers via call-to-action solicitation) is more effective than using the peripheral route.

INTRODUCTION

Online media sources are growing and traditional media sources, such as traditional television, are declining in popularity. In a 2016 study commissioned by Google, a 2,940-responder survey executed by comScore showed millennials preferred YouTube to traditional television (Heltai, 2016). The research in this paper focusses on what methods YouTube video creators can use to effectively increase their total number of channel subscribers. The results showed using a call-to-action technique (asking for YouTube subscribers) is more effective than not using a call-to-action technique. Furthermore, a simple call-to-action at the end of a video gained the largest number of new YouTube subscribers.

Many YouTube videos end with a call to action. For example, in a video called *Sun VS. Atomic Bomb*, Hank Green ends his video by saying, "If you want to have more of this, you can subscribe at [YouTube.com/SciShow](https://www.youtube.com/SciShow)" (Green, 2012). Using a call-to-action technique at the end of a video appears to be the most commonly used method employed on YouTube. There are billions of videos on YouTube and the scope of this research did not include obtaining a truly random and representative sample; however, based on research observations, this method seemed successful. The purpose of this research was to test call-to-action methods with originally-produced YouTube videos. The conjecture was the most effective method for gaining subscribers would be a simple call to action near the end of the video. This indeed proved to be the most effective method tested.

This phenomenon can be explained in part by R. Petty and J. Cacioppo's Elaboration Likelihood Model (Petty & Wegener, 1999). Petty and Cacioppo developed a model which explained persuasion. They propose communicating a persuasive message through the central route (via candor elaboration) is more likely to produce strong attitude changes than going through the peripheral route (via mental shortcuts) (Petty & Wegener, 1999).

LITERATURE REVIEW

The prime subject of this research is YouTube videos and audience interaction with those videos. According to the company's website, "Youtube allows billions of people to discover, watch and share originally-created videos" (About YouTube, 2016). YouTube includes videos on virtually every subject, most of which are created by amateur videographers; furthermore, many businesses, companies, government agencies, universities, and non-profit organizations maintain YouTube channels (Kim, 2012). In her doctoral dissertation, Jin Kim stated, "Merging different media in hybrid genres, YouTube.com is an online video storehouse" (Kim, 2012).

A YouTube channel is a homepage for a content creator's videos. YouTube video creators look for subscribers to their YouTube channel because gaining more YouTube subscribers will gain them more views per video. When someone logs into YouTube, the website features videos from the channels the person has subscribed to. A subscriber can also sign up for email notifications from a YouTube channel (About YouTube, 2016).

R. Petty and J. Cacioppo developed a model called the Elaboration Likelihood Model. According to these researchers, there are two routes two for a message to be processed: the central route and the peripheral route. The central route involves elaboration or "the extent to which a person carefully thinks about issue-relevant arguments" (Petty & Cacioppo, 1986). The central route requires cognitive processing. The peripheral relies on cues and context from the communicator. This requires little or no conscious thought (Petty & Cacioppo, 1986). In his book *A First Look at Communication Theory*, E. A. Griffin wrote, "The peripheral route offers a mental shortcut path to accepting or rejecting a message" (Griffin, 2012).

Petty and Cacioppo identified six methods for pushing a message through the peripheral route: Reciprocation (quid pro quo), consistency (routine or tradition), social proof (peer or social pressure), liking (attractiveness of the communicator), authority (credibility of the communicator), and scarcity (shortage or availability or resources). Please note, most messages are not purely categorized as peripheral or central (Petty & Cacioppo, 1986). As Griffin points out, "Most messages receive middle-ground attention between these poles" (Griffin, 2012). YouTube call-to-action techniques fall in this "middle ground."

The six methods for peripheral persuasion are often used by YouTube channel hosts. For example, a YouTube channel with many subscribers (social proof), may gain increased subscribers based solely on this fact. A viewer may subscribe to a YouTube channel based on the likability or authority of the host or video content, etc. YouTube videos with a call to action use the central route to attempt to gain new subscribers by setting forth a stated argument on why a viewer should subscribe. Some may argue a YouTube channel host who does not ask for channel subscribers is not attempting to use any route of persuasion (central or peripheral); however, YouTube provides the option for a viewer to subscribe to a channel alongside every video on the site. All YouTube video creators would benefit from new subscribers and most video creators seek for new subscribers whether they expressly state it or not. Those YouTube videos which do not contain a call to action are still engaged in the peripheral route. The Elaboration Likelihood Model can be used to explain why certain call-to-action techniques work for gaining new subscribers and will be discussed more in the conclusion.

METHODOLOGY

Martha Hunt, a seamstress from Kaysville, acted as a YouTube channel host and instructor in an original video series. The videos were filmed on Saturdays for several months. Four videos were released in October one week apart from each other (the exact dates are in a table to follow). At the same time the videos were being released, Facebook advertisements for the videos were running to obtain a larger audience. Advertising money was dispersed evenly throughout the month to avoid creating any variable which increased the views of one particular video.

Three methods for soliciting YouTube subscribers were used in this study:

1. A call to action at the end of the video
2. A call to action at the beginning of the video
3. An incentivized call to action at the beginning of the video

In addition to these three techniques, a control video was used. This video had no call to action. The control video was used to test the most peripheral route of persuasion. The incentivized call to action offered the viewer an award for subscribing. It was then explained that all subscribers would be entered into a contest ending on November 6, 2016. The winner of the contest won a free online sewing consolation session with Martha Hunt via online video chat. An incentivized call to action was not used at the end of any video because Martha Hunt did not have the time available to do more than one sewing consolation and a different type of incentive would not have been comparable to the first.

Data was collected from YouTube Analytics (Analytics Overview: Martha Hunt, 2016). The results are biased towards those interested in dress alteration because the data was collected from the viewers of these videos only. For example, there were about twice as many female viewers as male viewers. It is also interesting to note that only a slight majority of viewers (51.9%) were millennial-age or younger (Analytics Overview: Martha Hunt, 2016). As mentioned earlier, research commissioned by Google in 2016 demonstrated that millennials prefer YouTube to television (Heltai, 2016). Nearly half of the viewers of the sewing videos in this research were above millennial age (30% between the ages of 55 and 64); this is probably due to the demographics of those seeking to alter special occasion dresses.

Another limitation to this research is that the content of each video differs in the following ways: Popularity, duration, and average watch time. This could have swayed the results. For example, the video about adding sleeves to a dress was the most popular in terms of number of views and had the potential to obtain more subscribers as a result. There may be more people going on YouTube to look up how to add sleeves to a dress than there are looking to hem a dress, etc. The video adding shoulders to a dress had the longest average watch time (on average, the viewers watched a little over four minutes before stopping), but it had the lowest number of total views.

Also, the first video about hemming was available publicly for the longest amount of time. To accommodate, the number of subscribers gained on a particular video was only counted the week after the video was released. Finally, the time of year and holidays could have affected the results (the last video was released on Halloween).

RESEARCH RESULTS

The method which gained the most subscribers was a call to action at the video end of the video. The control video gained no new subscribers. The call-to-action at the beginning of a video gained one new subscriber. The call-to-action at the end of the video gained two new subscribers. The incentivized call-to-action at the beginning of the video gained one new subscriber. The average watch time of all of the videos was less than the total video time; however, that does not mean that everyone who watched the videos refused to watch to the end.

CONCLUSIONS

The Elaboration and Likelihood Model explains why asking for subscribers in a straight-forward manner is more successful than implying the viewer should subscribe. Using a call to action (as opposed to no call to action)—in other words, going through the central route—is more effective than purely going through the peripheral route. Every

video which asked for subscribers bluntly gained at least some number of new subscribers. However, using the central route at the end of the video is more likely to gain new subscribers than going through the central route at the beginning of the video. Call to actions at the beginning of videos (whether incentivized or not) appear not to be as effective because viewers may be annoyed with a request before starting the video. Although this request is expressly stated and goes through the central route, the viewer has not had a chance to process very many peripheral cues (likability, authority, social proof, etc.).

Every video, including those going through the central route, used the peripheral route to gain new subscribers as well. For example, the liking and authority are employed in all videos by the video host as well as the video content itself. Social proof is also provided on every video because YouTube shows its users how many subscribers each channel has by default. However, consistency is employed by using a call to action in more than just one video. Scarcity is only used when the YouTube channel offers a contest or reward that will expire by a certain date or because of lack of resources. The incentivized call-to-action technique used scarcity.

Further tests with larger sample sizes need to be completed. Statistical correlation cannot be proven with the data because the sample size is not large enough for a sound statistical analysis. The results should not be received as applicable to all YouTube channels.

SUGGESTIONS FOR FUTURE RESEARCH

Future researchers should attempt to remove all unrelated variables wherever possible. As discussed earlier, popularity, duration, average watch time, holidays, and time of year could have affected the results. This could be avoided by releasing the same video with different types of call-to-action techniques on many different channels. This could also be accomplished by testing the same video with different call-to-action techniques on the same channel for a small duration of time and then immediately removing the video before releasing it again at a different time of the year.

Future researchers should also attempt to obtain a larger sample size. The best method for obtaining a larger sample size is to gain a larger pool of participating YouTube channels. Different YouTube channels have different audiences with different demographics. A collaboration between YouTube and Google would greatly increase the opportunity to obtain a large representative sample of YouTube channels. YouTube may also be able to help provide data on the number of YouTube channels currently engaged in using call-to-action techniques and which call-to-action techniques are currently being used. More funds may need to be allocated to incentivizing YouTube content creators to participate.

Finally, future researchers may consider testing different aspects of the Elaboration Likelihood Model. For example, comparisons could be made between YouTube channel

hosts' likeability and credibility and their abilities to gain new YouTube subscribers. Also, if a YouTube channel host was too explain why the channel is seeking more YouTube subscribers (an even more persuasive central-route method), a future researcher could test how that would affect the number of subscribers as well (Petty & Wegener, 1999).

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TABLES

| Video title | Call-to-action technique | Release dates |
|-----------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|------------------|
| How to Hem a Prom Dress https://youtu.be/OTkfps-8GdR0 | Control (no call to action used) | October 10, 2016 |
| How to Add Shoulders to a Prom Dress https://youtu.be/6Cx-7mpvmUpE | A call to action at the beginning of the video | October 17, 2016 |
| Adding Ruching to a Dress (How to Ruche) https://youtu.be/wU1ds-bl3txA | A call to action at the end of the video | October 24, 2016 |
| How to Add Sleeves to a Prom Dress https://youtu.be/mFIK2C-tRn_o | An incentivized call to action at the beginning of the video | October 31, 2016 |

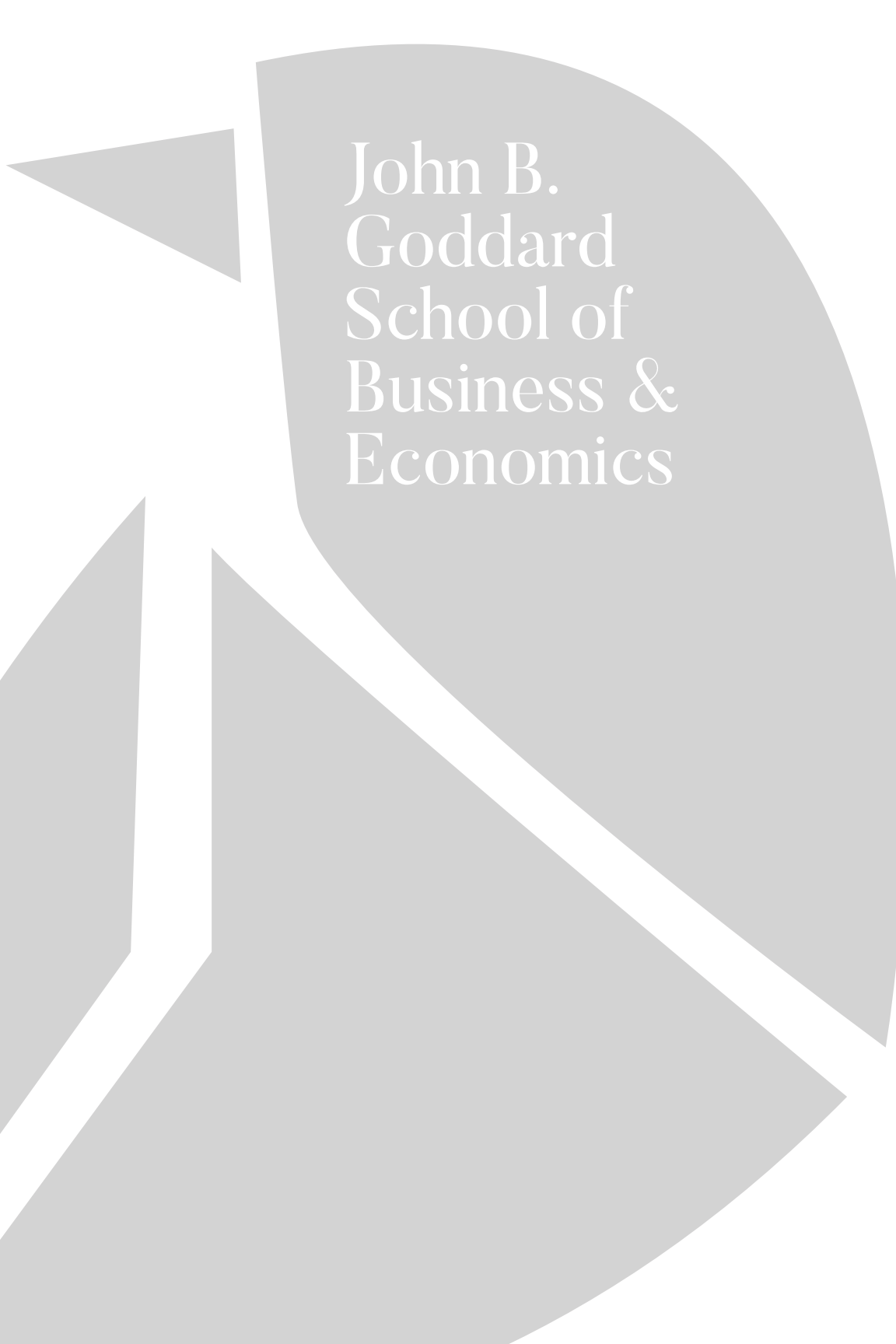
This table contains audience data from YouTube (Analytics Overview: Martha Hunt):

| Category | Data |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Gender | 66.3% female 33.7 % male |
| Location | 79.9% United States (country of origin) |
| Age | 4.9% between 13-17 years 29% between 18-24 years 18% between 25-34 years 11% between 35-44 years 6.1% between 45-54 years 30% between 55-64 years 0.6% between 65+ years |

A table showing the peripheral route method used by each video.

| Video title | Peripheral route type | Subscribers |
|------------------------------------------|--------------------------------------------------------|-------------|
| How to Hem a Prom Dress | Authority, liking, social proof | 0 |
| How to Add Shoulders to a Prom Dress | Authority, liking, social proof, consistency | 1 |
| Adding Ruching to a Dress (How to Ruche) | Authority, liking, social proof, consistency | 2 |
| How to Add Sleeves to a Prom Dress | Scarcity, authority, liking, social proof, consistency | 1 |

| Video title | Total video time | Average watch time | Number of views |
|------------------------------------------|------------------|--------------------|-----------------|
| How to Hem a Prom Dress | 10:54 minutes | 2:35 minutes | 62 |
| How to Add Shoulders to a Prom Dress | 10:54 minutes | 4:11 minutes | 44 |
| Adding Ruching to a Dress (How to Ruche) | 2:40 minutes | 1:25 minutes | 54 |
| How to Add Sleeves to a Prom Dress | 6:37 minutes | 1:59 minutes | 86 |



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Telecommunications and Microfinance Markets

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Mentor: THERESE GRIJALVA

ECONOMICS

ABSTRACT

This study examines how improvements in telecommunications may improve microfinance activity in lesser-developed countries. Using country-level data from the World Bank, International Monetary Fund, Microfinance Exchange, and the Heritage Foundation, I regress microfinance capital flows and lending interest rates on per capita mobile cellular subscriptions, while controlling for other variables. An ordinary least squares regression shows that an increase of 100 mobile cellular subscription correlates with an increase of \$1800 in microfinance capital flows, and a 0.03% decrease in the lending interest rate. These findings contribute to the debate over the importance of telecommunication technology development and financial markets.

INTRODUCTION

The purpose of this study is to examine how improvements in telecommunications may improve microfinance (MF) opportunities in lesser-developed countries. The number of mobile cellular subscriptions (MCS) are used as an indicator of telecommunications. MF provides small loans for people in the developing world who hope to start their own business. Typically, microfinance loans have relatively low transaction fees as compared to other loans. Gaining access to MF services is challenging when the services are only available in cities, often significant distances from villages, that have no banking services. Mobile technology can help facilitate MF transactions. People in the developing world can get access to financial services with their mobile phones such as mobile money or mobile pocket. For instance, Alleman and Rappoport (2010) studied the relationship between mobile money and the MF market using data from ITU (International Telecommunication Union), and found that telecommunication technology positively influences the MF market.

The mobile phone industry has developed rapidly in recent years. Data show that mobile phones are relatively inexpensive in poor countries. According to Perlman (2010) and Grameen Foundation (undated), mobile phones are omnipresent and more widespread than fixed lines in developing countries. Advances in telecommunications have been made possible through the global system for mobile communication (GSM) and the code division multiple access (CDMA) network (Hamid, 2011). Improvements in the dissemination of information makes it convenient for people to participate in financial and banking markets, and increase financial knowledge (Dhond 1993; Hamid 2011). For instance Alleman and Pappoport (2010) state that mobile payment systems reduce banking transaction fees, thus making MF services more practical (e.g. see Sengupta and

Aubuchon 2008). Brau and Wokker (2004) find a positive relationship between MCS and economic growth.

Another benefit of MCS is that it provides customers information about interest rates. When people do not have access to information or the ability to compare rates based on different lending conditions, banks have market power and can charge high interest rates. Mobile technology should enable potential borrowers to price compare, which would lead to lower interest rates. For instance, Jasna and Boris (2008) studied the Serbian banking system and found that competition reduces lending interest rates. However, information only lowers interest rates if there are many banking options, and consumers are mobile and able to price compare. Dhond (1993) shows that the increase in foreign banks and trade openness in developing countries will increase industry competition, and put downward pressure on lending interest rates. Dhond further illustrates that the advantages of competition are improved through improvements in the dissemination of financial information; thus, mobile technology is an avenue for greater competition.

THEORY

According to transaction cost theory, all costs associated with engaging in an economic activity (e.g., search, information, and bargaining) will be inversely related with the level of economic activity. It is believed that advancements in telecommunications will lower transaction costs for economic exchanges including MF activity (Alleman, and Rappoport 2010). Essentially, mobile technology enhances market information and provides a virtual stage for clients and MF institutions to negotiate contracts through cellular networks. According to the theory of perfect competition, market liberalization will increase competition and lower interest rates (Dimitrijevic 2005). A perfect market means that information is transparent, capital can flow freely, and that there are many buyers and sellers, so that not one side in the market can affect the market price individually. In an imperfect market, big banks have market power to set high lending interest rates. Thus, the development of telecommunication technology can increase the transparency of the credit market, and borrowers can easily compare the lending interest rate among different banks through cellular technology.

DATA AND METHODS

Data for this study are collected from the International Monetary Fund (IMF), World Bank, Microfinance Information Exchange (MFIE), and the Heritage Foundation. The data and sources are presented in Table 1. Data are collected for over 200 countries for the year 2013; however, the number of commercial bank branches was only available for 2012, so 2012 data was used. Many indicators were not available for all countries.

The primary dependent variable is a measure of MF capital flows. In this study, I use MFIE data on MF loans per borrower. The MFIE does not provide data for all countries (e.g., excludes most of North America and Western Europe), resulting in 72 country-level observations. Loan figures are normalized into U.S. dollars.

The other dependent variable is an average of country-level lending interest rates, provided by the IMF. Since a variety of interest rates exists, the IMF analyzes lending interest rates and identifies a representative interest rate. Lending rate data is available for 92 countries. In this study the focus variable is MCS. The data on MCS per 100 people was collected from the World Bank. MCS are subscriptions to a public mobile phone service using cellular technology. This data includes both post-paid and prepaid subscriptions. Furthermore, the data on fixed-line broadband Internet subscriptions per 100 people was also collected. Fixed-line broadband is the broadband that requires a digital subscriber line, cable modem, or other high-speed wire-required telecommunication technology. Figures 1A and 1B show scatterplots of the relationships between MF loans per borrower (MICROFLOANS) and MCS, and the lending rate (LENDINGRATE) and MCS, respectively. A notable downward trend exists between the LENDINGRATE and MCS.

According to the literature, additional variables explain financial markets including the unemployment rate, income, the inflation rate, and an index of economic freedom. The inflation rate is defined as the GDP deflator. The income data is defined as Gross National Income (GNI) minus consumption of natural resources and fixed capital assets. The Index of Economic Freedom, created by the Heritage Foundation, is based on 10 indicators of freedom: property rights, freedom from corruption, government spending, and fiscal, business, labor, monetary, trade, investment, and financial freedom. A higher score indicates greater freedom. Lastly, the sophistication of financial or banking infrastructures is an important indicator when measuring the economic condition of a certain country. In this study, the data on the number of commercial bank branches per 100,000 adults was obtained from the World Bank.

ECONOMETRIC MODELS AND RESULT

An Ordinary Least Squares (OLS) regression was used to examine the relationship between microfinance capital flows (MICROFLOANS) and MCS, and the lending interest rate (LENDINGRATE) and MCS.

The OLS regression can be represented by the model below:

$$y = x\mu + \varepsilon$$

y represents either dependent variable, MICROFLOANS or LENDINGRATE, x represents a vector of explanatory variables including FREEDOM, BORROWERS, MICROFBANK, LENDINGRATE, MCS, FIXEDLINES, INFLATION, UNEMP, FEMALE, CAP, POP, COMBANK and INCOME, μ represents a vector of estimated coefficients, and ε represents the unobserved error in a model. In addition, MCS was interacted with FIXEDLINES to determine if the effect of MCS is different based on the number of fixed lines.

Table 2 represents the OLS results. The adjusted R² for Models 1 (MICROFLOANS) and 2 (LENDINGRATE) are 38.38% and 28.42%, respectively. Also, the F-test hypothesis that all coefficients are equal to zero has a significant value, which means the null hypothesis

esis is rejected and at least one significantly meaningful variable was found in this model. Referring to Model 1, the effect of MCS on MICROFLOANS is found by partially differentiating MICROFLOANS with respect to MCS:

$$\partial \text{MICROFLOANS} / \partial \text{MCS} = -354 + 194.4 ((\text{FIXEDLINES})^{\wedge}),$$

where $(\text{FIXEDLINES})^{\wedge}$ represents average FIXEDLINES. The result shows that, given the average of FIXEDLINES, an increase of mobile cellular subscription per 100 people will increase the microfinance capital flow by \$1800.27. MICROFLOANS is negatively related to FIXEDLINES and INCOME.

In Model 2, the effect of MCS on LENDINGRATE is found by partially differentiating LENDINGRATE with respect to MCS:

$$\partial \text{LENDINGRATE} / \partial \text{MCS} = -0.0885 + 0.00522 ((\text{FIXEDLINES})^{\wedge})$$

The result shows that, given the average of FIXEDLINES, an increase of mobile cellular subscription per 100 people will lead to a decrease in the lending interest rate by 0.03%. FIXEDLINES and INCOME have a significantly negative correlation with LENDINGRATE. Because of large country differences in economic indicators, I also test and correct for heteroskedasticity in both models.

DISCUSSION AND CONCLUSIONS

The purpose of this study was to determine whether mobile cellular subscriptions improve financial market activity. According to transaction cost theory, it is expected that MCS would be positively related to microfinance loans. The results indicate that the expected relationship holds. Further, according to competitive markets, it is expected that an inverse relationship will exist between MCS and the lending interest rate. The results indicate the expected negative relationship; as MCS increases, the lending interest rate falls. Overall, the results of this study give readers confidence when talking about the predicted effects that improvements in telecommunications and technology will have on the financial market.

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TABLES & FIGURES

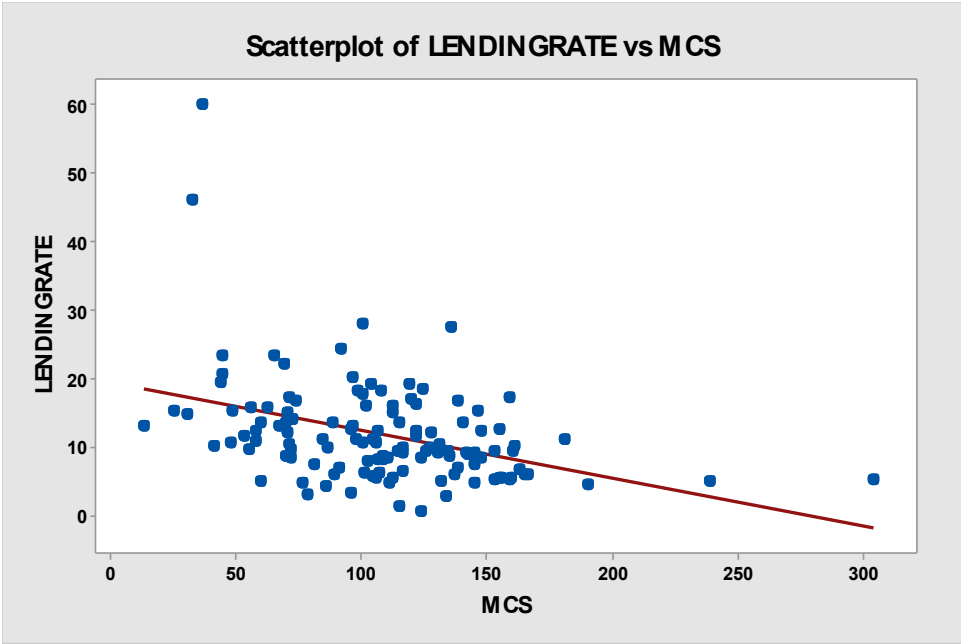
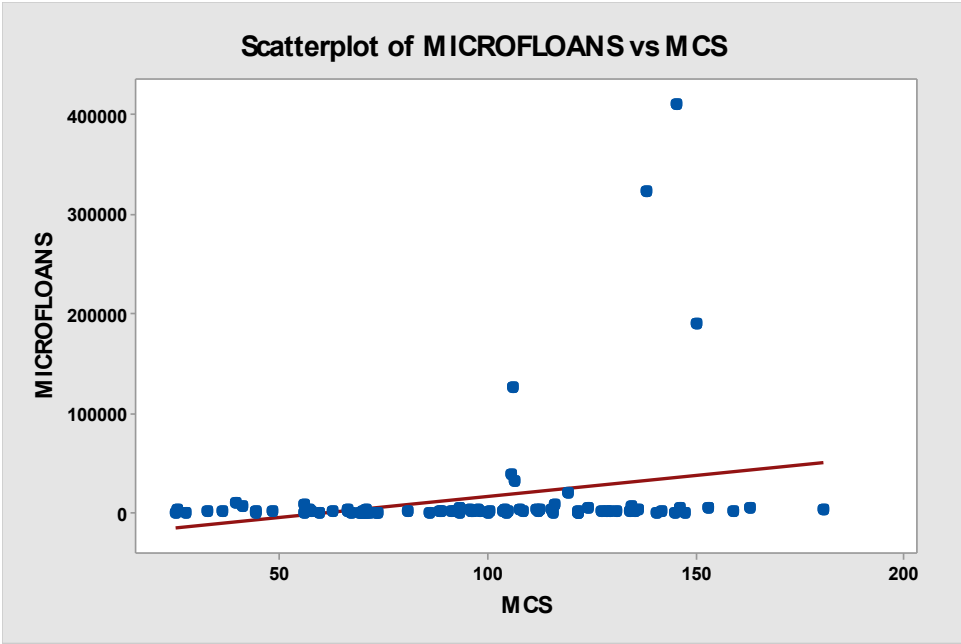
Table 1: Variable Descriptions, sources, and descriptive statistics.

| Variable | Description | Source | Mean (St.Dev.) | N |
|--------------|---------------------------------------------------------------|-----------------------------------|---------------------------|-----|
| FREEDOM | Index of economic freedom | Heritage Foundation | 59.77 (10.73) | 175 |
| MICROFLOANS | Per borrower microfinance loans | Microfinance Information Exchange | 15097.83 (59887.98) | 89 |
| BORROWERS | Amount of active microfinance loan borrowers | Microfinance Information Exchange | 971728.67 (3791671.49) | 89 |
| MICROFBANK | Number of microfinance institutions | Microfinance Information Exchange | 9.39 (11.99) | 92 |
| COMBANK | Amount of commercial bank branches per 100000 adults | International Monetary Fund | 18.43 (17.09) | 210 |
| MCS | Amount of mobile cellular subscriptions per 100 people | The World Bank | 102.71 (41.17) | 237 |
| FIXEDLINES | Amount of fixed broadband Internet subscribers per 100 people | The World Bank | 11.08 (12.37) | 237 |
| INCOME | Per capita income | The World Bank | 10433.89 (14566.61) | 202 |
| LENDINGRATE% | Average country-level lending interest rate | The World Bank | 11.75 (7.55) | 128 |
| INFLATION% | Official percent inflation rate by a GDP deflator approach | The World Bank | 3.91 (6.35) | 217 |
| UNEMP% | Official percent unemployment rate | The World Bank | 8.6 (5.68) | 208 |
| FEMALE% | Percent female percentage of the whole population | The World Bank | 50 (3) | 229 |
| POP% | PERCENT POPULATION GROWTH RATE | The World Bank | 1.31 (1.17) | 249 |
| CAP% | Percent capital formation of gross GDP | The World Bank | 23.94 (7.89) | 177 |

Table 2: OLS Results

| Variable | MICROFLOANS | LENDINGRATE |
|-------------------------------|---------------------------------|------------------------------------|
| Constant | 203686 | 15.37 |
| FREEDOM | -1728 [0.269] (0.383) | 0.147 [0.186] (0.267) |
| BORROWERS | 0.00019 [0.951] (0.930) | |
| MICROFBANK | -587 [0.586] (0.450) | |
| COMBANK | 727 [0.263] (0.356) | 0.0192 [0.733] (0.650) |
| MCS | -354 [0.369] (0.425) | -0.0885** [0.024] (0.065) |
| FIXEDLINES | -16244** [0.03] (0.131) | -0.742** [0.031] (0.031) |
| INCOME | -13.64*** [0.004] (0.024) | -0.000178*** [0.036] (0.002) |
| %INFLATION | -4161* [0.085] (0.108) | 0.283** [0.016] (0.068) |
| %UNEMP | 419 [0.816] (0.773) | -0.198* [0.162] (0.074) |
| %POP | -18283 [0.185] (0.270) | |
| LENDINGRATE | 148 [0.891] (0.875) | |
| MCS*LENDINGRATE | 194.14*** [0.002] (0.066) | 0.00522* [0.068] (0.066) |
| F-test | 3.7*** [0.001] | 5.52*** [0.000] |
| R-square Adjusted | 38.38% | 28.42% |
| Number of Observations | 72 | 92 |

*, **, *** indicate that the coefficient is statistically significant at the 0.10, 0.05, and 0.01 level, respectively. P-values are in brackets, and the heteroskedasticity-robust P-values are in parentheses.



The Effect of Technological Growth on the Unemployment Rate of the United States

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ECONOMICS

ABSTRACT

The purpose of this paper is to analyze the effect technological progress has on the unemployment rate of the United States. The number of patents issued a year between 1961 and 2014 are used as a measure of technological growth. The data was entered into a distributed lagged OLS time-series regression model. The results indicate that, three years after the new technologies are introduced, the unemployment rate increases a small amount in reaction to new technologies. The model also indicates that the effect of technological change is diminished over time.

Keywords: Patents Technological Change Unemployment

INTRODUCTION

There has been a long history of anxiety over technological unemployment, exemplified by the Luddite movement during the Industrial Revolution. This concern has reemerged in recent decades, rising from the current rate of technological progress and the Great Recession [Mokyr, Vickers, and Ziebarth 2015].

Since the 1980's, the United States has been experiencing a surge in technological progress [Feldmann 2013]. These advances have been beneficial to the economy, increasing the productivity of several industries. However, technological progress has the potential to increase the unemployment rate.

The purpose of this paper is to examine the effect that technological progress has on the unemployment rate. This paper contributes to previous studies by examining the macroeconomic effect of technology on the unemployment rate of the U.S, between 1961 to 2014. This paper uses a more robust measure of technological growth than previous studies.

LITERATURE REVIEW

Numerous studies examine the relationship between the unemployment rate and technological progress, without any definitive consensus as to the nature of this relationship. The following briefly reviews current literature.

Horst Feldmann (2013) thoroughly examines the effect of technological progress on

the unemployment rate of twenty-one industrial countries. The number of triadic patent families issued annually between 1985 and 2009 are used as a proxy for technological progress. Using a two-step regression analysis, he found that an increase in technological progress leads to an increase in the unemployment rate over the course of three years. He also found no long-run increase in unemployment.

Research by Georg Duernecker (2014) focused on differences between the unemployment rate in the U.S and Europe due to differences in technological progress. The proxy that is used for technological progress is Information and Communication Technology (ICT) over the period of 1980-2007. The results found indicate that the technology gap between countries has a small effect on the unemployment rate of those countries and indicates that countries with high levels of technological progress experience only a slight increase in unemployment.

A study done by David Autor (2015) had different findings about technological unemployment. He examines changes in capitals' share of production relative to changes in labors' share of production and how these changes would affect various U.S industries. The results of this research found that the overall unemployment rate would not change because technology tends to complement the production of labor more that it substitutes for labor. It is argued that technological advancement tends to lead to job polarization rather than unemployment.

THEORY

The *creative destruction* theory describes an economic evolutionary process where new technologies cause employment losses in an economy. The technologies destroy jobs as labor is substituted for the more efficient capital. This causes a short-term increase in the unemployment rate. However, new jobs and industries emerge that take greater advantage of the newer technologies. It should be noted though that the *creative destruction* theory allows for the possibility that the number of jobs created is not always equal to the number of jobs destroyed. The *capitalization effect* is closely tied to the *creative destruction* theory. This occurs when companies take advantage of lower costs that result from technological progress. With costs lowered, a company has the potential to expand, which often includes the creation of new jobs.

DATA

Since there is not a standard measure for technological advancement, it is necessary to find a variable to serve as proxy data for technological growth.

Patents provide a useful reflection of technological growth in the U.S, because of their legal nature. By law, for a patent to be issued by the United State Patent and Trademark Office (USPTO), they must be unique, useful, and not obvious. The strict enforcement of patent law in the U.S ensures robust data for evaluating technological progress.

also do not differentiate between a new products or processes. In general, using the number of patents issued as a proxy for technological advancement is semi-effective.

Carley, Jackson, Marco, and Myers (2015) produced an algorithm that divided patents into eight categories, each with several sub-categories. Data from the categories more generally associated with new technologies increases the robustness of the patents data. The Computers and Communications category was selected to be the proxy along with several sub-categories. The data from these categories were then summed together.

Previous studies that utilized patents as the proxy for technological growth did not have access to classification system presented by Carley, Jackson, Marco, and Myers (2015). Therefore, the data from those previous studies was not as robust as the data presented here due to the presence of patents that are unrelated to technological progress present in their data.

However, some of the same problems that general patents data had remain. The lack of differentiation between products and processes still exists. A selection bias exists because of the division of the patents. It is possible that there are patents that should be included but were not because they were placed into a different class, while some were included that should not have been. However, the removal of many of the categories that are not related to new technologies significantly increases the robustness. The patent data was scaled by dividing the data by 1000.

Table 1 provides descriptions, statistics of the data and their sources. The data for the U.S ranges from 1961 to 2014, allowing for a 54-year sample time-period.

The economic theories, *Okun's Law* and the *Phillip's Curve*, state that real GDP per capita and the inflation rate have an influence on the unemployment rate. Therefore, they must be controlled for in the model. The real GDP per capita is in chain 2009 US dollar and was scaled by dividing by 1000.

Econometric Model

The data was entered into a lagged time-series OLS regression model as follows in Equation 1.

$$[1] \\ unem = \beta_0 + \beta_1 Patents_t + \beta_2 Patents_{(t-1)} + \beta_3 Patents_{(t-2)} + \beta_4 Patents_{(t-3)} + \beta_5 Patents_{(t-4)} + \beta_6 rGDPc_t + \beta_7 infl_t + \beta_8 t + \varepsilon_t$$

The patent variable was lagged four-years to observe the effect of technological progress over time. A time trend variable was also introduced into the regression model. The time trend controls for trends in the variables over the course of the sample time-period. The ε variable represents the unobserved effects.

$$[2] \\ LRM = \beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5$$

Equation 2 shows how the long-run effect of patents can be seen using the Long-Run Multiplier. The LRM is used to indicate the permanent change in unemployment caused by the increase in patents. The LRM is tested for significance using an F-test.

RESULTS

An adjusted R^2 of 0.7509 indicates a high level of explanation for the unemployment rate in the model. Table 2 shows the results of the regression analysis. The analysis indicates that the initial, the first, second and third year effects of the newer patents is statistically insignificant. The patent variable that was lagged four years was significant at the 5% level. A potential explanation of this delay in significance is that it takes time for the new technologies to be fully incorporated into the workplace.

The coefficient of the four-year lagged patent variable indicates that an increase of 1000 patents at time t will cause a 0.06% increase in the unemployment rate four years after the patents were initial introduced, holding all other factors constant. This positive relationship indicates that technological growth influences the unemployment rate, albeit a relatively small effect compared to the control variables.

The LRM test results indicate that an increase of 1000 patents in a year causes a 0.027% permanent increase in the unemployment rate, holding all other factors constant. Though the LRM includes insignificant coefficients, the F-test for the LRM indicates that the long-run effect is significant at the 10% level. This would indicate that the effect after the fourth year diminish over times, with a small portion being permanent.

The results of the control variables are as follows. The model indicated that for every increase of \$1000 in the real GDP per capita, the unemployment rate would fall by 1.109% at a 1% level of significance, holding all other factors constant. The real GDP appears to be the main driving force behind the changes in the unemployment rate. Inflation, appears to be insignificant. The time trend variable states that the unemployment rate has had a positive trend over the sample time-period.

CONCLUSION

The purpose of this study was to determine if technological progress influences the unemployment rate of the U.S. Using a lagged time-series OLS regression, we determined that after a three-year delay, technological change has a small effect on the unemployment rate. This effect diminishes over time, with a small portion of the adverse effect found to be permanent in the long-run. This would indicate that the anxiety over massive job loss due to technological improvement is unnecessary.

We also found that the effect of real GDP per capita outweighs the effect of technological growth. Any increase in technological unemployment can be stymied by the growth in real GDP per capita, either from the economy being in an expansion phase, or due to firms experiencing the *capitalization effect*.

Future research should utilize some variables that were left out either because they were unknown or there is not sufficient data on these variables. Future research can take advantage of a larger sample time-period to increase our understanding of the long-run effects technological growth.

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TABLES

Table 1: Variable Description and Descriptive Statistics

| Variable | Description | Min | Max | Mean | Standard Deviation | Source |
|----------|----------------------------------------------------------------|-------|--------|----------|--------------------|----------------------------------|
| UNEM | The unemployment rate | 3.5 | 9.7 | 6.115 | 1.591 | Bureau of Labor Statistics (BLS) |
| PATENTS | The number of technologically related patents issued in a year | 6753 | 155682 | 37150.35 | 37932.88 | USPTO |
| RGDPC | The real GDP per capita | 17351 | 50065 | 34247.8 | 10281.83 | Bureau of Economic Analysis |
| INFL | The Inflation rate | 1 | 12.4 | 3.9 | 2.58 | BLS |
| T | Time Trend | | | | | |

Table 2: Results

| Variable | Coefficient | t-stat |
|-------------------------|-------------|--------|
| PATENTS | -0.0225 | -0.85 |
| PATENTS_LAGGED 1 YEAR | -0.027 | -0.87 |
| PATENTS_LAGGED 2 YEARS | -0.0189 | -0.57 |
| PATENTS_LAGGED 3 YEARS | 0.0309 | 0.98 |
| PATENTS_LAGGED 4 YEARS | 0.0651** | 2.29 |
| RGDPC | -1.109*** | -10.25 |
| INFL | 0.0366 | 0.58 |
| T | 0.74*** | 10.68 |
| CONS | 23.147*** | 11.58 |
| ADJUSTED R ² | | 0.7509 |
| LRM | | 2.39* |

a *** ** * indicates that the coefficient is statistically significant at the 1%, 5%, and 10% levels, respectively.

The Relationship Between the Exchange Rate and Trade Balance Between the United States and Japan

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INTERNATIONAL ECONOMICS

ABSTRACT

This paper investigates the relationship between the real exchange rate and the real trade balance between the United States and Japan. It uses quarterly time-series data from 1995Q1 to 2014Q4 and applies the ordinary least squares (OLS) regression to examine the relationship between the variables of interest. The results indicate that there's a negative but not significant relationship between the real exchange rate and the real trade balance between the United States and Japan.

Keywords: real exchange rate, trade balance, GDP, the United States, Japan

INTRODUCTION

Japan is currently the United States' fourth largest goods trading partner with \$204 billion in total (imports and exports) goods trade during 2013. Goods exports totalled \$65 billion; Goods imports totalled \$139 billion. Dollar depreciation against the yen should promote US exports to Japan and reduce US imports from Japan, leading to a progressively narrowing of the US trade deficit with Japan over time (Rahman, Mustafa, and Burckel, 1997). According to the fact listed above, it is significant to find out whether there's a relationship between the exchange rate and trade balance between the U.S. and Japan. If there is a relationship, then what kind of relationship is it, a linear relationship or a non-linear relationship? I also expect to find the impacts of the exchange rate on the trade balance between these two countries and to examine if these impacts are positive or negative. Among the literatures that I find, most of them focus on the impacts of the exchange rate volatility on the trade flows between two countries. Some of these literatures pay attention to the impact of exchange rate on trade balance in one country. Only a few concentrate on the relationship between exchange rate itself and trade balance between two countries, so it is important and interesting to figure out the relationship between the exchange rate and the trade flow between the U.S. and Japan.

According to the literature on the same topic, there's a relationship between the real exchange rate and trade balance. On the one side, the real exchange rate and trade balance affect each other instead of one-way impact. The yen-dollar real exchange rate and the US-Japan real trade balance may be explained regarding "income" and "substitution" effects. There are two possible connections between the real trade balance and the real exchange rate (Rahman, Mustafa, and Burckel, 1997). On the other side, the impacts of

the real exchange rate on trade balance are different in the long run and short run. The exchange rate affects the trade balance in the long run, while the trade balance responds rather slowly to exchange rate shocks (Shirvani and Wilbratte, 1997). The real exchange rate does have a positive influence on the trade balance in the long run and negative consequences in the short run but will not last long (Trinh, 2014).

This study investigates the relationship between the real exchange rate and real trade balance between the United States and Japan using the ordinary least squares (OLS) method. The sample period is from 1995Q1 to 2014Q4. Data are collected from FRED Economic Data and OECD database. I use the trade balance theory and demand theory in this paper. Based on these theories, I selected my key variables and made expectations before running the test. After collecting all data, I use multiple linear regressions to testify the results. I find that there's a negative relationship between the real exchange rate and trade balance between the United States and Japan from 1995Q1 to 2014Q4.

THEORETICAL FRAMEWORK

According to the theory of trade balance, the trade balance (equal to exports minus imports) is mainly determined by the real exchange rate, the level of home income, and the level of foreign income. These three key determinants provide the following insights. First, if there is a real depreciation in the home currency, then the foreign goods will be more expensive comparing to home goods. The home country will export more and import less. Second, if the home income increases, then the home country will import more so that the trade balance will decrease. Third, if the foreign income increases, then the home country will exports more so that the trade balance will increase. Based on these three insights, lots of literature uses the trade balance in their theoretical parts. For example, Igue and Ogunleye (2014) write in their study that the trade balance is determined by some macroeconomic variables such as real output, exchange rates, money supply, etc. and there is a direct and indirect casual feedback mechanism between the trade balance and these macroeconomic variables. They define the trade balance as a function of the real exchange rate, gross domestic income, and world income. Relied on the trade balance theory, I explain my function as follow, where TB is the real trade balance between the US and Japan, $USGDP$ is the real GDP for the US, and $JPGDP$ is the real GDP for Japan.

The demand theory is about the relationship between consumer demand for goods and services and their prices. In the case of other conditions unchanged, the demand for a commodity and its price change in the opposite direction, namely the demand decreases with the rising price of the commodity itself. According to this theory, a depreciation of the home currency will lead to a rise in the price of foreign goods and a decrease in the price of domestic goods so that imports decrease and exports increase leading the increase of trade balance. If the home currency appreciate, then the price of foreign goods will decrease and the price of domestic goods will increase so that the home country will import more and export less causing the decrease of trade balance. Shirvani and Wilbratte (1997) posit that the demand for imported goods depends on the relative price of imports

and domestic income. They use this theory to express the relationship between the trade balance and the real exchange rate. In my paper, I hypothesize that the relationship between the real exchange rate and trade balance between the U.S. and Japan is negative because as the dollar depreciates, the U.S. imports from Japan will decrease so that the trade balance will increase.

REVIEW OF RELEVANT LITERATURE

According to theories, the dollar depreciation against the yen should promote US exports to Japan and reduce US imports from that country, leading to a progressively narrowing of the US trade deficit with Japan over time (Rahman, Mustafa, and Burckel, 1997). It's very important to investigate the relationship between the real exchange rate and the US-Japan real trade balance. Rahman, Mustafa, and Burckel (1997) examined the short- and long-run dynamics between the yen-dollar real exchange rate and the US-Japan real trade balance. Before their study, questions were being raised, such as "whether the yen-dollar exchange rate is essentially determined in the foreign exchange market by the normal forces of supply and demand in goods markets" (Rahman, Mustafa, and Burckel, 1997). They employed cointegration and error correction models to examine the dynamics of the yen-dollar real exchange rate and the US-Japan real trade balance using the quarterly data from 1973Q1 to 1993Q4. This study concluded that the yen-dollar real exchange rate and the US-Japan real trade balance might be explained regarding "income" and "substitution" effects. However, this study only found there's a relationship between the real exchange rate and real trade balance. It didn't find whether it is a positive or negative correlation.

Shirvani and Wilbratte (1997) tested for the existence of a long-run relationship between the real exchange rate and the trade balance based on bilateral trade between the U.S. and the other G7 countries. They used trade balance model, which expresses the balance of trade as a function of the real exchange rate and the levels of domestic and foreign incomes. This function is highly related to my research paper because I use the same idea of expressing the trade balance. They collected monthly data on the real merchandise trade balance, industrial production and the real exchange rate for all of the G7 countries from the *Survey of Current Business* and OECD data. My research paper referred to this article and used quarterly data on GDP for the U.S. and Japan from OECD website also. Their conclusions are that the trade balance is unresponsive to the exchange rate in the very short run and devaluations improve the trade balance in the long run. According to these conclusions, if exchange rate goes down, the trade balance will go up. That leads to my hypothesis that the trade balance is negatively related to the real exchange rate.

Haynes, Huschison, and Mikesell (1989) explored the response of the US-Japan trade balance in manufacturing to movements in the yen-dollar exchange rate. Their research based on both structural and reduced form approaches concluded that US imports from Japan were essentially insensitive to exchange rate movements, but US exports to Japan were highly exchange rate elastic. Referring to their conclusion, my research paper considered using the demand theory to explain why there could be a relationship between

the real exchange rate and trade balance. However, this study examined the exports and imports separately instead of putting them all together to represent the trade balance. That's why they concluded that US manufacturing exports to Japan are highly sensitive to exchange rate movements, but US manufacturing imports from Japan are unresponsive. They didn't state the relationship between the exchange rate and trade balance directly.

Igue and Ogunleye (2014) investigated whether the depreciation of exchange rate has a favorable impact on the trade balance in Nigeria. This topic is related to my research topic because it also intended to figure out if the relationship between exchange rate and the trade balance is negative or positive. They expressed the trade balance as a function of the real exchange rate for Nigeria, gross domestic income and world income and controlled for the effect of domestic and foreign income. The way they expressed the trade balance gave my research reference so that my function is very similar to theirs. The US-Japan trade balance in my paper is expressed by a function of real exchange rate, real GDP for the U.S. and real GDP for Japan. After the test, they concluded that depreciation of the exchange rate has a positive effect on the trade balance in the long run, which means that there's a negative relationship between the exchange rate and trade balance, giving a reference for my hypothesis.

Trinh (2014) focused on the short- and long-run impact of the real exchange rate on the trade balance in Vietnam from 2000 to 2010. The trade balance is expressed by a function of the real effective exchange rate, domestic output, and foreign output. My research paper uses the same model but uses the real exchange rate to take the place of the real effective exchange rate, because my topic focuses on the trade balance between only two countries. The trade balance was defined as the ratio of exports to imports (X/M) in Trinh's research. It is preferable because it is not sensitive to the unit of measurement and can be interpreted as representing either nominal or real trade balance (Bahmani, 1999).

The studies listed above are good literature for this topic. All these papers are based on the trade balance theory. They offer the basic idea of referring economic principles, defining variables, funding models, finding data and using methodology. By reviewing the research above, it becomes clearer to follow the steps and doing the research.

DATA METHOD

Data Description

This study used quarterly data from 1994 (Q1) to 2014 (Q4) to investigate the relationship between the real exchange rate and real trade balance between the United States and Japan. I collected data of trade balance and exchange rate from FRED Economic Data and GDP for the US and GDP for Japan from OECD database. Relied on these secondary, I mainly used econometric analysis of time-series data to test the hypothesis that as the real exchange rate goes up, the real trade balance goes down.

Dependent and Independent Variables

The topic of this study is the relationship between the real exchange rate and real trade

balance. The dependent variable is real trade balance, and the key independent variable is real exchange rate. Based on the trade balance theory, the home income and foreign income also can affect trade balance. Because GDP is the best measurement of a country's income, I regard the real GDP for the US and the real GDP for Japan as independent variables also. Considering that the real exchange rate, home income, and foreign income of last year might have an influence on current-year real trade balance, I used a lag on my independent variables so that the sample period of real exchange rate, real GDP for the US, and real GDP for Japan is 1994 (Q1) – 2014 (Q4). The data of real trade balance are from 1995 (Q1) to 2014(Q4).

Most of the data I gathered from FRED Economic Data and OECD database are nominal data. I used different ways to transfer those nominal data to the real one. The reason why I use real data instead of nominal data is that my research topic is the relationship between the real exchange rate and the real trade balance. To keep all data consistent, I selected the real data for all variables. For the real trade balance (exports minus imports) between the US and Japan, I collected the US nominal exports to Japan and the US imports from Japan, then I transfer these data using the following formula:

For the real exchange rate, I found the nominal exchange rate and adjust it to real exchange rate using the following formula:

I collected the real GDP for the US and Japan on OECD database.

Table 1 shows the variables I obtained from FRED Economic Data and OECD database.

Table 2 shows the standard descriptive statistics of my dependent variable and independent variables.

METHODOLOGY

This study intends to testify the relationship between the real exchange rate and real trade balance between the US and Japan. Is there a relationship between these two variables? If yes, then is this relationship positive or negative? To answer these questions, I use ordinary least square (OLS) regression model to test the hypothesis. The model is listed as follow

(4)

where RTB is real trade balance (X-M), RER_t is yen-dollar real exchange rate, $USGDP_t$ is real GDP for the US, $JPGDP_t$ is real GDP for Japan, RER_{t-1} is yen-dollar real exchange rate with one-year lag, $USGDP_{t-1}$ is real GDP for the US with one-year lag, and $JPGDP_{t-1}$ is real GDP for the Japan with one-year lag. Considering that the independent variables in previous years may have an influence on the present trade balance, I use one-year lag on all of my independent variables. Because the values of the real GDP of the US and Japan are much larger than the values of the real exchange rate, I did the test twice, with the original data and the logarithm of the original data each time.

According to the model above, the null hypothesis and the alternative hypothesis are listed as follow

H_0 = There is no relationship between exchange rate and trade balance

H_A = There is a relationship between exchange rate and trade balance

I hypothesize that the null hypothesis will be rejected so that there is a relationship between the real exchange rate and real trade balance between the United States and Japan. My alternative is there is a negative relationship between the real exchange rate and the real trade balance. When the real exchange rate goes up, the real trade balance will go down. I also assume that there's a negative relationship between the real GDP for the US and the real trade balance that is when home income increases, the trade balance will decrease; and there's a positive relationship between the real GDP for Japan and the real trade balance that is when foreign income increases, the trade balance will increase.

ESTIMATION RESULTS

I examined multicollinearity among the three independent variables before I ran the multiple linear regression tests. Multicollinearity means each independent variable is not separate to each other and has correlations among them. Because the data I used at first were collected from OECD database, I simply gained the data of real GDP for the US and Japan from that website. When I examined the multicollinearity among the real exchange rate, real GDP for the US, and real GDP for Japan, it turned out that the correlation between the real GDP for the US and the real GDP for Japan is very high measured by adjusted R-square. The adjusted R-square demonstrates 0.9719 that means the two independent variables have 97.19% of correlations to each other. I suddenly realized that the data I collected from OECD database were calculated by the same method, so the correlation between these two variables is extremely high. To solve this problem, I got the nominal GDP for Japan in yen and transferred it to real GDP in US dollar by using GDP deflator for Japan and exchange rate. After calculating, I examined the multicollinearity among the three variables again and all the correlations were low. The correlation between the real GDP for the US and the real GDP for Japan is much lower this time. The adjusted R-square went down to 0.1802 that means the two independent variables have only 18.02% of correlations to each other. Then the data of my independent variables are good to use.

Table 3 presents the estimation results of Model (4). The results show whether the real exchange rate, real GDP for the US, and real GDP for Japan have significant effects on the real trade balance (X-M) or not. According to trade balance theory and demand theory, I expected a negative coefficient on the real exchange rate and the real GDP for the US, and I also hypothesized a positive coefficient on the real GDP for Japan. Column 1 shows the coefficients on the independent variables, and Column 3 shows the coefficients on the independent variables after taking the logarithm of all variables. Column 2 and 4 states the t-statistics of all independent variables.

According to Column 1, the coefficient on the real exchange rate is negative that means

as the real exchange rate goes up; the real trade balance will go down. By referring to the p-value, this result is not significant but it matches the demand theory that if the home currency appreciate, then the price of foreign goods will decrease and the price of domestic goods will increase so that the home country will import more and export less causing the decrease of trade balance. The coefficient on the real GDP for the US is negative and significant that shows the real GDP for the US have negative and significant effect on the real trade balance. This result proves that my hypothesis on the relationship between the real GDP for the US and the real trade balance is correct. The trade balance theory illustrates that when home income increases, people in that country will import more and export less so that the trade balance will decrease; in this case, the estimation result agrees with the theory. The coefficient on the real GDP for Japan is negative and not significant. This result is not appropriate to refer. Column 3 shows the results after taking the regression of the logarithm of all variables. The values of the coefficients are different from Column 1, but the signs of the coefficients agree with the results showed in Column 1. This illustrates that the estimation results are reasonable and receivable.

However, when it comes to the real exchange rate with one-year lag, the coefficient on it is positive and significant that makes me a little confused. In order to double-check the results, I did a robustness check by using the same model as Model (4) but defining the trade balance as a ratio of exports to imports (X/M). Then I ran the OLS regression test and found that the results are almost the same from the former results of Model (4). Table 4 shows the results of that model. The former coefficient on the real exchange rate of Table 3 presents that when the real exchange rate increases by one unit, the real trade balance decreases by 32.64 units. The coefficient on the real exchange rate of Table 4 states that when the real exchange rate increases by one unit, the trade balance (X-M) decreases by 0.0008 units. The signs of the coefficients are the same as the former results, while the numbers of the coefficients are much smaller because of using a ratio of exports to imports. This result enhances the correctness of the former estimation results.

CONCLUSION

The purpose of this paper is to find out the relationship between the real exchange rate and the real trade balance between the United States and Japan. The main finding is that the real exchange rate has negative but not significant effects on the real trade balance. This finding is a little different from my assumption. My inference is that, on the one hand, apart from real exchange rate, there are lots of factors that might influence the real trade balance. For example, the cost of production, the availability of inputs, taxes and restrictions on trade, non-tariff barriers, the availability of adequate foreign exchange, and prices of goods manufactured at home can also affect the real trade balance between the United States and Japan. In this paper, I only take the real exchange rate, home country GDP, and foreign country GDP into account, and I didn't consider the impact of the above factors on the real trade balance. On the other hand, the previous studies on the same topic all use time-series analysis to find out the results. Most of the literature, to which I referred, employs cointegration and error correction models to examine the relationship between the exchange rate and trade balance. In this study, I use an alternative to time-series analysis that is applying regression analysis on my independent variables

with one-year lag. Regression analysis focuses on comparing values of a single time series or multiple dependent time series at different points in time that is different from the real time-series analysis. The above limitations can cause the results different from other studies. For the future investigation, I would consider the influences of other factors that also have impacts on the real trade balance, and I would also learn to use time-series analysis to find out the relationship between exchange rate and trade balance.

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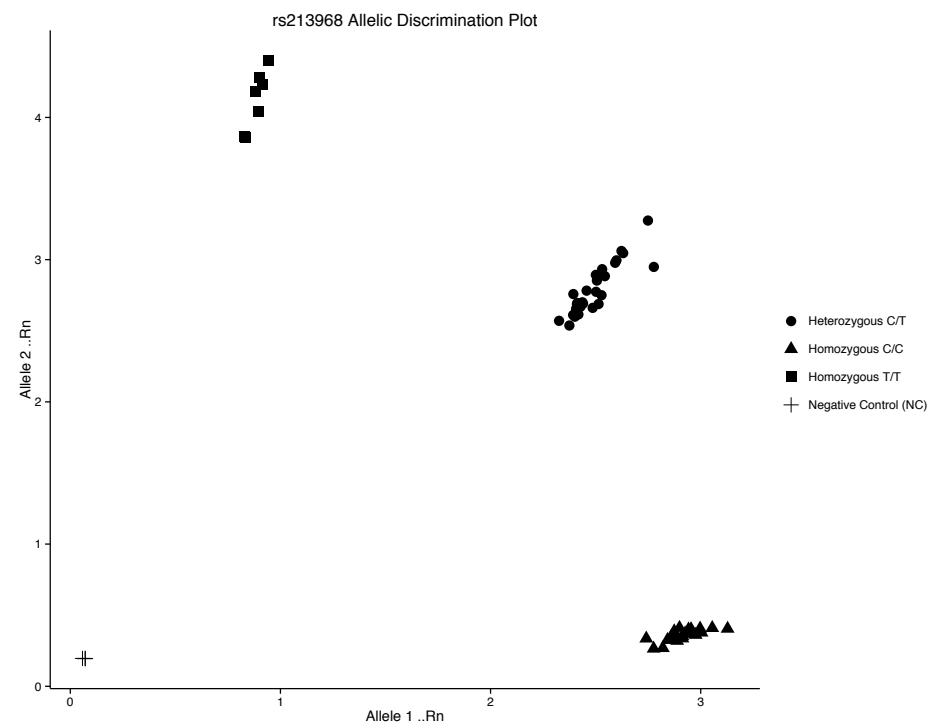
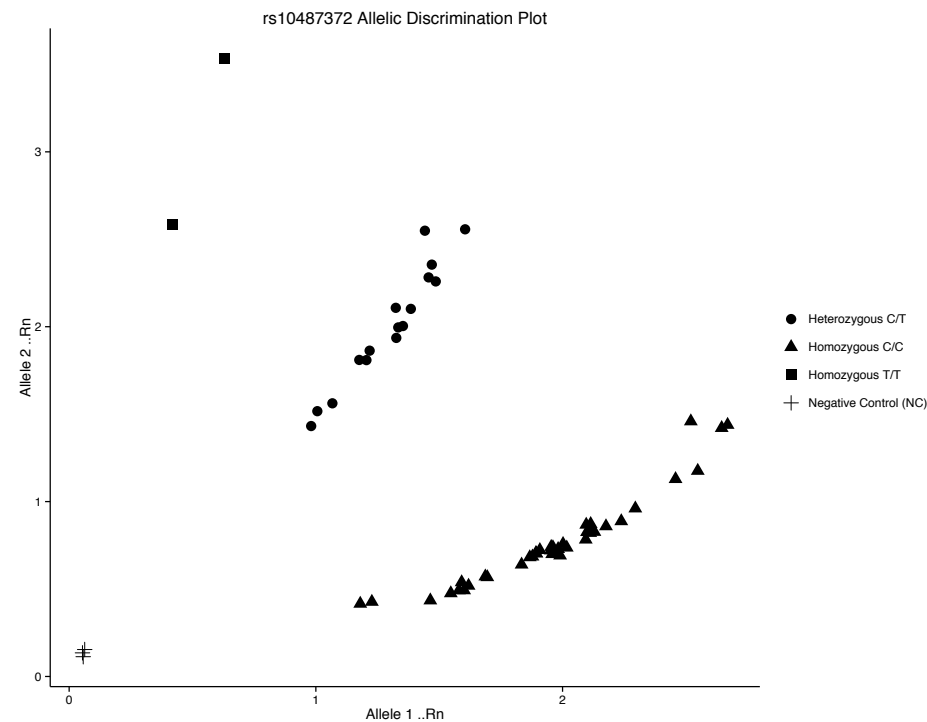
TABLES & FIGURES

Table 1: Demographics

| Variable | IBS | Asthma | Control |
|---------------------------------|------|--------|---------|
| Age | | | |
| Mean | 30.7 | 25.8 | 26.8 |
| Biogeographical Ancestry | | | |
| European | 13 | 9 | 30 |
| Asian | 0 | 1 | 7 |
| African | 0 | 0 | 1 |
| Gender | | | |
| Male | 7 | 6 | 21 |
| Female | 7 | 4 | 14 |

Table 2: Statistical Analysis

| | rs10487372 | | | rs213968 | | | rs10487372 | | | rs213968 | | |
|--------------------------------|---------------------|-------|-------|-----------------------------------|-------|-------|-------------------------------------------|-------|-------|---------------------|-------|-------|
| | TT/TC/CC | p | | TT/TC/CC | p | | TT/TC/CC | p | | TT/TC/CC | p | |
| IBS results vs Controls | | | | Asthma results vs Controls | | | Either disease results vs Controls | | | | | |
| Genotypic | U 2/12/28 | | | 6/22/14 | | | 1/14/31 | | | 5/25/16 | | |
| | A 0/4/10 | 1 | | 1/6/7 | 0.618 | | 1/2/7 | 0.409 | | 2/3/5 | 0.295 | |
| Allelic | U 16/68 | | | 34/50 | | | 16/76 | | | 35/57 | | |
| | A 4/24 | 0.777 | | 8/20 | 0.368 | | 4/16 | 0.754 | | 7/13 | 1 | |
| | OR (95% CI) | p | | OR (95% CI) | p | | OR (95% CI) | p | | OR (95% CI) | p | |
| Logistic Regression | 0.563 (0.212-1.494) | 0.249 | | 0.714 (0.219-2.325) | 0.576 | | 1.182 (0.354-3.948) | 0.786 | | 0.869 (0.305-2.473) | 0.792 | |
| | 0.880 (0.324-2.389) | 0.802 | | 0.734 (0.319-1.689) | 0.467 | | 0.880 (0.319-2.389) | 0.802 | | 0.880 (0.319-2.389) | 0.802 | |
| Haplotype | OR | Freq | p | OR | Freq | p | OR | Freq | p | OR | Freq | p |
| | CC 1.780 | 0.625 | 0.249 | 1.150 | 0.625 | 0.792 | 1.360 | 0.625 | 0.467 | 1.360 | 0.625 | 0.467 |
| | CT 0.635 | 0.196 | 0.435 | 0.699 | 0.196 | 0.584 | 0.752 | 0.196 | 0.559 | 0.752 | 0.196 | 0.559 |
| | TT 0.714 | 0.179 | 0.576 | 1.180 | 0.179 | 0.785 | 0.880 | 0.179 | 0.802 | 0.880 | 0.179 | 0.802 |



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Mutation in Patients Diagnosed with IBS and Asthma

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ABSTRACT

Cystic fibrosis (CF) is a genetic disorder that causes thickened secretions in the body. Approximately 70% of CF cases are caused by the F508deletion mutation (rs113993960) in the cystic fibrosis transmembrane conductance regulator (CFTR) gene. People homozygous for the mutation suffer from malabsorption, digestive complications (constipation/diarrhea, bloating, etc.), and pulmonary obstructive symptoms. Irritable bowel syndrome (IBS) is a broad diagnosis for patients experiencing any kind of idiopathic disruption in their digestive processes. Asthma also has many subset causes, some of which are not yet known. The goal of this study is to find the prevalence of rs113993960 in the northern Utah population diagnosed with IBS and asthma. A decreased expression of the CFTR gene could explain the presence of CF-like symptoms in IBS/asthma patients. DNA was collected using a buccal swab and extracted with a DNA extraction kit. A TaqMan™ SNP (single nucleotide polymorphisms) genotyping assay identified the frequencies of rs113993960 in the participants. After statistical analysis comparing genotype, allele, and haplotypes frequencies between cases and controls, rs113993960 was not significantly associated with IBS or asthma.

INTRODUCTION

Cystic Fibrosis (CF) is a genetic autosomal recessive disease that affects the pancreas, liver, kidneys, lungs and gastrointestinal tract. The disease can be caused by many different mutations in the cystic fibrosis transmembrane conductance regulator (CFTR) gene. The protein coded for by the CFTR gene is responsible for chloride ion movement across a cell membrane. These chloride ion channels are found on cells that produce mucus, sweat, and digestive enzymes. Mutations in the gene can affect production and structure of the protein channel, disrupting proper function. With ions not transporting in and out of the cells correctly, the membranes of mucosal tissues accumulate mucus. The excess mucus blocks mucosal sites within organ systems. Due to this, CF patients commonly experience gastrointestinal symptoms: fatty or bulky stool, acid reflux, constipation and diarrhea. Patients also experienced respiratory symptoms: difficulty breathing, and mucus buildup (CFTR, 2008).

The most prevalent mutation in the CFTR gene is the F508deletion (rs11339360). This mutation is a deletion of the amino acid phenylalanine at position 508 in the CFTR gene. The resulting protein channel is not stable and breaks down before reaching the membrane surface (CFTR, 2008). Approximately seventy percent of people with CF are homozygous for the gene mutation, inheriting a copy of rs11339360 from both parents.

(Dahl, Tybjaerg-Hansen, Lange, & Nordestgaard, 2005).

Irritable Bowel Syndrome (IBS) and asthma share common symptoms with Cystic Fibrosis (CF). The symptoms commonly seen in patients with IBS include upset stomach, fatty stool, reflux, constipation, and diarrhea. IBS is idiopathic in nature, meaning the cause is not known or understood (Symptoms and Causes of Irritable Bowel Syndrome, 2015). In their study, Dahl et al. showed a correlation between participant who had a CFTR gene mutation and diagnosis with asthma, including the commonality of symptoms (Dahl, Tybjaerg-Hansen, Lange, & Nordestgaard, 2005).

If an individual inherits the mutation from only one parent (heterozygote), he or she may still present complications related to the defective gene. This study aimed to determine the prevalence of rs113393960 in the northern Utah population diagnosed with IBS and/or asthma. If the mutation is present at a higher frequency in the IBS/asthma individuals, when compared to healthy controls, it would suggest that the mutation plays a role in the etiology of IBS and asthma, which could lead to better diagnosis and treatment.

In the U.S., those with homozygous inheritance of CF mutations demonstrate severe symptoms, and in most cases, are diagnosed not long after birth. Unlike CF, the cause of IBS is relatively unexplained. The question was, are people who inherited one copy of the rs113393960 mutation diagnosed with IBS and asthma because symptoms are not severe enough to be diagnosed as CF? Studies have shown that individuals of European descent (the vast majority of the northern Utah population) have approximately a 5% probability of being a carrier for the rs113393960 mutation in the CFTR gene (Li, Sun, Wu, Babovic-Vukasanovic, Cunningham, & Yang, 2010). In addition, it has been shown that 10.8% of the global population displays symptoms consistent with IBS (Hungin, Chang, Locke, Dennis, & Barghout, 2005). With the relatively high prevalence of CF carriers and common diagnosis of IBS, it seemed probable that some are given a blanket diagnosis of having IBS when the underlying cause is a CFTR gene mutation.

In previous asthma studies (Dahl, Tybjaerg-Hansen, Lange, & Nordestgaard, 2005; Maurya, Awasthi, & Dixit, 2012) individuals were first tested for CF mutant alleles. The researchers then compared the prevalence of asthma between those who were carriers and those who were not. These studies showed there was a higher prevalence of those with asthma among CF carriers than the general population. This study is expanding on previous studies by looking to confirm the asthma association and the possible link with IBS.

MATERIALS & METHODS

Study Population

Fifty-six participants were recruited from northern Utah. Individuals were recruited via flyers and announcements made around the Weber State University campus. The majority of participants were students or relatives of students attending WSU. Flyers indicated a need for participants between the ages 18-65, men and non-pregnant women, and both healthy and those diagnosed with the target diseases. Participants were given a survey, and asked to

self-report demographic data, disease status, and what (if any) symptoms they experienced. Cases were defined as having been diagnosed as IBS, asthma, and/or CF.

DNA extraction and Genotyping

DNA was collected from each participant using a nylon buccal swab. Participants swabbed both sides of their own cheeks for a minimum of 45 seconds before placing the swab tips into sterile collection tubes, which were stored at 5°C. DNA was extracted within 24 hours of collection using a Qiagen Blood and Tissue kit, extracted samples stored at -20°C for genotyping. Each individual was genotyped for three SNPs—rs113393960, rs213968, and rs10487372—using a TaqMan™ genotyping assay. Due to quality control difficulties within the assay, identifying the rs113393960 mutation resulted in unreportable data. Two tag SNPs rs213968 and rs10487372 were selected using Haploview (Barret, Fry, Maller, & Daly, 2005) to define the LD structure around the CFTR deletion. Linkage disequilibrium shows how likely a person is to inherit one mutation along with another. Both of the selected SNPs are in high linkage disequilibrium (>95%) with the rs113393960 mutation (Li, Sun, Wu, Babovic-Vukasanovic, Cunningham, & Yang, 2010). The TaqMan™ assay was run on a real-time PCR (polymerase chain reaction) to amplify the target region of DNA, using a Quantstudio 3 thermocycler. The predesigned SNP assay—containing distinct fluorescent probes specific to rs213968 and rs10487372—identified the alleles present and produced an allelic discrimination plot based on default settings within the software. The inheritance of a thymine (T) in place of a cytosine (C) for both SNPs signifies a mutation of the allele.

The Context Sequence [VIC/FAM] for rs10487372 is

TACAAAAAATCTGAGTGTCTTAG[C/T]GGACACAGATATTTGTCTAGGAG-GG.

The Context Sequence [VIC/FAM] for rs213968 is

AGGGCAGGAACTGTATAATTTTGC[C/T]ATTGTATTTTGGACACATAGCATGG.

Statistical analysis

Analysis was done using Plink software (Purcell et al., 2007). Genotype/Allele frequencies were compared between cases and controls using a Fisher's exact test, the Cochran-Armitage trend test, and logistic regression. Comparisons were made for the prevalence of these SNPs between people with IBS or asthma and the healthy control, as well as having either disease state versus the control. Each SNP was tested for Hardy-Weinberg equilibrium to assess the quality of the genotyping assays. An alpha level set at 0.05 determined significant differences in genotype and haplotype frequencies.

RESULTS

Study Population

Of the 56 participants studied, 14 reported having IBS, 10 having asthma, and 35 having no disease status. The average age for the entire population was 27.3 years, with those diagnosed with IBS being an older population, and the asthma and control groups being

younger than the average. Most of the participants are of European descent, which follows the general northern Utah population trend. The gender spread for both disease states was approximately even between male and female. The control population was 33% more male than female (Table 1).

Allele and Genotype Frequencies

Figures one and two show the allelic discrimination of rs213968 and rs10487372, with each sample being called as Homozygous C/C, T/T or Heterozygous C/T. For rs213968, there were 21 individuals called for C/C, 7 for T/T, and 28 for C/T. For rs10487372, there were 38 individuals called for C/C, 2 for T/T, and 16 for C/T. There was no significant difference between the numbers of mutant alleles found in the cases compared to controls (p -values ≥ 0.2953). A combined comparison of both SNPs found that the haplotype frequency of carrying C/C was 62.5%, C/T was 19.6%, and T/T was 17.9% (Table 2).

Odds Ratios

Odds ratios (OR) were calculated with cases (IBS, asthma, or either disease) vs control for both SNP assays. IBS cases had an OR of 0.5633 (rs10487372) and 0.7136 (rs213968). Asthma cases had an OR of 1.182 (rs10487372) and 0.8688 (rs213968). The OR for having either one of the disease states and inheriting the mutant genes was 0.8798 (rs10487372) and 0.7338 (rs213968). With all p -values obtained being 0.2487 or greater, these results are not statistically significant (Table 2).

These results show a trend that being a carrier of the mutation may have a protective effect from having IBS, and no effect on having asthma. With further research and a greater number of participants obtained, a significant value may be obtained to strengthen this conclusion.

DISCUSSION

The goal of this research was to discover the relationship between heterozygous inheritance of the F508deletion and diagnosis of IBS and asthma. The hope was to prove that such an inheritance was leading to a less-severe disease state, where perhaps patients heterozygous for the mutation were being diagnosed as having IBS or asthma.

The results show heterozygous inheritance of the F508deletion does not lead to increased diagnosis of IBS or asthma. If anything, results show there may be a protective influence from being a carrier of the deletion, making an individual less likely to be diagnosed with IBS or asthma. Results from the odds ratios were insignificant, with p -values much higher than a 5% α -level, so this correlation cannot be proven. This insignificance is due to the relatively small sample size. The majority of genetic studies have participants in the thousands and this sample size simply was not large enough to find any significant results.

Based on the observed associations, it would be interesting to pursue the topic further in order to determine if there is any protective influence from heterozygous inheritance

against bowel disease. A larger sample size might indeed prove such a relation. The small sample may not have exposed any true results, and with a larger sample it might be found that the original hypothesis is true. Maurya et al., found an association between those who carried the mutation and also suffered from asthma and pulmonary disease (2012), the opposite of what appears to be found in this study. Ultimately, further studies with more participants are what are needed.

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TABLES & FIGURES

TABLE 1: Demographics: 56 total participants. Mean age, biogeographical ancestry, and gender sorted by case (irritable bowel syndrome, asthma, or control). *Three participants identified as having both IBS and asthma were counted in both columns.

| Table 1: Demographics | | | |
|---------------------------------|------|--------|---------|
| Variable | IBS | Asthma | Control |
| Age | | | |
| Mean | 30.7 | 25.8 | 26.8 |
| Biogeographical Ancestry | | | |
| European | 13 | 9 | 30 |
| Asian | 0 | 1 | 7 |
| African | 0 | 0 | 1 |
| Gender | | | |
| Male | 7 | 6 | 21 |
| Female | 7 | 4 | 14 |

TABLE 2: Statistical Analysis (*U=Unaffected, control; A=Affected, disease status)

- The genotypic association test is for a disease trait and is based on comparing genotype frequencies between cases and controls. Also implemented was the Cochran-Armitage trend test to compare allele frequencies
- Logistic regression was used to compare interactions between disease status and SNP association.
- Haplotype data was calculated from the combined SNPs using linear and logistic regression to perform haplotype-based association analysis.

| Table 2: Statistical Analysis | | | | | | | | | | | | | | | | | | |
|-------------------------------|-------------------------|---------------|---------|----------------------------|---------------|---------|------------------------------------|---------------|---------|-------|---------------|-------|-------|---------------|-------|-------|---------------|-------|
| | IBS results vs Controls | | | Asthma results vs Controls | | | Either disease results vs Controls | | | | | | | | | | | |
| | rs10487372 | rs213968 | | rs10487372 | rs213968 | | rs10487372 | rs213968 | | | | | | | | | | |
| | TT/TC/CC | p | | TT/TC/CC | p | | TT/TC/CC | p | | | | | | | | | | |
| Genotypic | | | | | | | | | | | | | | | | | | |
| U | 2/12/28 | | 6/22/14 | 1/14/31 | | 5/25/16 | 1/11/23 | | 4/20/11 | | | | | | | | | |
| A | 0/4/10 | 1 | 1/6/7 | 0.618 | 1/2/7 | 0.409 | 2/3/5 | 0.295 | 1/5/15 | 0.885 | 3/8/10 | 0.346 | | | | | | |
| Allelic | | | | | | | | | | | | | | | | | | |
| U | 16/68 | | 34/50 | | 16/76 | | 35/57 | | 13/57 | | 28/42 | | | | | | | |
| A | 4/24 | 0.777 | 8/20 | 0.368 | 4/16 | 0.754 | 7/13 | 1 | 7/35 | 1 | 14/28 | 0.548 | | | | | | |
| Logistic Regression | | | | | | | | | | | | | | | | | | |
| | OR | (95% CI) | p | OR | (95% CI) | p | OR | (95% CI) | p | OR | (95% CI) | p | | | | | | |
| | 0.563 | (0.212-1.494) | 0.249 | 0.714 | (0.219-2.325) | 0.576 | 1.182 | (0.354-3.948) | 0.786 | 0.869 | (0.305-2.473) | 0.792 | 0.880 | (0.324-2.389) | 0.802 | 0.734 | (0.319-1.689) | 0.467 |
| Haplotype | | | | | | | | | | | | | | | | | | |
| | OR | Freq | p | OR | Freq | p | OR | Freq | p | OR | Freq | p | | | | | | |
| CC | 1.780 | 0.625 | 0.249 | 1.150 | 0.625 | 0.792 | 1.360 | 0.625 | 0.467 | | | | | | | | | |
| CT | 0.635 | 0.196 | 0.435 | 0.699 | 0.196 | 0.584 | 0.752 | 0.196 | 0.559 | | | | | | | | | |
| TT | 0.714 | 0.179 | 0.576 | 1.180 | 0.179 | 0.785 | 0.880 | 0.179 | 0.802 | | | | | | | | | |

FIGURE 1: Allelic Discrimination Plot for rs213968. Each participant's genotype is plotted with Allele 1 (wild type) vs Allele 2 (mutation).

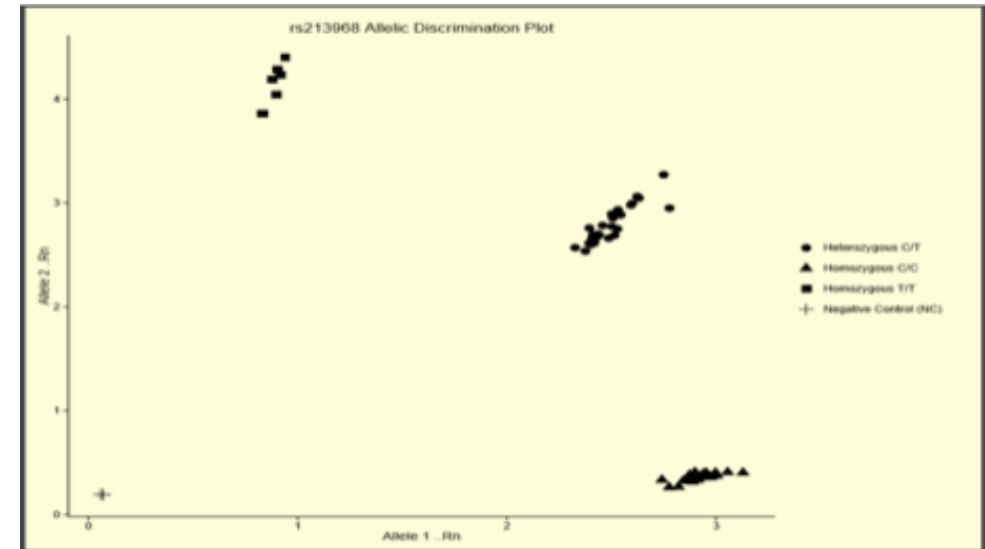
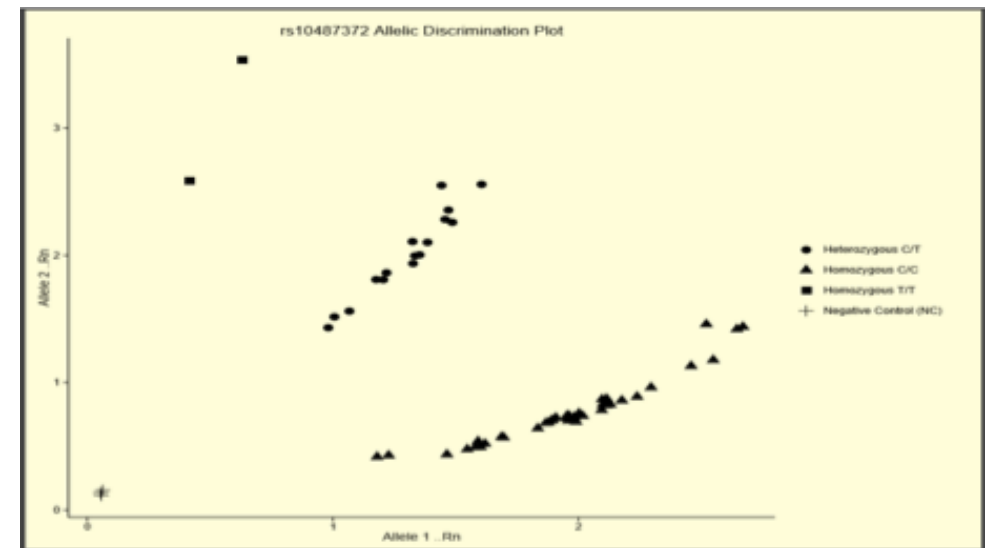


FIGURE 2: Allelic Discrimination Plot for rs10487372. Each participant's genotype is plotted with Allele 1 (wild type) vs Allele 2 (mutation).



Intrinsic Factor Inhibition Due to the Use of Isotretinoin

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ABSTRACT

Isotretinoin (Accutane) is a therapeutic drug used for the treatment and prevention of severe acne. A study done on the effects of isotretinoin concluded that patients taking isotretinoin showed a significantly prolonged activated partial thromboplastin time (aPTT). aPTT is a timed, clinical test to detect abnormalities in the intrinsic pathway of the coagulation cascade. An irregular or prolonged aPTT indicates at least one factor deficiency or inhibition in the intrinsic pathway. The objective of this study is to investigate which factor(s) of the pathway are inhibited. Normal patient plasma was collected, treated with a standardized concentration of isotretinoin, and an aPTT was performed. The collected plasma, was then pooled into one solution and underwent a factor assay. Factor assay consists of using reagent factor deficient plasmas (XII, XI, IX, and VIII). The pooled patient plasma was homogenized with each reagent plasma and an aPTT was be measured. The factor assay was performed with the pooled plasma as a control and then treated with isotretinoin. Results indicate the factor assay show statistically significant ($p < 0.001$) prolonged aPTT times in factor deficient XI and IX when treated with isotretinoin. There were no significant prolonged times for factor deficient XII and VIII, suggesting that isotretinoin had no inhibitory effect on these coagulation factors. In conclusion, isotretinoin prolongs aPTT times by inhibiting factors XI and IX in vitro in the intrinsic pathway of the coagulation cascade.

INTRODUCTION

Acne is a common skin condition that is described as pimples, blackhead, whiteheads and oily skin typically in the face. A classic treatment for acne is isotretinoin, commonly known as Accutane. Isotretinoin impacts acne by influencing skin cell-cycle progression, cellular differentiation, cell survival and apoptosis; resulting in a significant reduction in sebum production in sebaceous glands (Layton 2009). It is known to express both mild and very serious side effects, such as nosebleeds or spontaneous abortions. A study done by Kaptanoglu, et al, concluded that patients prescribed with isotretinoin showed a significant delay in their activated partial thromboplastin times (aPTT); which assesses the intrinsic coagulation pathway. aPTT is a timed clinical test used to detect abnormalities in the coagulation cascade, specifically the intrinsic pathway. A prolonged aPTT indicates that there is a disruption involving this pathway causing a coagulation delay (Rogers, 2005). The objective of this study is to determine which specific factor(s) are inhibited by isotretinoin.

Internal bleeding occurs when a blood vessel becomes damaged. To prevent further bleeding, a multistep biochemical reaction known as the coagulation cascade is initiated. The coagulation cascade plays a critical role in clotting to prevent further internal bleeding from damaged vessels. The coagulation cascade can be separated into three different pathways: common, intrinsic, and extrinsic. (Geddings & Mackman, 2014). Activation of either the intrinsic or extrinsic pathway will lead to the activation of the common pathway resulting in the development of the platelet-fibrin hemostatic plug to prevent further hemorrhaging.

The intrinsic pathway consists of four main coagulation factors: XII, XI, IX, & VIII. All coagulation factors circulate in the blood as inactive enzymes until they are activated by contact from a damaged blood vessel or contact with another activated factor (Gailani & Renne). The main intrinsic pathway factors, undergo a series of step-wise reactions that lead to the initiation of the common pathway and lead to the formation of the hemostatic plug (Moake, 2012). This study intends to identify which intrinsic coagulation factor(s) are repressed by isotretinoin, causing a delay in the clotting cascade.

MATERIALS & METHODS

Isotretinoin Solution

Isotretinoin is a derivative of Vitamin A, thus it has hydrophobic properties and is insoluble in water. In order to form an aqueous solution of isotretinoin, 40 mg of isotretinoin was dissolved in 1 mL of Dimethyl Sulfoxide (DMSO). 10 mL of aqueous isotretinoin was diluted to 4 mL with Phosphate Buffered Saline (PBS) giving a solution of 0.1mg of isotretinoin per 1 mL of solution.

aPTT Testing

Plasma was collected from normal healthy donors not prescribed isotretinoin. Blood samples were collected in Sodium Citrate tubes which prevents clotting to occur. The tubes were then centrifuged to separate plasma from cellular components and then the plasma was stored at -20°C prior to testing. All testing was performed on the ACL Elite Coagulation Instrument in the Hematology Laboratory of the Medical Laboratory Sciences Department. An initial aPTT time was performed to establish a control group. Using the 0.1 mg/mL isotretinoin solution, 10 mL was aliquoted into the patient plasma samples giving concentrations of 1000 and 2000 ng isotretinoin per one milliliter of patient plasma. Following the addition of isotretinoin, another aPTT was performed.

Factor Assay

Once initial aPTT testing was established the remaining patient plasmas were then pooled into one homogenous solution. Pooling the patient plasma controls for the varying aPTT times of each individual and how it may react with the factor deficient plasmas. Using the ACL Elite, the instrument mixes aliquots of pooled plasma, of one of the factor deficient plasmas, and an aPTT will be measured. The concept of mixing the pooled plasma and one of the factor deficient plasmas is that the pooled plasma will compensate for the factor deficient plasma thus continuing the clotting process. This process was performed with factor deficient plasmas: VIII, IX, XI and XII. A control group was established by

analyzing the aPTT times of the pooled plasmas mixed with each factor deficient plasma. The pooled plasmas were then treated with a 1000 ng/mL of isotretinoin. Using the treated pooled plasma, the factor assay was repeated with each of the factor deficient plasmas. It is hypothesized that if isotretinoin inhibits one of the intrinsic factors, then the treated pooled plasma will be unable to compensate for the factor deficient plasma resulting in a longer aPTT time.

RESULTS

To account for the effects of DMSO and PBS diluents used in the study, an initial set of experiments were conducted to ensure the diluents had no significant effects to aPTT times. Parallel testing included four different groups: control, patient plasma treated with 10 mL of PBS, plasma treated with 10 mL DMSO, and two groups of patient plasmas treated with 1000 ng/mL and 2000 ng/mL of isotretinoin. Given the results of the parallel testing (Table 1.) each group was normally distributed. To determine if the diluents had significant effects on the aPTT measurements, an Analysis of Variance (ANOVA) was performed to determine if there were significant differences among the means of the groups. The ANOVA calculated an F value of 0.704 and a P value of 0.59. With an alpha level set at 0.001, the ANOVA indicates that the groups showed no statistical difference in the means among the groups and the DMSO and PBS diluents displayed no effects to the aPTT times.

Comparison of the factor assay results can be seen in figure 2. The factor assay was performed on pooled plasma as a control group and the pooled plasma treated with 1000 ng/mL of isotretinoin. Due to pooling the plasma and controlling for various aPTT times, the groups were not normally distributed. Because the groups are not normally distributed non-parametric testing was used to determine statistical significances. A Kruskal-Wallis Rank Sum Test was performed to determine if there are statistically significant differences between the medians of one or more of the groups. The Kruskal-Wallis Test computed a P value of 2.2×10^{-16} . With an alpha level set at 0.001 this indicates that the groups are statistically different. After determining the medians of the groups were statistically significant, factors XI, and IX display prolonged aPTT times when treated with isotretinoin compared to their control groups. (Figure 2.). Because the groups are not normally distributed, a Mann-Whitney U was used to compare the means of the prolonged treated groups to the control group. Comparing treated factor XI to its control, the Mann-Whitney U Test computed a P value of 1.215×10^{-5} . Comparing treated factor IX to its control, the Mann-Whitney U Test computed a P value of 5.775×10^{-5} . Both P values are less than our alpha level of 0.001. Thus we conclude that the treated factors XI and IX have significantly prolonged aPTT means.

DISCUSSION

The objective of this study was to investigate what isotretinoin is inhibiting resulting with an elongated aPTT time. The results from ANOVA for the initial aPTT testing suggest no statistical delay in aPTT times when the patient plasmas were treated with isotretinoin. However, the patient plasmas treated with 1000 ng/mL of isotretinoin showed longer

mean and median aPTT times. Although this delay is not statistically significant, clinical providers may determine that the slight delay is clinically significant to their patients.

From the factor assay, when the pooled plasmas were mixed with either factor XI or IX deficient plasma and treated with 1000 ng/mL of isotretinoin showed statistically elongated aPTT times. A Mann-Whitney test was used to compare the means of the treated groups vs the control groups and both P values obtained were statistically significant (0.001). The researchers conclude when plasma is treated with Isotretinoin inhibits coagulation factors in the intrinsic pathway of coagulation, specifically Factors XI and IX. It is still unclear the mechanism of how isotretinoin inhibits the clotting factors, and also how isotretinoin effects the factors IX and XI *in vivo*. Further can be performed as an *in vivo* study, investigating how isotretinoin effects aPTT tests on patients who are currently prescribed with this medication.

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TABLES & FIGURES

Table 1. – Parallel aPTT testing results to determine if diluents used displayed statistical significance. Groups were treated with 10 μ L of respective reagent. Groups Iso-1000 and Iso-2000 were patient plasma groups treated with 1000 ng/mL and 2000 ng/mL of isotretinoin.

| | Mean (s) | Median (s) | Standard Deviation |
|-----------------|----------|------------|--------------------|
| Control | 27.97 | 27.30 | 3.4 |
| PBS | 28.54 | 28.1 | 2.45 |
| DMSO | 28.73 | 28.00 | 3.04 |
| Iso-1000 | 28.91 | 28.40 | 3.11 |
| Iso-2000 | 27.93 | 27.60 | 3.15 |

Table 2. – Results from the Factor Assay analysis. Factor deficient groups are paired with their control group and isotretinoin treated group. Treated groups were treated with 10 μ L of 1000 ng/mL isotretinoin.

| | Mean (s) | Median (s) | Standard Deviation |
|--------------------------|----------|------------|--------------------|
| XII Def. Control | 39.73 | 39.80 | 0.26 |
| XII Def. Treated | 40.09 | 39.90 | .82 |
| XI Def. Control | 45.63 | 45.50 | 0.68 |
| XI Def. Treated | 46.70 | 47.20 | 1.23 |
| IX Def. Control | 39.41 | 39.30 | 0.46 |
| IX Def. Treated | 40.21 | 40.40 | 0.57 |
| VIII Def. Control | 49.21 | 49.15 | 0.36 |
| VIII Def. Treated | 45.14 | 45.85 | 2.26 |

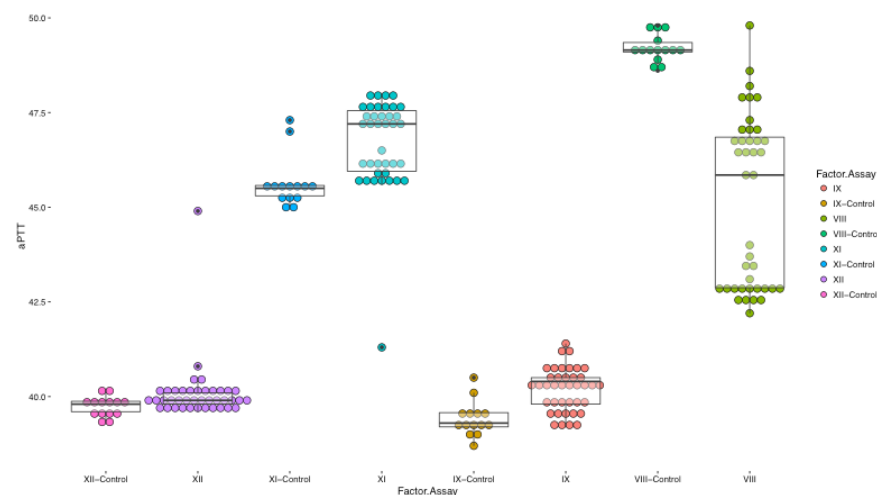


Figure 2 – Factor assay comparing the four intrinsic factors. Boxplot shows aPTT times and vertical lines indicate the median value of each group. The four control groups comprise of pooled patient plasma undergoing the factor assay comparing to groups: XII, XI, IX, VIII which have been treated with 1000 ng/mL of isotretinoin.

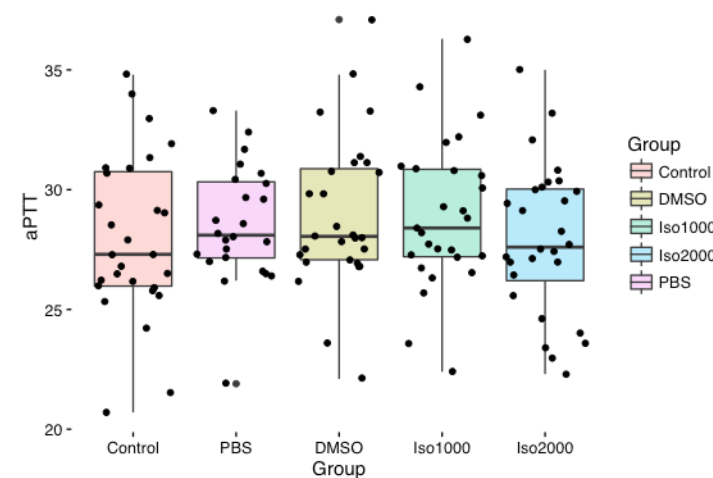


Figure 1. – Boxplot displaying the aPTT measurements for each group. Vertical lines within boxes indicate median value. Groups were treated with 10 μ L of respective reagent. Groups Iso-1000 and Iso-2000 were patient plasma groups treated with 1000 ng/mL and 2000 ng/mL

Role of Type 3 Deiodinase in Idiopathic Epileptic Syndrome

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ABSTRACT

Type 3 Deiodinase (D3) is the main physiological regulator of thyroid hormones (THs). During embryonic development, abnormal activity of the D3 enzyme may cause dysregulation of THs and affect neurological development that leads to epilepsy. Studies have shown a correlation between elevated TH levels and epilepsy. Mutations in the DIO3 gene have shown to cause depressed function of the D3 enzyme that may be responsible for the increase of TH function. Taqman® Single Nucleotide Polymorphism (SNP) Genotyping Assay was performed on the DIO3 gene on chromosome 14 of 39 healthy and 4 epileptic subjects to detect for SNP rs945006 in the DIO3 gene. Thyroid stimulating hormone (TSH) and thyroxine (T4) levels were also measured in both groups to assess the effect of the DIO3 gene mutation on these hormones. There appeared to be no significant association between the SNP and epilepsy, although there is a slight trend in the Odds Ratio that suggests that individuals with the Guanine (G)/Thymine (T) genotype are 1.28 times more likely to have epilepsy. Likewise, TH levels between both groups did not show statistically significant differences. These findings suggest that there is no correlation between the rs945006 SNP and generalized idiopathic epilepsy.

INTRODUCTION

Epilepsy is a central nervous system disorder in which nerve cell activity in the brain becomes disrupted, causing seizures or periods of unusual behavior, sensations, and sometimes loss of consciousness. Epilepsy has no identifiable cause in about 15-20% of those with the condition. In others, the condition may be traced to various factors such as genetics, head trauma, brain conditions, infectious diseases, prenatal injuries, and developmental disorders (Jallon & Latour, 2005). Our research focused on the genetic influence of the DIO3 gene polymorphism in idiopathic epilepsy.

The DIO3 gene found in chromosome 14 codes for Type 3 Deiodinase (D3). This enzyme is highly expressed in the pregnant uterus, placenta, and fetal and neonatal tissues, playing an essential role in the regulation of THs inactivation during embryological development. There are a number of mutations in the DIO3 gene that make the D3 enzyme functionally inactive (Kuiper, Klootwijk, & Visser, 2003), making it worthy of study since the D3 enzyme is also involved in the maintenance of the physiological function of the central nervous system (CNS) during development (Santini et al., 2001), THs are metabolism regulators, and they play a significant role in the development of the prenatal and postnatal brain. Thyroid hormone dysregulation in neonatal/gestational development causes defects in both cellular and anatomical structures due to abnormal

activity, which may play a determining role in pathogenesis of epilepsy (Tamijani et al., 2015). Uncorrected THs regulation in early life may result in irreversible neurological and motor deficits. THs influence neurological migration, differentiation, myelination, synaptogenesis, and neurogenesis in developing and adult brains. THs also seem to affect the brain's ability to defend itself against antioxidants (Das & Chainy, 2004), and hyperthyroidism has been associated with increased oxidative stress (Venditti & Di Meo, 2006). TH concentrations have also been compared in epileptic patients and non-epileptic patients on a variety of anti-epileptic drugs. It has been found that epileptic patients have elevated thyroid hormone concentrations compared to the control group, and patients taking anti-epileptic drugs showed lower concentrations of thyroid hormones (Larkin, J. et al., 1989).

Our focus was the rs945006 SNP of Guanine to Thymine (FWD) in the DIO3 gene, with an allele count of G=0.1897/950 (1000 Genomes). Although this SNP has shown no clinical significance regarding THs measures in healthy adults (Panicker et al., 2008), we surmised that it may be associated in the alteration of the D3 enzyme during neonatal/gestational development, resulting in the abnormal levels of THs observed in idiopathic epilepsy.

MATERIALS & METHODS

Study Population

Participants (N=44) were recruited from the Weber State Ogden Campus. Individuals were given a survey to self-report disease status and various demographic data (Table 1). QIAamp® DNA Mini Kit was used for DNA extraction from buccal swabs. Subjects were instructed to swab the inside of their cheeks, alternating for 45 s, followed by venipuncture for blood collection. Blood samples were sent to the Ogden Clinic laboratory for TSH and T4 assays.

DNA COLLECTION AND GENOTYPING

Buccal swabs were placed in a 2 mL microcentrifuge tube and stored at 4°C. 500 µL of PBS were added to the samples. 20 µL of Proteinase K and 500 µL of AL Buffer were added to the samples and then mixed immediately by vortexing for 15 s. Samples were incubated at 56°C for 10 min and then briefly centrifuged to remove droplets from inside the lid. 500 µL of ethanol (96-100%) were added to the samples, mixed again by vortexing, and briefly centrifuged to remove droplets from inside the lid. 700 µL of the mixture were carefully pipetted to QIAamp Mini spin columns (in a 2 mL collection tube) without wetting the rim. The caps were closed, and then centrifuged at 8,000 rpm for 1 min. The QIAamp Mini spin columns were then placed in a clean 2 mL collection tubes, and the tubes containing the filtrates were discarded. 700 µL of the remaining mixture were pipetted again to the QIAamp Mini spin columns. The columns were carefully opened and 500 µL of Buffer AW1 were added without wetting the rim. The caps were closed and the columns centrifuged at 8,000 rpm for 1 min. The columns were then placed in a clean 2 mL collection tube, and the collection tube containing the filtrate was discarded. 500 µL of

Buffer AW2 were added to the columns and then centrifuged at full speed of 14,000 rpm for 3 min. The columns were placed in new 2 mL collection tubes, and the old collection tubes with the filtrate discarded. The new tubes were centrifuged at full speed for 1 min. The columns were placed in a clean 1.5 mL microcentrifuge tube, and the collection tubes containing the filtrate were discarded. 100 μ L of Buffer AE were added to the columns and incubated at room temperature (15- 25°C) for 5 mins, and then centrifuged at 8,000 rpm for 1 min. 100 μ L of Buffer AE were added again to the columns. The columns were then centrifuged again at 8,000 rpm for 1 min and then stored at -25°C. Samples were thawed and aliquoted to an optical reaction plate to be quantified and analyzed using a BioTeK® Epoch 2 Microplate Spectrophotometer. Samples were then stored again at -25°C.

Samples were thawed again and diluted to 1.3 ng/ μ L and both the original samples and the diluted samples were stored at -25°C. Diluted samples were thawed for analysis using TaqMan® SNP Genotyping Assays custom SNP. The G nucleotide probe was labeled with a VIC fluorochrome, and the T nucleotide probe was labeled with a FAM fluorochrome. The 40X Custom SNP Genotyping Assay was diluted to a 20X working stock solution. 11.25 μ L of DNA sample were mixed with 12.50 μ L of 20X TaqMan® Master Mix and 1.25 μ L of 20X Assay Working Stock in a 96-well plate. MicroAmp® Optical Adhesive Film was placed over the plate and then centrifuged briefly before being placed in the QuantStudio™ machine. The AmpliTaq Gold®, UP, and Enzyme Activation step were held for 10 min at 95°C. There were 40 cycles of the denaturation step for 15 s at 95°C, and 40 cycles of the annealing/extension step for 1 min at 60°C.

STATISTICAL ANALYSIS

Statistical tests were done using the Plink Software (Purcell et al., 2007). The Hardy-Weinberg Equilibrium test was done to assess genotype frequencies. Linear and logistic regressions were also performed. R Studio was used for the Shapiro-Wilk Normality Test and the Student's t-Test for the analysis of the mean.

RESULTS

There were 44 patients enrolled, including 27 males and 17 females. The mean age of the study was 25.80 (range, 19-60 years). There were a total of 40 control patients and 4 epileptics, 2 of which had their condition under control with medication (Table 1). Ethnicities included 38 Caucasian, 4 Hispanic, and 2 Asian. TSH mean was 1.730 (range, 0.764 – 4.705 mIU/L), and T4 mean was 8.952 (range, 5.700-14.300 μ g/mL). The rs945006 SNP was successfully identified in 43 out of the 44 subjects. Out of the 43 subjects, 33 had a T/T genotype, 9 had a G/T genotype, and there were no G/G genotypes (see Figure 1). The Hardy-Weinberg Equilibrium p-value for all three genotypes was 1 showing a good quality of the genotyping assay. The means and standard deviations of TSH for the T/T and G/T genotypes were 1.744/0.841 and 1.680/0.571, respectively. The means and standard deviations of T4 for the T/T and G/T genotypes were 9.1/2.3 and 8.8/2.4, respectively (see Table 1). The linear regression analysis showed that the genotypes explain

about 0.11% of the variation in TSH levels with $P > 0.05$, and 0.25% in T4 levels with $P > 0.05$. The logistic regression showed an Odds Ratio value of 1.292.

DISCUSSION

The purpose of this study was to correlate mutations in the DIO3 gene and idiopathic epilepsy by identification of the rs945006 SNP in epileptic and non-epileptic subjects. TSH and T4 levels were also measured to assess any dysregulation in adult THs levels due to the mutation. There appears to be no significant association between this specific genotype and epilepsy, though there is a slight trend in the Odds Ratio suggesting that individuals with the G/T genotype are at 1.28 times more likely to show the epileptic phenotype.

The overall effect of the regression is not significant due to the low allelic sample size. The P-values were not significant. It was not expected to get significant TH values because the genotype mutation should not have had clinical significance in healthy subjects, but we were expecting to find a significant correlation between the mutation and TH values in epileptic subjects. The mutation frequency may be more significant if the epileptic sample size were greater than 4. The logistic regression analysis shows that for every T nucleotide there is a 1.3 times likelihood to have epilepsy. There is a 20-30% increase in risk, except the confidence interval ranges were from 0.1-14.0. These values are non-significant due to high variation and a small data set.

Further investigation and research linking the DIO3 gene to epilepsy requires a larger epileptic sample size to yield any statistically significant results. Ultimately, a better study could be done by working in conjunction with neurologists treating epileptic patients by collecting blood and DNA samples at the time of diagnosis before therapy.

Enzymatic activity of the D3 enzyme with the rs945006 SNP on the DIO3 gene could also be analyzed in vitro using different methods for detecting protein-DNA interactions, similar to what has been done with Catechol-O-Methyltransferase (COMT) (Chen, J. et al., 2004). Another approach could be measuring THs levels from neonatal blood samples and perform DNA analysis on babies that display abnormal Electro Encephalographic (EEG) activity, although sample collection may be more intrusive due to the young age of the subjects. This may also be controversial due to the ethical nature of dealing with neonates. This research would also require a more extensive IRB petition and researchers with more experience and credentials.

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TABLES & FIGURES

Table 1. Demographic distribution among epileptic subjects.

| Gender | Ethnicity | Non-epileptic | Epileptic | Total (N=44) |
|--------|--------------|---------------|-----------|--------------|
| Male | Caucasian | 23 | 1 | 24 |
| | Hispanic | 1 | 0 | 1 |
| | Asian | 2 | 0 | 2 |
| | Total | 26 | 1 | 27 |
| Female | Caucasian | 12 | 2 | 14 |
| | Hispanic | 2 | 1 | 3 |
| | Asian | 0 | 0 | 0 |
| | Total | 14 | 3 | 17 |

Distribution of participants into their respective categories.

Table 2. Demographic TSH and T4 values.

| Variables | TSH (mIU/L) | | T4 (µg/mL) | |
|------------------|-------------|-------|------------|-----|
| | Mean | SD | Mean | SD |
| Gender | | | | |
| Male (n=27) | 1.889 | 0.857 | 8.1 | 3.4 |
| Female (n=17) | 1.478 | 0.565 | 10.5 | 2.5 |
| Ethnicity | | | | |
| Caucasian (n=38) | 1.696 | 0.781 | 8.8 | 2.2 |
| Hispanic (n=4) | 1.548 | 0.292 | 11.55 | 2.3 |
| Asian (n=2) | 2.749 | 0.936 | 6.9 | 1.1 |
| Genotype | | | | |
| T/T (n=34) | 1.744 | 0.841 | 9.1 | 2.3 |
| G/T (n=9) | 1.680 | 0.571 | 8.8 | 2.4 |
| Epilepsy | | | | |
| Negative (n=40) | 1.695 | 0.582 | 8.8 | 2.3 |
| Positive (n=4) | 1.338 | 0.459 | 10.2 | 2.8 |

Means and standard deviations (SD) are shown for each variable included in the study.

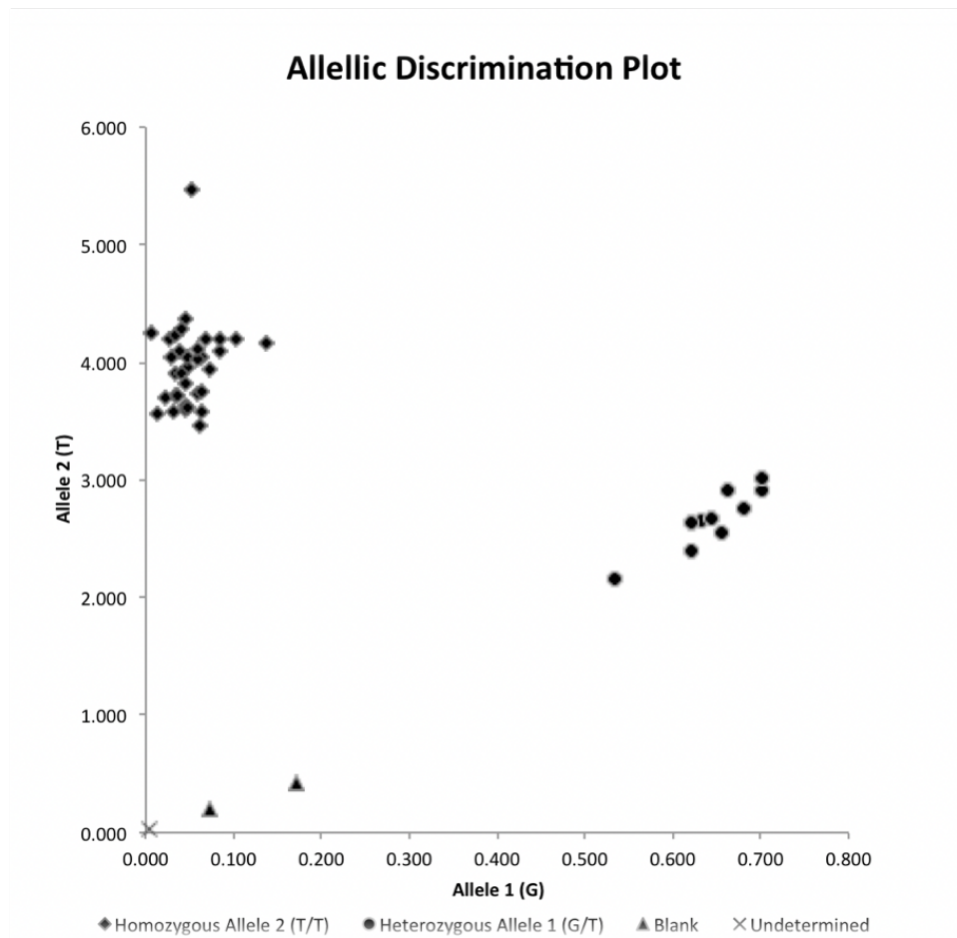


Figure 1. Genotype calls for rs945006. Diamonds represent the homozygous T/T genotypes, and circles represent the heterozygous G/T genotypes. There were no homozygous G/G genotypes. The “X” represents the undetermined samples and the squares represent the blanks.

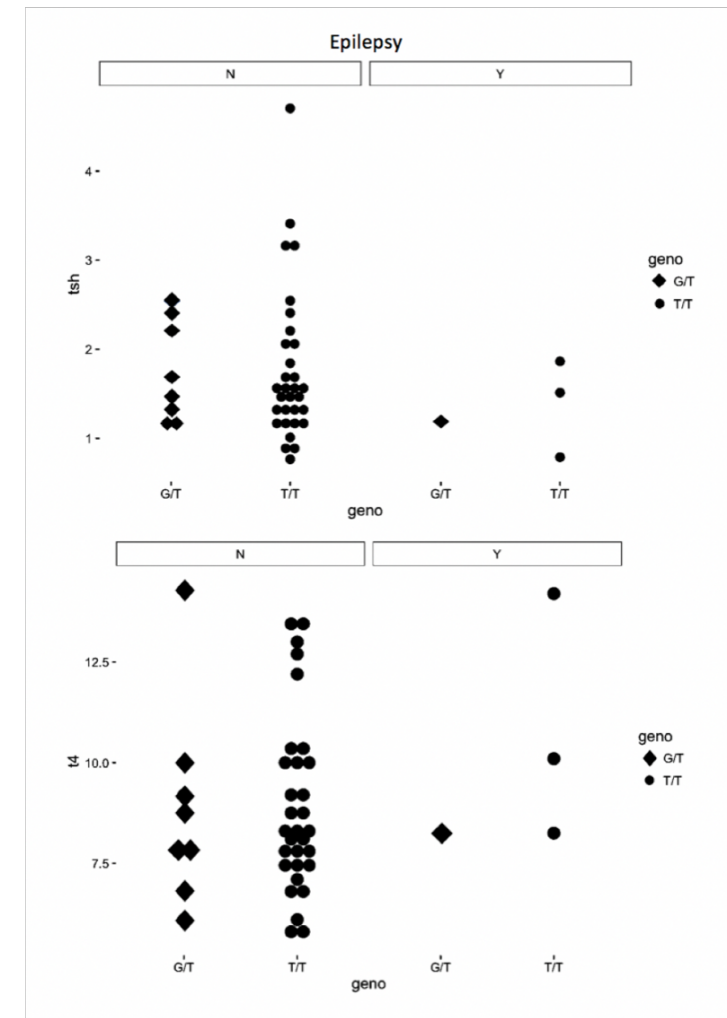


Figure 2. TSH and T4 levels are compared against the genotypes and phenotypes (epilepsy). As shown, there was a small epileptic sample size. Both TSH and T4 values are spread out among the genotypes.

The logo for the College of Science is a large, stylized letter 'S' composed of several overlapping, semi-transparent grey shapes. The text 'College of Science' is written in a white, serif font across the middle of the 'S' shape.

College of Science

Effect of Bio-Protective Lactic Acid Bacteria on *Lactobacillus Wasatchensis*

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MICROBIOLOGY

ABSTRACT

Late gas defect in aging cheese results in significant losses to the manufacturer. A new nonstarter lactic acid bacteria (NSLAB), *Lactobacillus wasatchensis*, was isolated from aged Cheddar cheese exhibiting late gassy defect. Experimental and survey data indicates *Lactobacillus wasatchensis* is an important cause of late gas defect in aged Cheddar cheese. Controlling growth of this unwanted organism could be done by incorporation of specific lactic acid bacteria strains (termed bio-protective cultures) into the cheese during manufacture, which would inhibit its growth during aging. Determination of inhibition between bio-protective cultures and *Lactobacillus wasatchensis* was done using the spot test along with the agarflip method. MRS supplemented with 1.5% ribose (MRS-R) was inoculated with each bio-protective culture and incubated anaerobically at 25°C for 48 h or 72 h. The agar was flipped over and either *Lactobacillus wasatchensis* WDC04 or CGL04 was swabbed on the exposed surface and the plate incubated anaerobically at 25°C for up to 72 h. At an incubation time of 48 h, bio-protectives LB-3, P210, P220 did not produce a significant zone of inhibition than the other test cultures since results for *Lactobacillus brevis*, *Lactobacillus fermentum* LF7469, and P200 all had similar but identifiably larger inhibition zones. With an incubation time of 72 h, P200 showed the largest inhibition zones for both the *Lb. wasatchensis* WDC04 and CGL04. The next most inhibitory bio-protective culture was LB-3 against WDC04, and *Lb. fermentum* LF7469 also produced a large zone of inhibition. To test for bacteriocin production by the test cultures, a paper disc assay test was performed. Results confirmed that a number of test cultures were producing a bacteriocin by showing a very small zone of inhibition of *Lb. wasatchensis* around the paper disc. Compound diffusion into the media shows that inhibition was due to secretion of inhibitory compounds. Examining the antagonism between bio-protective cultures and NSLABs for *Lb. wasatchensis* strains allows for selection of lactic acid bacteria strains that could inhibit this problematic bacterium during cheese ripening.

INTRODUCTION

A novel non-starter lactic acid bacteria (NSLAB), *Lactobacillus wasatchensis*, was recently isolated from a sample of gassy Cheddar cheese manufactured at Utah State University, Logan, UT (Oberg et al., 2016). *Lactobacillus wasatchensis* uses ribose as its primary carbohydrate and forms pinpoint colonies after 48 h of anaerobic incubation on de Man, Rogosa, and Sharpe (MRS) agar supplemented with 1.5% ribose (MRS+R). Since isolation of NSLAB has generally been restricted to species forming easily observed col

onies within 2 d at 30 or 37°C on MRS with glucose as the primary carbohydrate source (Oberg et al., 2011), *Lb. wasatchensis* and other slow-growing lactobacilli species have been overlooked in past attempts to isolate bacteria that cause gas problems and textural defects in aging Cheddar cheese.

Late gas formation (“late gassy defect”) in Cheddar cheese is a concern among manufacturers especially during accelerated ripening (Mullan, 2000). This defect is generally manifest by slits or voids in the cheese body and/or “blown” packaging wrappers in cheeses aged longer than 3 months (Laleye et al., 1987). Gassy defect tends to be sporadic, recurrent and has been experienced at most cheese-making plants (Mullan, 2000). During cut and wrap packaging prior to retail sale, late gassy defect can affect cutting cheese blocks uniformly and even the slicing ability of the cheese during the commercial cutting process. If the defect is severe, the block can crumble upon cutting, increasing cutting losses by up to 50% (Elliott et al., 1981; Donnely et al., 2014). Since the cheese is downgraded and sold at a lower price, time and money spent on the aging process are also lost (Martley and Crow, 1996; Golnazarian, 2001).

Lactobacillus wasatchensis produces gas in experimental cheese batches when added to milk at a concentration of 10^4 cfu ml⁻¹ and in controlled culture studies (Ortakci et al., 2015b,c). These studies have shown that after 23 weeks of incubation at 12°C, gas accumulates in the cheese packaging, inflating the bag and causing splits in the cheese with an increase in the detectable number of presumptive *Lb. wasatchensis* to 10^8 cfu g⁻¹ (Ortakci et al., 2015b,c). The presence of this organism in commercial Cheddar cheese could mean the possibility of the cheese becoming blown or split during aging, resulting in downgraded cheese.

Other NSLAB cultures are always present in the cheese (Banks and Williams, 2004; Peterson and Marshall, 1990), and there have been observations in the laboratory that some of these NSLAB strains can inhibit *Lb. wasatchensis* (Walker, 2016). A potential way to control the growth of *Lb. wasatchensis*, which propagates very slowly during the first few month of cold storage, is to incorporate competitive lactic acid bacteria cultures that produce inhibitory compounds specific for *Lb. wasatchensis*. Lactic acid bacteria species and strains produce a wide range of bacteriocins (O’Sullivan, 2002; De Vuyst and Leroy, 2007), and some of these may inhibit the growth of *Lb. wasatchensis*. Interactions between antagonistic NSLAB in aging cheese may explain some of the randomness of late gassy defect even in the same lot of cheese.

The purpose of this research was to determine if strains of *Lactobacillus* species commonly found in cheese could inhibit the growth of *Lb. wasatchensis*. Of particular interest were a group of commercial lactobacilli cultures previously designated as bio-protective cultures, along with several cultures shown to have an inhibitory affect in previous work (Walker, 2016). In addition, another research objective was to implement the spot test incorporating the agar flip method so inhibition results could be quantified to make more accurate comparisons.

MATERIALS AND METHODS

Media

De Man, Rogosa, and Sharpe (MRS) media was used to propagate all cultures. Broth for growth of *Lb. wasatchensis* strains and agar petri plates for the spot test contained 1.5% ribose added to the MRS (MRS-R agar) to ensure *Lb. wasatchensis* growth since it has been shown to require ribose for rapid growth (Ortakci et al., 2015a).

Organisms

Lactobacillus wasatchensis WDC04 was tested against four lactobacilli bioprotective cultures supplied by Vivolac Inc. (Indianapolis, Indiana). The four cultures were *Lb. rhamnosus* P-200, *Lb. paracasei* P-210, *Lb. paracasei* P-220, and *Lb. rhamnosus* LB-3. In addition, several NSLAB cultures that showed some inhibition of WDC04 in previous experiments (Walker, 2016) were examined using the spot test, both as controls and to see if the spot test provided more accurate measurements than the previously used challenge test. Additional test cultures were *Lactobacillus fermentum* 23271, *Lactobacillus fermentum* 7469, *Lactobacillus brevis*, *Lactobacillus casei* F19, and *Lactobacillus paracasei* (LiLa).

Spot Test

MRS-R agar plates were prepared with each petri plate containing 20 ml of agar to standardize the diffusion rate between test plates. Fifteen microliters of the test culture was inoculated in the center of the plate and the plate incubated for the designated time at 30°C anaerobically in a GasPak™. Plates were then removed from the GasPak™, the agar was aseptically flipped over and a 48 h broth culture of either *Lb. wasatchensis* WDC04 or CGL04 swabbed as a lawn on surface of MRS-R. Plates were then incubated anaerobically in a gaspak for 72 hours at 25°C with the zone of inhibition measured in mm afterwards.

Bacteriocin Production

To determine if a bacteriocin was present resulting in inhibition of *Lb. wasatchensis*, broth cultures were prepared of the four different bio-protective cultures in MRS-R broth. After 48 h of incubation, 1.5 ml of broth was removed and spun down at 13,000 G for 5 min. The supernatant was then filtered through a 0.45 µm filter followed by a 0.22 µm filter to generate a cell-free extract. The resulting filtrate was stored at -80°C. This process was repeated at 72 and 96 h. Two strains of *Lb. wasatchensis* (WDC04 and CGL04) were inoculated onto MRS-R agar plates by swabbing them across the agar surface. Aseptic technique was used to place two blank BBL Taxo 13mm diameter Paper Discs on each agar plate. 70 microliters of each bio-protectant culture filtrate was pipetted on each appropriate disc. Plates were incubated anaerobically in a gaspak at 25°C for 40 h.

Soft Agar Bacterial Overlay

The bio-protective cultures were spotted on plates and incubated to the same specifications in the spot test procedure. After incubation, the agar was flipped using aseptic technique. The overlay consisted of 0.8% soft agar made with MRS and 1.5% ribose added. Two hundred (200) microliters of *Lb. wasatchensis* (WDC04 and CGL04) were

added to 4 ml of soft agar, vortexed, and then poured on the flipped agar plate. The agar was allowed to set-up for 5 minutes and the plates were incubated in GasPak jars at 25°C for 120 h.

RESULTS

All the test cultures used in this experiment displayed some level of inhibition for both strains of *Lb. wasatchensis*, WDC04 and CGL04. The bio-protective cultures exhibited the greatest zones of inhibition (Figures 1 and 2). Generally, the longer the bio-protective test cultures were allowed to incubate on the MRS-R plate before being challenged with the *Lb. wasatchensis* cultures, the greater the zone of inhibition. After the flip plate method was performed and *Lb. wasatchensis* WDC04 and CGL04 were incubated for either 48 or 72 h, results indicated a small increase in the inhibition zone for several of the test cultures at 72 h.

The 48 h incubation time of the bio-protective cultures did not produce significantly greater zones of inhibition than other test cultures. *Lactobacillus brevis*, *Lactobacillus fermentum* LF7469, and P200 all had similar inhibition zones (Figure 1). *Lactobacillus brevis* exhibited slightly more inhibition towards *Lb. wasatchensis* WDC04 with an average zone size of 25 mm, and CGL04 with an average zone of inhibition of 22 mm at 48 h (Figure 1). When extending the test culture incubation time to 72 h, P200 showed the largest inhibition zones for both the *Lb. wasatchensis* WDC04 and CGL04. The next most inhibitory bio-protective culture was LB-3 and *Lb. fermentum* LF7469, which also produced a large zone of inhibition (Figure 2). Results of the paper disk assay confirmed that a number of test cultures were producing a bacteriocins against *Lb. wasatchensis* around the paper disk where inhibition took place (Figure 3).

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Antagonism between lactic acid bacteria has been well documented. Some strains are able to significantly inhibit other strains (Fox, et al., 1998; Banks and Williams, 2004). Our results show that selected strains of bio-protective lactic acid bacteria could be incorporated into the cheese and have the potential to inhibit *Lb. wasatchensis*. Results indicate that the longer the bio-protective culture grows, the greater the inhibition suggesting that the inhibitory compound accumulates over time.

In order to determine if the cultures produced a bacteriocin, a spot test was used. This test showed small zones of inhibition around the paper disk, which indicates the bio-protective bacteria are producing a bacteriocin. Another factor that can influence the inhibition of *Lb. wasatchensis* WDC04 and CGL04, includes how well the bacteriocin diffuses through the media (MRS-R). Other organisms that are a part of cheese normal flora also exhibited inhibition towards *Lb. wasatchensis* WDC04 and CGL04 suggesting there are more potential bio-protective cultures that may be available for use in cheese production and aging. Understanding the antagonistic relationships between *Lb. wasatchensis* and other lactic acid bacteria that are part of the cheese microbiota could be a way to reduce this gassy

defect in aged cheese. Controlling growth of *Lb. wasatchensis* could be achieved through the addition of adjunct cultures to cheese that could suppress its growth. Fortunately, these adjunct cultures are part of the NSLAB cheese population and can therefore be added in larger amounts. By doing this there is a possibility of slowing the formation of gassy cheese.

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FIGURES

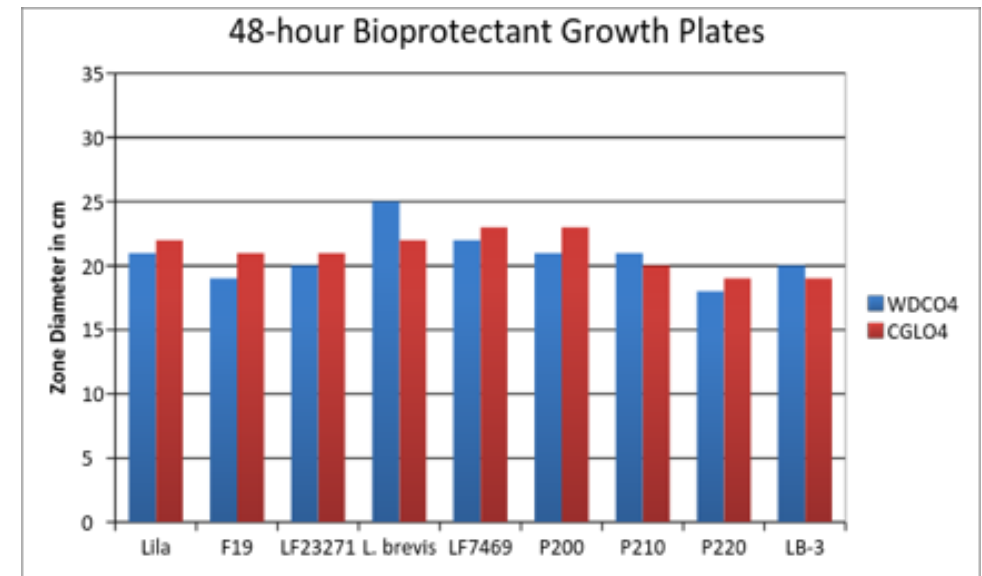


FIGURE 1. Inhibition zones for bio-protectant cultures against *Lactobacillus wasatchensis* WDC04 and CGL04 after the bio-protectant culture had incubated for 48 h with WDC04 and CGL04 incubated at 25°C for 72 h.

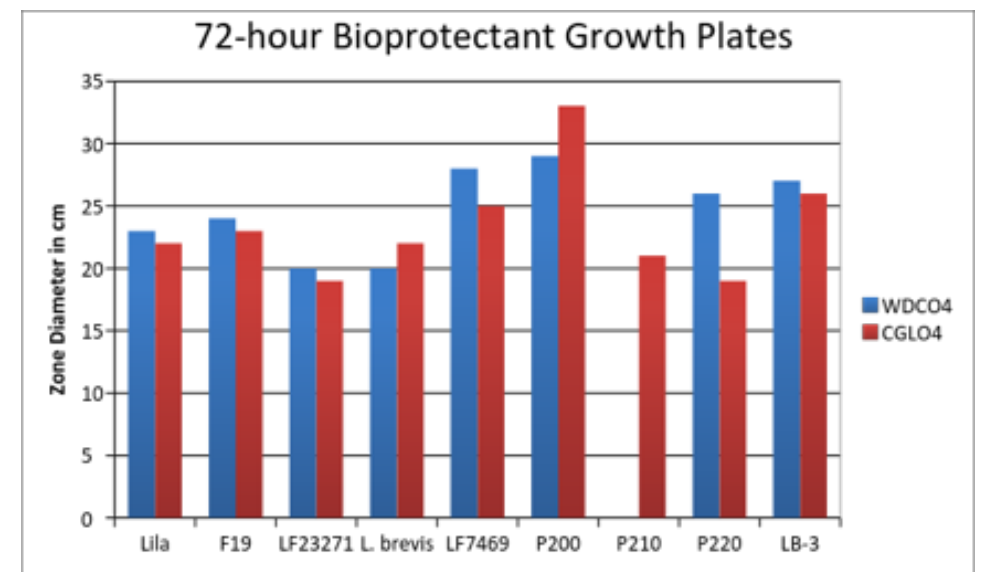
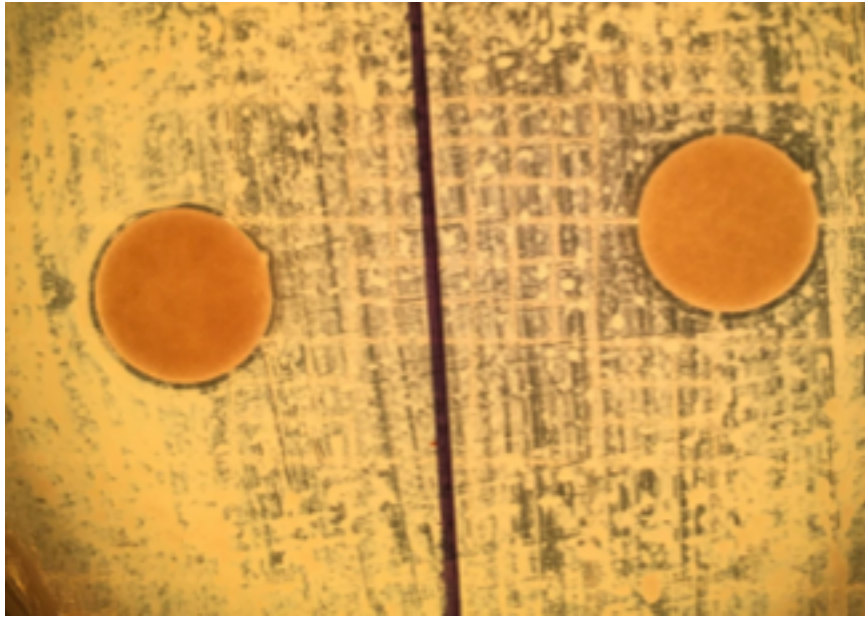


FIGURE 2. Inhibition zones for bio-protectant cultures against *Lactobacillus wasatchensis* WDC04 and CGL04 after the bio-protectant culture had incubated for 72 h with WDC04 and CGL04 incubated at 25°C for 72 h.



P-220

LB-3

FIGURE 3. Evidence for the production of a bacteriocin by P-220 (left photo) and LB-3 (right photo). The bacterial lawn on the MRS-R agar is *Lb. wasatchensis* with the small zone of clearing around the paper disk indicating bacteriocin inhibition.

Double-Crested Cormorant Foraging Responds to Fish Stocking in Suburban Ponds in Northern Utah

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ZOOLOGY

ABSTRACT

Double-crested cormorant (*Phalacrocorax auritus*) foraging on fish populations has increasingly become a problem in North America. The cormorant is a piscivorous bird which populates a wide variety of aquatic habitats. Our project quantified the level of cormorant foraging in local stocked fishing ponds in relation to water temperature, turbidity, and fish-stocking date. We hypothesized lower water temperatures would lead to greater foraging success. By contrast we expected greater turbidity to decrease foraging success for these visual predators. Finally, we expected foraging to increase just after stock dates and decrease thereafter. Foraging was observed at two ponds: Farmington Pond in Farmington, Utah, and Meadow Creek Pond in Roy, Utah. For 31 days, we surveyed both ponds concurrently, from 06:00 to 14:00, taking a census of the number of cormorants present, the surface water temperature, and turbidity using a Secchi-tube, at half-hour intervals. We noted foraging cormorants surfacing with and swallowing fish, and time of catch. Fish species could not be systematically determined. Cormorant foraging success was estimated by how many fish were caught per hour. We used Pearson correlations to determine relations of fish per hour versus: 1) mean daily water temperature and turbidity, 2) number of days post fish stocking, and 3) mean number of cormorants fishing per hour. Cormorants caught a total of 669 fish, but neither water temperature nor turbidity were correlated to fish caught per hour. We found a positive correlation between the number of cormorants at a given pond and the number of fish caught per hour, and a negative correlation between the number of days since the ponds were stocked and the number of fish caught. Our findings indicate that cormorant foraging success at stocked suburban ponds in northern Utah is driven primarily by the number of fish stocked and the stocking dates. Environmental conditions have minimal impact.

INTRODUCTION

The double-crested cormorant (*Phalacrocorax auritus*) is a highly adaptable piscivorous bird which populates many aquatic habitats in North America (Cornell Lab of Ornithology, 2015). They are powerful swimmers, diving for long periods to catch their prey. Once considered an endangered species, they were placed on the list of protected species under the Migratory Bird Treaty Act of 1918 (USFWS, 2016). The species has lately made a robust comeback to their traditional territories, and have encroached into non-traditional territories. Cormorant foraging on sport and economic fish populations has increasingly

become a problem worldwide (Kumada et al., 2013).

In 2001, the Utah Division of Natural Resources (UDNR) began partnering with local Utah communities in an effort to create sport fishing opportunities in man-made ponds near urban areas. Since then, the population of cormorants foraging at these ponds has risen. This may give the perception that the cormorants are possibly disrupting sport fishing for which these ponds were intended, but there is still no concrete evidence of this. While non-lethal harassment, such as chasing the birds with remote control boats, has been shown to effectively distract cormorant foraging elsewhere (Hawkes et al., 2013), the UDNR has not taken part in an official effective harassment policy at the present time.

Our objective was to study the relationship between levels of cormorant foraging, environmental conditions such as water temperature, turbidity, and time of fish stocking. It was intended that more intensive observations would shed light on real versus perceived success of the foraging cormorants and show whether cormorant foraging success is under environmental influence. Water temperature, for example, directly affects burst speed in prey fishes (Cairns et al., 2008). Also, turbidity can affect underwater vision (Strod, et al. 2008). We also predicted that when more prey fish were present after stocking, cormorant foraging success would be greater. Therefore, we hypothesized that the above environmental conditions and fish stocking dates would affect the foraging success of cormorants.

MATERIALS & METHODS

Study Site

Meadow Creek Pond in Roy, Utah (Figure 1) and Farmington Pond in Farmington, Utah (Figure 2) are both located in the north-central portion of the west side of the Wasatch Mountains. Farmington Pond is in the foothills and receives snow-melt runoff from Farmington Creek. Farmington Pond is 16190 m², with some tree coverage. The average depth for Farmington Pond is roughly 3.7 m. Meadow Creek Pond is roughly 8 km west of the mountains and receives the majority of its input from groundwater and suburban runoff. Meadow Creek is also 16190 m², with some tree coverage. The average depth of Meadow Creek Pond is 1.4 m. Both sites are located within residential areas and have consistent angler activity.

Environment Conditions

Each day from 2-31 May 2016, two two-person teams surveyed each pond concurrently, from 06:00 to 14:00. Upon the team's arrival, observation began with a census of cormorants, and environmental parameters such as surface water temperature, water turbidity, air temperature, and wind speed were measured. Surface water temperature was measured with a standard thermometer. Water turbidity was measured with a Secchi-tube. Both air temperature and wind speed were measured with a Kestrel 1000 Pocket Wind Meter. After initial measurements, the number of cormorants and surface water temperature were documented at half-hour intervals for the

Cormorant Activity

If no cormorants were present at the beginning of the observation, the time of the first arrival was documented. Thereafter each two-person team attempted to document all instances of cormorants surfacing with a fish and noted the time when the fish was swallowed. The exact species of the fish could not be systematically determined. If all cormorants left during the set observation time, the team would stay for one additional hour. If no cormorants returned, the team ended the observation.

Fish Stocking

The stocking schedule and amount the fish were stocked were taken from the UDNR's stocking report located within their website, <https://wildlife.utah.gov/>.

Data Analysis

Cormorant foraging success was estimated by how many fish were caught per hour. We used IBM SPSS software to run Pearson correlations to determine relations of fish caught per hour versus: 1) mean daily water temperature, 2) turbidity, 3) number of days post fish-stocking and 4) mean number of cormorants fishing per hour. The total number of fish per hour was calculated by dividing the individual totals of fish caught per pond and divided by the total number of observation hours for each pond. We performed a Student t-test and linear regression test to assess significance.

RESULTS

Observations were taken for 30d, totaling 314h. Meadow Creek averaged 5.74 cormorants/hr, while Farmington averaged 2.76/hr. The total fish caught for Meadow Creek was 407, while Farmington saw 264 fish caught. The total fish/hr for Meadow Creek and Farmington ponds were 1.77 and 1.5 fish, respectively. Water temperatures for Meadow Creek ranged from 12 - 18.8 and turbidity from 14.7 to 65 cm. Farmington water temperatures ranged from 3 - 8.5 and turbidity from 4.8 to > 100 cm.

There was no correlation between water temperature and cormorant fishing success (Meadow Creek $R = 0.25$, $df = 27$, $P = 0.20$; Farmington $R = 0.06$, $df = 27$, $P = 0.75$). The same was true for turbidity (Meadow Creek: $R = -0.03$, $df = 27$, $P = 0.87$, Farmington: $R = -0.29$, $df = 27$, $P = 0.14$) and wind speed (Meadow Creek: $R = -0.29$, $df = 27$, $P = .141$, Farmington: $R = 0.09$, $df = 27$, $P = 0.64$). Meadow Creek Pond was consistently more turbid than Farmington Pond ($t = -5.82$, $df = 27$, $P < 0.01$), yet did not show less success overall ($t = 0.80$, $df = 27$, $P = 0.43$). There was a significant correlation between the number of cormorants on site at a pond and the number of fish caught (Meadow Creek: $R = 0.79$, $df = 27$, $P < 0.01$, Farmington: $R = 0.81$, $df = 27$, $P < 0.01$). There was also a significant negative correlation found between the number of days since the last fish stocking of the pond and the number of fish caught by cormorants. That is, the more time passed since the most recent stocking, the fewer fish caught by cormorants each hour (Meadow Creek: $R = -0.43$, $df = 27$, $P = 0.02$, Figure 3; Farmington: $R = -0.431$, $df = 27$, $P = 0.02$, Figure 4).

DISCUSSION

We hypothesized that environmental metrics would play a significant role in the foraging success of cormorants. Specifically, endotherms have greater success when foraging for ectotherms in cooler water (Cairns et al., 2008), so water temperature was expected to have the greatest impact on foraging success. As cormorants are visual hunters, we expected turbidity would also significantly effect on their ability to fish (Strod, et al. 2008).

The results show that cormorant foraging success in these two locations correlates most strongly with the availability of prey fish, to such a degree that all measured environmental metrics were not predictive. This strongly suggests that the availability of prey will overcome water temperature and turbidity for foraging cormorants. Furthermore, fish stocking appears not only to increase fishing success but also to attract additional cormorants.

The relationship between stocking dates and catch rates would be worth exploring in possible future studies. There are several sport fishing ponds within the foraging radius of the cormorants nesting at the Bear River refuge (Dorr et al., 2014). A larger survey tracking how quickly more of these locations are depleted would provide better data as to the actual effects of cormorant foraging on numbers of prey fish.

Although agonistic nesting behaviors between cormorants and ground nesting birds has been studied (Somers et al, 2011), documenting how other piscivorous birds, such as the American white pelican (*Pelecanus erythrorhynchos*), which were often spotted during the observations, actively compete with cormorants while foraging at these locations would be helpful. This would help support or reject the assumption that cormorant foraging success alone is negatively correlated with angler success at these ponds.

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FIGURES

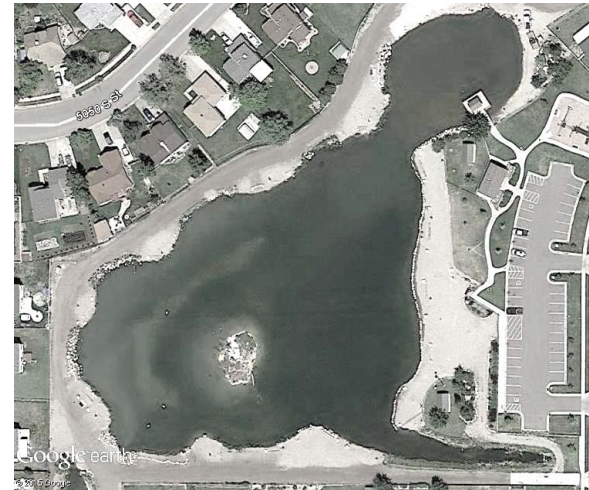


FIGURE 1 Meadowbrook Pond, Roy, Utah



FIGURE 2 Farmington Pond, Farmington, Utah

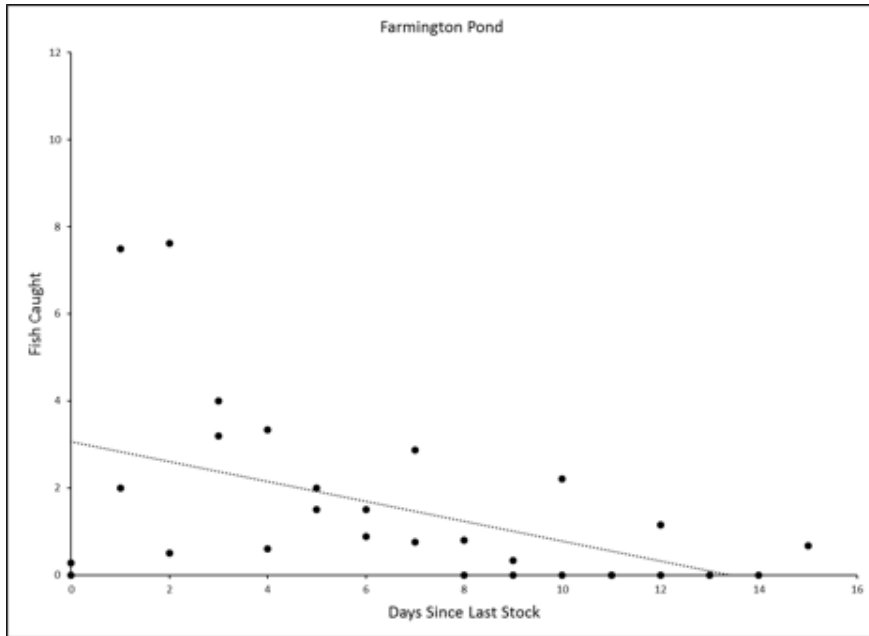


FIGURE 3. Days elapsed since the last fish stock by DWR vs. Number of fish caught by cormorants for Meadow Creek Pond in Roy, UT ($R=-0.431$, $p=0.020$).

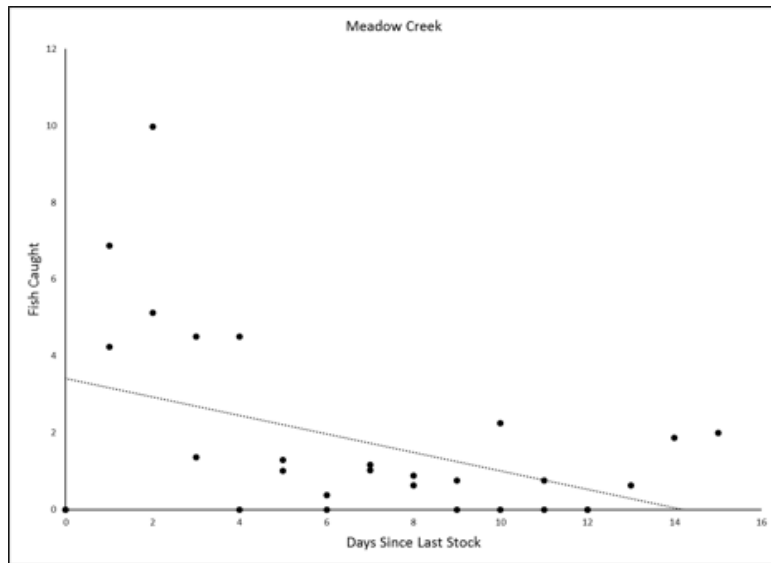


FIGURE 4. Days elapsed since most recent stocking by DWR vs. Number of fish caught by cormorants at Farmington Pond in Farmington, UT ($R=-0.431$, $p=0.020$).



College of Social & Behavioral Sciences

Particulate Matter Pollution Monitoring and Community Perception in Weber County, Utah

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Mentor: DAN BEDFORD

GEOGRAPHY

ABSTRACT

The Particulate Matter Pollution Monitoring, conducted in Utah's Weber County, occurred from late spring to early winter of 2016. The campaign had two targets. The campaign had two targets: The first was to investigate the 24-hour average concentrations of PM_{2.5} and PM₁₀ to gain an understanding of the dynamics of particulate pollution, and the correlation, or lack of correlation, of topographical elevations and the duration of poor air quality occurrences. The second target investigated the current air quality knowledge of Weber County citizens, their perception of air pollution, and their possible contribution to poor air quality. This paper reviews these topics and analyzes air quality sensor data in an attempt to ascertain human contribution to the air pollution problems that plague Utah.

THE BACKGROUND

Although many improvements are being made across the United States, air pollution continues to be an alarming issue for many states, including Utah. Utah has some of the worst air in the country at various times. In recent years the particle pollution counts have caught the attention of local citizens, as well as making national news because of high levels of pollution. Many citizens are sensitive to the poor ambient air quality throughout the year. Respiratory sensitivities, due to allergies, or diseases could potentially be exacerbated.

All residents of Utah, including fauna, are directly affected by pollution, even if one does not have allergies. We all need clean air. Seasonal inversions trap and hold particulates, which only increases the ambient air pollution, especially during winter months. The mountains of the Wasatch Range form a bowl by surrounding the valley floor. Warm air traps the cold, dense air, down in the valleys, contributing to a buildup of particulate pollutants, stifling the air movement along the Wasatch Front. Poor air quality impacts all living things because the particles are small and migrate easily. Particles smaller than or equal to ten micrometers are smaller than a human hair or even a fine grain of sand. The composition of particles can be complicated. Some particles can contain a mixture of liquid droplets, dust, or smoke, and can alternate from a gaseous state to a solid state. There are some particulates that can be seen with the naked eye. Others are microscopic and are only visible through the use of an electron microscope. The two particle sizes that will be measured in my study will be of two weights; PM_{2.5}, fine, inhalable particles and PM₁₀, inhalable particles. These particles combine with smog or other pollutants and the combination makes the air look hazy. These particles can enter the lungs, heart, and brain of any living creature, which can cause serious health effects.

In addition to the sensor particulate counts, it is important to understand the public's perception of the ambient air quality, so a twelve or six question survey was given to random Weber County Citizens. These serious health effects underlie the goals of my project, which are to, first, investigate the habits of Ogden residents and their knowledge of air pollution, and, second, to study the behavior, ebb, and flow, of particle pollution.

Weber County is one of several areas in Utah that has a recurring poor air quality rating from establishments like the American Lung Association, U. S. Environmental Protection Agency, Airnow.gov, World Health Organization, and Utah Department of Air Quality. Utah has two compounding issues, a growing population that prefers to drive, and a mountainous topography that adds to seasonal temperature inversions (Holmes, et al., 2015). Air pollution causes health issues in much of the human population, flora and fauna. To solve the current failing air quality and to direct citizens to a practical course of action the perceptions of citizens should be understood. Measuring and analyzing the behavior of Particulate Matter during lower temperature events, elevation levels, and active weather patterns to include inversions, will provide insight into causation. Exposure to these particulates can cause various health maladies, which can be noticed by local citizens.

Particulates are always in the ambient air, but not all particulate counts are harmful to living things. Since we are not always aware of the dangerous levels around us, eleven sensors have been installed in Weber County. Only four air quality sensors had been installed previously. Three of those sensors were the PurpleAir brand, and one other sensor belongs to the State of Utah. The PurpleAir Sensor is an optical particle counter. Maps of the sensor locations are provided in Figures 1 and 2. The research questions were, "What is the particle pollution concentration level around the Ogden area on any given day?" And "What are residents doing to contribute to particle pollution?"

Results from sensor monitoring and survey responses have been compiled into a final report, discussing the findings of the air pollutant monitoring data and the seventy-nine survey responses from the public.

The following are examples of sensor data, displayed in graphs, during August of 2016. The data compares the average monthly particulate counts with the mean particulate counts at various times of day. The first example is for a sensor located near the mouth of Weber Canyon Highlands and the second is for a sensor in the Hooper city lowlands. They both display a raised concentration beginning around 7 pm, but the Weber Canyon Sensor readings drop off around 10 pm, while the Hooper sensor readings show high concentrations until 5 am.

DISCUSSION AND CONCLUSION

Graphical comparisons of max pollution levels, by time of day with weather conditions (air temperature and active weather patterns) do show some interesting relationships, as discussed below. Pollution levels do indeed rise at expected times of day: the morning and evening commute, approximately 7 AM to 9 AM, and the evening commute, approximately 4 PM to 7 PM. On weekends the build up of pollution particles is delayed slightly. Another correlation of particulate concentration was seen during inversion and holiday

events. Sensors display very high concentrations, during evening and early morning hours; this should be explained by firework ignitions during the months of July and January. In the lower elevations the pollution levels tend to pool and have a prolonged duration of high concentrations of $PM_{2.5}$ and PM_{10} , as seen in Hooper sensor graph provided on the previous page.

Pollution levels rise during Cold Air Pools (CAPs) when cold air is trapped in low-lying areas such as valley floors. Overlaying storm patterns onto graphs of pollution levels reveals that when light rain is falling, the pollution levels decrease (the temperature also decreases, but cannot necessarily be credited with the drop in pollutant levels). When the rain is heavy the temperature drops, but the pollution levels rise, due to the violent collisions of raindrops onto surfaces that have accrued a condensation of pollution particles, stirring up the particles into the air, as displayed in Graph 3 below.

Survey responses varied. Intuitively a correlation might be expected between household illnesses such as sinusitis or asthma or bronchitis and knowledge of air pollutants or realization that when air pollution is at higher levels the general health of family member suffers. The survey responses fail to support that intuitive supposition. Similarly, an increase in academic education shows no correlation to increased knowledge of air pollution particles or their effect on human health.

Daily commute time and distance driven show no correlation to ownership of hybrid vehicles, nor does there seem to be a relationship between carpool/vanpool and public transit and daily commute time and distance. The lone hybrid owner reported a commute time of 5 minutes.

Owners of diesel-powered vehicles do not seem to idle their vehicles any more than the owners of gasoline-powered vehicles although a couple of respondents did say that the vehicle will be idling anytime they are inside it regardless of their knowledge of pollution particles in the air.

This study confirms that concentration of particulate matter increases during high traffic hours and decreases during early morning hours. The exception is the lowest elevations, specifically seen by the Hooper Sensor, where concentrations of matter pooled for extended periods of time, well into early morning hours. Additionally, weather turbulence also seems to affect the particulate matter counts in all sensors regardless of their elevation value. Multiple factors affect the levels of pollution including weather patterns and conditions such as rain, snow and wind, traffic patterns, the day of the week, and the time of day. Accounting for these multiple factors would require additional analysis, which could illustrate a correlation that, so far, is unseen. Placement of additional sensors in the Weber County area would also provide additional sensor data, which could help understand the topographical effect on levels of pollution. Elevation, proximity to mountains, canyons, rivers, knolls, plateaus, etc. may also affect localized levels of pollution. Continued study and monitoring of seasonal data is required. There were correlations formed with sensor data, however, there were no correlations made with the seventy-nine survey responses. A clearer insight into citizen's perception of air pollution could be provided if a greater number of surveys were completed.

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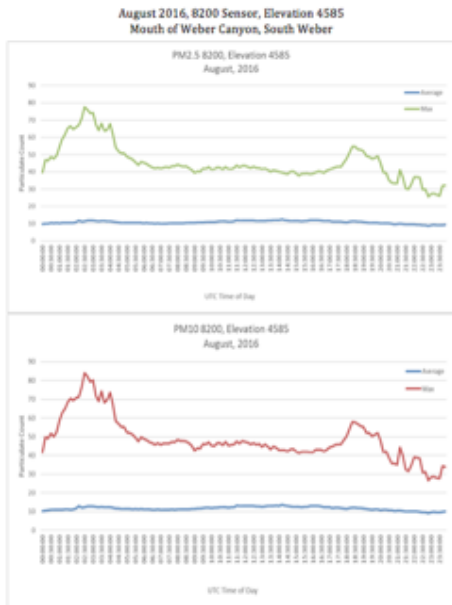
FIGURES



FIGURE 1: Air Quality Sensors before the research began

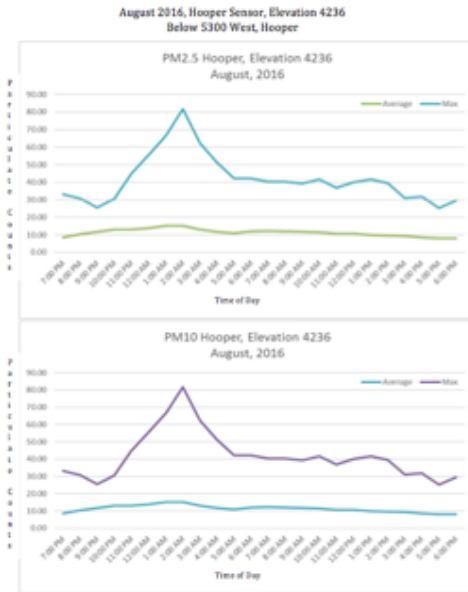


FIGURE 2: Air Quality Sensors after the research began



8200 Sensor max particulate counts stay high above 29 counts and spiking at 85 around 7pm. The average daily count for both are between 10 and 13 count throughout the month.

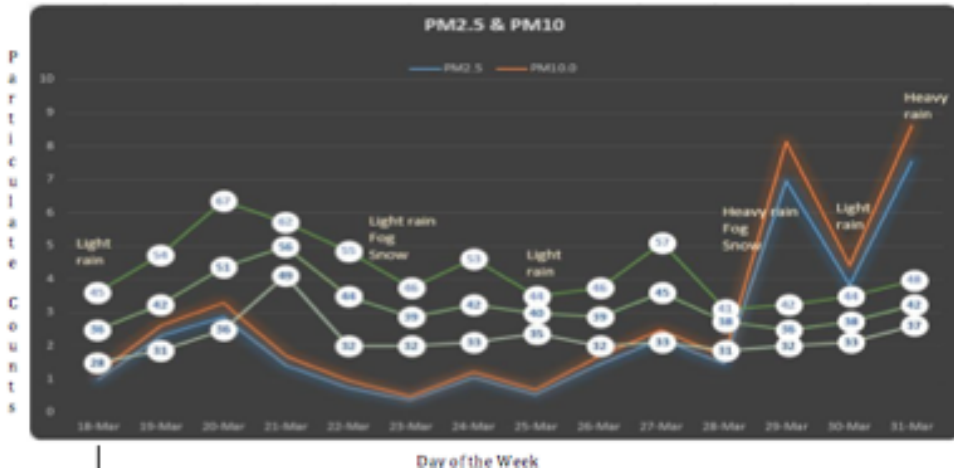
GRAPH 1. August 2016, Mouth of Weber County



Hooper Sensor max particulate counts soar up to 80 counts for both PM2.5 and PM10. These particulates concentrations gather from 10 pm until 5 am, then they level out around 6 am to a 40 count. The average count is above 10 for the duration of the month.

GRAPH 2. August 2016, Hooper

Graph 3, PM2.5 and PM10, during the month of March, with meteorological events.



Walking for Health with Pokémon Go

Author: AMY ORR

Mentor: BARRETT BONNELLA

SOCIAL WORK

ABSTRACT

Many Americans struggle with obesity and being overweight. One way that most people can stay healthier is to walk. Doctors and patients alike have struggled with the idea of how to make walking more appealing to the masses without success. Recently, a game was created that stands to turn things around: Pokémon Go. Pokémon Go is a type of video game that you can play on your phone. The main objective of this game is to collect Pokémon. By walking in the real world your character walks in the game world, collecting the Pokémon needed to further the game. The purpose of this study was to measure the impact of Pokémon Go on measured steps taken per day. I measured my average walking steps taken per day for one week, followed by a week of measuring my steps while playing Pokémon Go. Finally, I stopped playing for one week to see if my steps returned to baseline. The findings were then put into graph form and interpreted. I found that my steps went up in number during the intervention week, and though it dropped back down some, it did not go all the way back down to baseline afterwards. This could be significant but not conclusive since this study was so short and also because there was only one subject.

WALKING FOR HEALTH WITH POKÉMON GO

Obesity in the United States is a serious problem that we, as a society, need to address. According to an ABC News report in 2013, “More than 36 percent of Americans are now considered obese... [and] An additional 34 percent are considered overweight” (Neporent, 2013). With numbers increasing both on the scales and in the obese/overweight population size, more and more people need the motivation to lose weight. Walking is one form of exercise that is accessible to most and it alone may be enough to improve the health of this population.

According to one study done by a group of researchers from the University of Tennessee, “Adults [in the United States] reported taking an average of 5117 steps per day.” (Bassett et.al., 2010). They concluded “that low levels of ambulatory physical activity are contributing to the high prevalence of adult obesity in the United States.” Although many people think 10,000 steps per day is the ideal, that concept actually came from the name of a pedometer in Japan (manpo-kei) that translates to “10,000 steps meter”. The pedometer got very popular, and along with it the idea that walking 10,000 steps per day is the best for our health. That said, increasing one’s activity level in any way is likely going to be beneficial to his/her health (Rettner, 2014).

A study led by T. Dwyer (2016) examined whether or not walking is inversely related

to obesity. As part of their study, 1126 out of 1848 people who completed the AusDiam survey also wore a pedometer for two days. Dwyer measured the results using waist circumference and body mass index (BMI). Although he recommends further testing, his study showed a definite connection between how many steps a person took and their waist circumference and BMI. This study showed that walking more can deter obesity and lead to better health.

There are many cell phone apps to help people start walking more, one of them being Pokémon Go. It has had more media representation than any other app for a very good reason. It appears to be getting people walking on a large scale. Kate Silver (2016) wrote an article for The Washington Post examining this issue. Among interviews with people who have started walking more because of Pokémon Go, she has also offered some convincing numbers. Among 35,000 people who use Cardiogram Apple Watch, there was “an increase in users’ overall exercise the weekend after Pokémon Go launched. The exercise increase was across the board... On the day of the launch, about 45 percent of users were exercising 30 or more minutes. Two days later, on a Saturday, that number rose to 50 percent. The next day, it hit 53 percent” (Silver, 2016). Also, people using the UP fitness tracker mentioned Pokémon Go in their comments. “On average, the group that mentioned Pokémon Go was walking 62.5 percent more than usual” (Silver, 2016). And finally, “Mike Caldwell, co-founder of Pacer... says that his team looked at Pacer users... and saw a 5 to 10 percent increase in daily steps, overall, since the Pokémon Go launch, compared with the previous week” (Silver, 2016). Because it was across the board, and the data was collected without knowledge of who did and who didn’t play the game, we have no way of specifically linking these increases to Pokémon Go, but the likelihood is very high.

METHODS

In order to study the connection between playing Pokémon Go and an increase in the number of steps taken per day, I used a single subject design, with myself as the subject. I am a 44-year-old white female with a fairly busy lifestyle, yet not a lot of physical activity when beginning this study.

I purchased a Fitbit step tracker to count my steps taken per day. A Fitbit is an activity tracker that connects wirelessly with your computer or cell phone to keep track of steps taken, floors climbed, heart rate, and sleep quality. For the study, I would wear the Fitbit from the time I got up in the morning until the time I went to bed in the evening. At the onset of this study, I wore the Fitbit for one week beginning on a Thursday and ending on the following Wednesday, tracking my step numbers each day for my baseline. After downloading the Pokémon Go app on my iPhone, I began my intervention phase of the study. I played Pokémon Go while continuing to monitor my steps taken each day for another week. Next I began a week without the intervention as a return to baseline where I stopped playing Pokémon Go and kept tracking my steps from my Fitbit each day for the third and final week.

RESULTS

The step counts for each of the three weeks was collected and put into graphs. The graph in figure 1 plots each day's steps. With this graph, we can see that the changes in step count were subtle across the three-week period. The baseline shows a fair incline, while the intervention week shows an incline that is visibly steeper. You have to look closely, though, to see that the incline of the return to baseline week is a bit more than that of the baseline and only slightly less than that of the intervention week.

The other two graphs, figures 3 and 4, are used to show the results of this study. Figure 3 shows the total weekly step count between the three weeks and Figure 4 shows the average weekly step count. These graphs show virtually the same pattern as each other and give a clearer picture of the differences in steps walked between the three weeks of the study. As you can see, during the intervention week, I walked roughly 30 percent more than the first baseline week. Then for the third week, where I stopped playing Pokémon Go, my step count went down, but still stayed higher than my baseline.

DISCUSSION

Before playing Pokémon Go I had a fairly inactive lifestyle with an average daily step count of 3,725 compared to the national average of 5,117 steps. While I enjoyed walking, I rarely found time to do it. I have also always enjoyed playing video games. The first day of the second week recorded by far the most step counts for the three-week period at 10,439 steps. I found myself trying to find longer paths to places I often walked to. For example, when going to class, instead of parking at the parking lot next to my class I parked in one farther away. I also went on walks with my children to look at what Pokémon were around the neighborhood and we even drove to parks where there were a lot of Pokémon stops. I enjoyed playing Pokémon Go but did find that by the end of the intervention week, it felt like it got in the way of my walking. I would prefer to put my phone in my backpack with the app running to get the steps and walk without the hassle of holding my phone in front of me all the time.

I predicted at the beginning that my step count would go up by playing Pokémon Go, but I was surprised to see what happened for the following week when I stopped playing. My step count did go down a bit from the intervention week, but it stayed pretty high compared to the first week of baseline. I think it went down because without playing Pokémon Go there was no longer a reason to go to the park with my teen-age children. We also did not go on as many neighborhood walks. But it stayed high for a couple of key reasons. I got used to parking farther away and finding new ways to walk places and I found that I enjoyed the walking more than playing the game. I realized that it no longer felt like too much trouble to walk to nearby places as opposed to driving everywhere, so I kept doing it.

One problem with this research is that I found that interest in the game waned as I played it. I still enjoyed it for the entire week, but a longer study might show different results.

Another reason I believe this study turned out like it did is because of the weather during the study. It was the middle of summer when the weather was consistently nice and predictable. If this study was done in the winter, it may have shown a difference in walking distance. Another one of the problems in this research is that it is mainly speculation. Though there is good reason to speculate, as people commenting on Pokémon Go in the apps and the timing of the increase in steps across the board in virtually all the fitness apps seems more than coincidental. Still, it has yet to be tested specifically to my knowledge. I believe this is due to lack of time rather than interest, as the game has only been out to play for a short time in the United States. Again, if this study were done over a longer time period, the general outcome could reflect a more consistent pattern.

Two limitations with this study were that it was not only short, but only had one test subject. Because of this these findings are not conclusive, but they do suggest that Pokémon Go and similar apps may be worth more extensive research regarding their effect on how much people walk. Seeing the widespread success of the Pokémon Go game and the seeming massive increase in physical activity because of it, I think more studies should be done to see more of the long-term effects of the game and if they are consistent with the initial increases. Even if there are minor things to change to make it better, it could help the scientific community to produce an even more effective app that could do even greater good.

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FIGURES

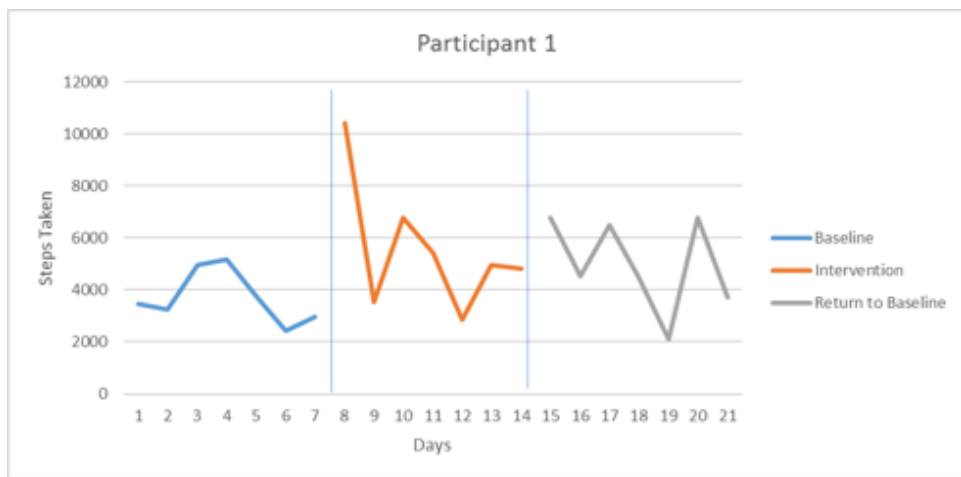


FIGURE 1. Daily step count. This figure illustrates the number of steps taken for each of the baseline, intervention, and return to baseline phases of the study.

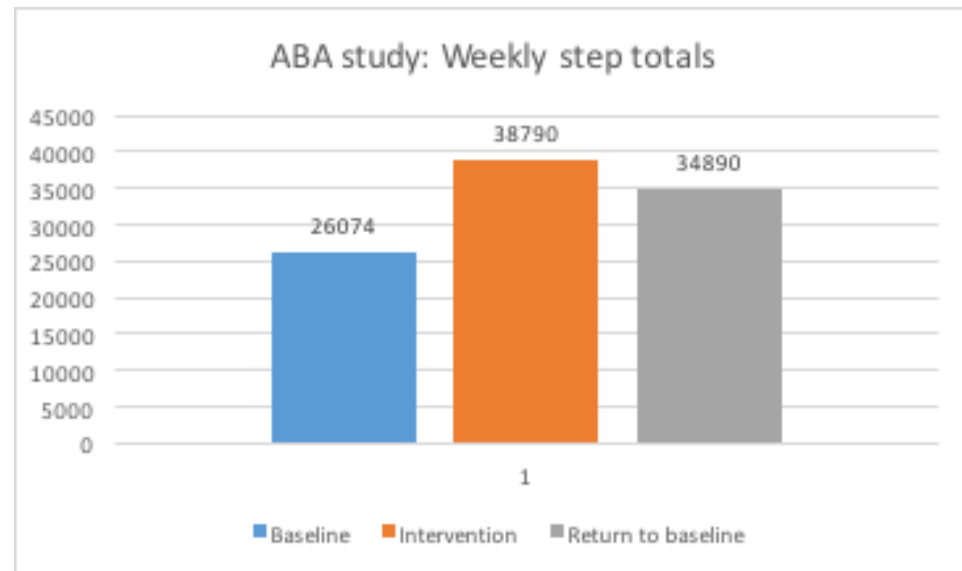


FIGURE 2. Weekly step totals. This figure illustrates the total number of steps taken each week.

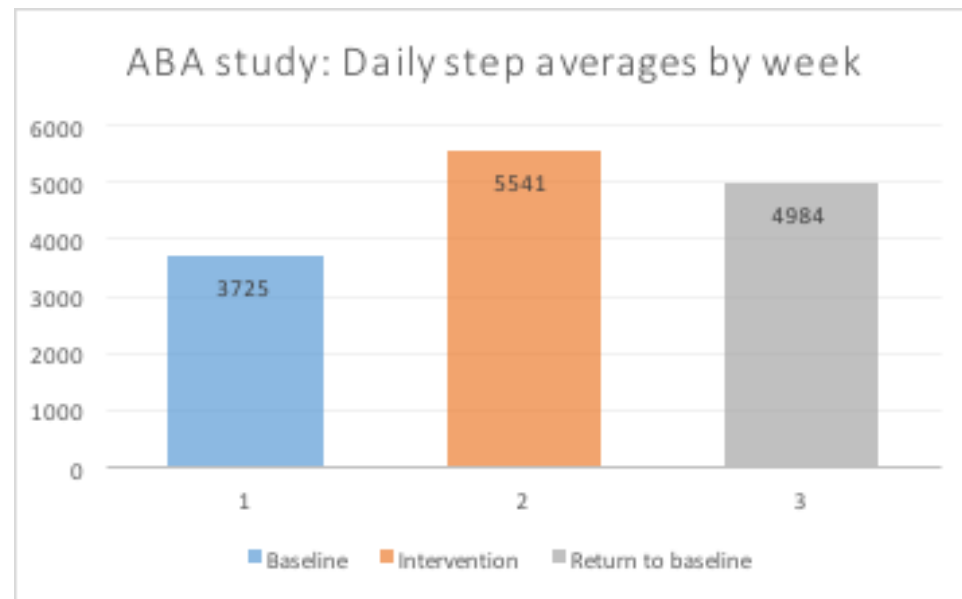


FIGURE 3. Daily step averages by week. This figure illustrates the average number of steps taken each week.

ABSTRACTS

Microstructure and Optical Properties of Perovskites

Author: NICHOLAS ALLEN
Mentor: KRISTIN RABOSKY

The Four Corners and Texas Sectors of the American Physical Society Joint Meeting
LAS CRUCES, NEW MEXICO (October 20 – 23, 2016)

Traditional silicon solar cells are costly and require much energy to refine the silicon. A developing alternative technology which shows great promise are perovskite solar cells; the active layer being made of $\text{CH}_3\text{NH}_3\text{PbI}_3$. We created perovskite samples using a spin-coating technique. After the samples were created, they were examined under an SEM to verify that they had a homogeneous amorphous structure. The sample thickness was determined using an AFM and an ellipsometer. A UV-Vis setup was also built using a monochromator, a series of lenses, and a detector in order to test the bandgap of the samples. By varying our material deposition techniques, we were able to create an amorphous sample with a bandgap of about 1.6 eV, which closely matches the solar spectrum. We will discuss our perovskite deposition process at WSU.

Deletion Mutation in Patients Diagnosed with IBS and Asthma

Authors: BRODY BARNEY | AUBREE NIELSEN | CHRISTIAN SMITH
Mentor: MATTHEW NICHOLAOU

NCUR 2016
UNIVERSITY OF NORTH CAROLINA AT ASHEVILLE, NORTH CAROLINA (April 7-9, 2016)

Cystic fibrosis (CF) is a genetic disorder which causes thickened secretions in the body. Approximately 70% of CF cases are caused by the F508deletion mutation (rs113993960) in the CFTR gene. People homozygous for the mutation suffer from malabsorption, digestive issues, and pulmonary obstructive symptoms. Irritable bowel syndrome (IBS) is a broad diagnosis for patients experiencing any kind of idiopathic disruption in their digestive processes. Asthma also has many subset causes, some of which are not yet known. The goal of this study is to find the prevalence of rs113993960 in the Northern Utah population diagnosed with IBS and asthma. These researchers theorize that a number of patients with IBS and/or asthma carry one copy of the mutation (are heterozygous). A decreased expression of the CFTR gene could explain the presence of CF-like symptoms in IBS/asthma patients. 250 subjects who have IBS and/or asthmas, plus 50 healthy control will be selected. DNA will be collected by use of a buccal swab and extracted using a Qiagen DNA extraction kit. A TaqMan™ SNP (single nucleotide polymorphisms) genotyping assay will identify the frequencies of rs113993960 in the participants. This study will find that participants with IBS or asthma have a significantly higher prevalence of mutant alleles compared to healthy controls. Knowing the prevalence of CF mutations in the IBS and asthma populations could potentially impact the treatment of patients with the use of CF treatment methods.

Genetic Exploration of Invertebrate Diversity in Great Salt Lake

Author: OSCAR BEDOLLA
Mentor: JONATHAN CLARK

Annual Meeting of Sigma Xi and Student Research Conference
ATLANTA, GEORGIA (November 11–13, 2016)

Great Salt Lake (GSL), in northern Utah, is the largest salt-water lake in the Western Hemisphere, with a total surface area of 4400 square kilometers. Great Salt Lake is the center of one of the world's most important migratory bird habitats, supporting an estimated population of over 7 million individuals. The ecology of GSL is influenced by three invertebrates: brine flies, the brine shrimp, *Artemia franciscana*, and the bug, *Trichocorixa*. There are no published studies on the distribution or identification of other invertebrates in the GSL ecosystem. DNA barcoding has become the international recognized standard for species identification and uses universal DNA sequence comparisons to differentiate species on the basis of genetics. The DNA barcode database includes information from thousands of samples from ecosystems around the world. This study examines the cytochrome c oxidase gene to establish DNA barcodes for samples of invertebrates associated with the GSL ecosystem. Data on interspecific and intraspecific sequence variation are considered and sequences are used to examine local species phylogenies. The results of this study can be compared to those from other saline environments to provide insights into the distribution of invertebrates in these important and underappreciated ecosystems.

Speech and Language Disorders: Working Memory and its Influence on Developing Language Skills

Author: AUBURN BINETTE
Mentor: AARON ASHLEY

Rocky Mountain Psychological Association
DENVER, COLORADO (April 14-16, 2016)

In recent years there has been growth in research regarding speech and language disorders. However, due to underlying factors, they have been shown difficult to study (Bishop et al., 2004). Because of this, there are not set definitions of what a speech disorder is, only diagnostic characteristics that may (but not always) be seen. With more research we are coming closer to understanding the differences between speech and language disorders, as well as treatment interventions that will best help the individual.

The current research represents an attempt to further examine three categories of speech and language disorders. It will also assess whether increases in working memory are accompanied by increased reading comprehension ability. There are two research studies associated with this project: the first is to measure working memory and reading comprehension to see if there is in fact a positive correlation associated between the two, and the second is to examine the effects of working memory training on both working memory efficiency and reading comprehension. We hypothesize that 1) There will be a positive correlation between both working memory and reading comprehension ability, and 2) Working memory can be trained to work more efficiently, which will increase reading comprehension.

Residential Stability and Trust in the Police

Author: CHRISTOPHER BINNING
Mentor: HEEUK LEE

Western Association of Criminal Justice
LAS VEGAS, NEVADA (October 11 – 14, 2016)

Studies have shown that the homeowners of a neighborhood may be a crucial source of stability and social cohesion in a community where they reside. Few empirical attempts have been made to identify the residential stability associated with the level of trust in the police. Using community survey data collected from over 400 citizens in a city in one of the mountain states, this study explores the importance of residential mobility, public perception and experience with police in predicting trust in the police. The results from the analysis found statistically significant predictor variables in support of the existing literature in regards to public trust in the police. There was a significant relationship between the residential stability and trust in the police. Limitations and future studies are discussed.

Social Anxiety, Religiosity, Gender Identity, and Sexual Orientation

Author: PRESTON BRADLEY
Mentor: THERESA KAY

Rocky Mountain Psychological Association
DENVER, COLORADO (April 14 – 16 2016)

The purpose of the present study is to examine levels of socially facilitated stress and fear in LGBTQ and allied individuals. In addition, we will measure individuals' levels of religious affiliation, taking into account denomination and how religiously active the individual is, in attempt to observe any interactions between religious association and social stress in LGBTQ individuals. Some research indicates that LGB individuals have reported experiencing higher levels of social anxiety than their straight counterparts (Safren & Pantalone, 2006). Studies have also indicated that religious affiliation and religiosity predict attitudes toward LGBTQ individuals. For example, one study revealed that non-Protestant individuals were much more likely to support same-sex unions than their Protestant counterparts. (Olson, Cadge, and Harrison, 2006). Furthermore, stronger beliefs that one's religion contains fundamental, inerrant truths appear to correlate with more automatic negative evaluations of homosexual relative to heterosexual individuals (Rowatt et al., 2006). A survey will be utilized comprising of two subscales. The first section of the survey will ask individuals to provide basic demographic information. They will be prompted to provide their age, gender, and sexual orientation, and the religious denomination with which they associate. The first subscale will include questions from the Centrality of Religiosity Scale (Huber and Huber, 2012) and aim to gather information regarding to what degree religion plays a role for the subjects. The second subscale will attempt to gather information regarding social anxiety using questions from the Social Phobia Inventory Test (Davidson et al., 1997). It is expected that levels of social anxiety will be positively correlated with greater levels of religious presence for LGBTQ individuals.

Who Knows What Little Red Riding Hood Believes and Feels?

Author: SANDRA DANSIE
Mentor: ERIC AMSEL

Rocky Mountain Psychological Association
DENVER, COLORADO (April 14 – 16 2016)

The story of Little Red Riding Hood (LRRH) has been used to investigate how children understand false beliefs and emotions. Although understanding that LRRH believes that only her grandmother is in the house, children from 4 – 5 still attribute fear to LRRH due to the wolf's actual presence (Bradmetz & Schneider, 1999; Harris, de Rosnay, & Ronfard 2014; Ronfard & Harris, 2014; Rosnay, Pons, Harris, & Morrell, 2004). In the present study, 4- to 7-year-old children were assigned to play various roles in a version of a play of Little Red Riding Hood in a local children's museum. In any given run of the play, children were assigned to one of three characters (Little Red, the Wolf, or the Narrator) and then acted out the character's role under the direction of researchers. Just as Little Red knocks on Grandma's door, the play was frozen and participants were independently asked what LRRH believes and feels. Children playing the Wolf ($M = 2.05$) out-performed LRRH ($M = 1.13$) by almost a full point with the Narrator ($M = 1.59$) performing in the middle. Only the difference between LRRH and the Wolf was statistically significant ($p < .05$). The same pattern emerged for the false belief and the emotion questions analyzed separately. There were more than twice the proportion of participants getting all three questions correct as the Wolf (55%) than as LRRH (22%), which again was significant ($p < .05$). The finding is a preliminary confirmation that acting out the deception may be key in children's understanding of not only false belief (Chandler, Fritz & Hala, 1989; Hala, Chandler & Fritz, 1991; Wellman, Cross, & Watson, 2001) but also the emotions which follow as a consequence.

The Harmful Effects of Segregating Oral and Medical Care

Author: JOY ENCE
Mentor: FRANCES MCCONAUGHY

American Dental Hygienist's Association Center for Lifelong Learning 93rd Annual Session
PITTSBURG, PENNSYLVANIA (June 7 – 10, 2016)

Objective: This research project was designed to study and explore the harmful effects of segregating oral and medical care. The academic work represents the agenda of the ADHA to expand access to care and raise awareness of the detrimental effects impacting our current national standard of care.

Background and Problem Statement: In our current healthcare setting, oral and medical care is segregated. This barrier is responsible for the perpetuation of a number of illnesses, including aspiration pneumonia. This leads to increased mortality rates with a significant decline in quality of life in all healthcare settings. The greatest challenge to the health care profession and the communities we serve is the lack of cognizance of the mortality rate and its correlation to oral health care.

Methodology: We evaluated several peer-reviewed research articles from different journals and educational resources. After careful evaluation we selected the top three articles that provided the most current and thorough examination of our selected topic. These articles showed qualitative and quantitative research suggesting a strong correlation between oral care and disease.

Conclusion: These illnesses are entirely preventable with the establishment of a dental hygiene position within healthcare facilities. We expect to increase access to care and the need of a dental hygienist in medical facilities. This will improve the quality of care of patients while decreasing mortality rates. Awareness will be raised through hands-on professional education by dental hygienists to medical staff, families, and communities.

Using Media Tools to Model Real World Situations

Author: YOLANDA FREDRICKSON
Mentor: PAMELA PAYNE

National Council on Family Relations Annual Conference
MINNEAPOLIS, MINNESOTA (November 1 – 5, 2016)

Dr. Pamela B. Payne and I will present on “Using media tools to model real world situations in family life education courses” at the 2016 National Council on Family Relations Annual Conference in Minneapolis, Minnesota. She is piloting the notion of utilizing media, specifically videos, to teach a parent education course for undergraduates. I conducted the majority of the literature review for this project.

Are We Leaving Things Out? Cognitive Dissonance Education vs Workplace

Author: AYSIA FOST
Mentor: SHELLY COSTLEY

American Dental Hygienists' Association Annual Session
PITTSBURG, PENNSYLVANIA (June 7-11, 2016)

Objective:

This table clinic was designed to further study what items, if any, may be being left out of a registered dental hygienist's performance, and the reasoning for leaving them out. We hypothesize that registered dental hygienists are leaving items out due to money and time constraints. Our objective behind this table clinic is to further research on the subject, and later implement solutions to fix the problem. Background and Problem Statement: As students of a dental hygiene education and training program, we have learned to perform things within our appointments that we, or our patients, have never had performed in our previous visits to the dental office. As students, we are curious as to the reasoning behind some registered dental hygienists leaving items out; even after being educated on the importance of performing everything we are taught. Methodology: We intend to perform our own research in the future, to help find these answers and come up with solutions to the problem by administering an anonymous survey to registered dental hygienists throughout the United States. Included with the survey will be a place for suggestions on how to solve the problem. By doing so, we expect to raise the self-awareness of each individual registered dental hygienist and receive answers to our questions. Conclusion: There is great importance behind each task a dental hygienist is taught to perform in his, or her, appointments performed in school. By furthering our research, we believe that we will be able to raise awareness and come up with solutions as to how to overcome the outside forces that may be limiting registered dental hygienists to perform to his, or her, full potential. By doing so, patients will receive the quality of treatment they deserve.

Analysis of Urinary Biomarkers in the Diagnosis of Depression

Author: JEREMY GARCIA
Mentor: RYAN ROWE

Rocky Mountain Psychology Association
DENVER, COLORADO (April 13-17, 2016)

Depression is a common psychological disorder and is frequently misdiagnosed. Currently, there is not an objective diagnostic tool for depression; clinicians must rely on symptoms of their patients in order to make a diagnosis. This study aims to provide clinical values of key biomarkers that will objectively differentiate between depressed and healthy patients. This study will analyze levels of Brain-Derived Neurotrophic Factor (BDNF), Norepinephrine (NE), and cortisol, found in participant urine. Adult men and women, currently living in the northern Utah area, will comprise the sample of 100 participants. Each participant will submit a first-morning-void urine sample and respond to the standardized demographic questionnaire and depression inventory. The Beck Depression Inventory will be used to classify participants as depressed or healthy control. All analytes will be measured using enzyme-linked immunosorbent assays (ELISA). Multivariate linear regression analysis will be used to determine how well this panel of analytes can be used to predict depression. Results will find that patients who identify as depressed will have decreased BDNF and NE levels and increased cortisol levels. These analyte concentrations will also decrease and increase respectively based on severity of depression in the participant. This study hopes to show that clinical psychologists and psychiatrists can accurately diagnose depression with the aid of an objective assay of BDNF, NE, and cortisol rather than solely interpreting the subjective feelings of their patients.

Downregulation of Glutathione S-transferase May Play a Role in Dietary Specialization

Author: ZACHARY GEE
Mentor: MICHELE SKOPEC

The Society for Intergrative and Comparative Biology
NEW ORLEANS, LOUISIANA (January 3 – 8, 2017)

Juniper foliage is a major component in the diet of some woodrats, even though it contains high levels of potentially toxic terpenes. In order to biotransform the terpenes in their diets, juniper specialists must utilize efficient metabolic pathways. Nitrogen is often a limiting factor for herbivores because plants have low levels of nitrogen and because nitrogen is lost in urine and feces. Thus it is important for herbivores to rely on biotransformation mechanisms that spare nitrogen. We analyzed liver samples from multiple populations of woodrats (genus *Neotoma*) that were either juniper specialists (*N. stephensi* and *N. lepida* from the Great Basin Desert) or not (*N. albigula*, a dietary generalist, and *N. lepida* from the Mojave Desert, a creosote specialist). This comparison allowed us to determine how strongly juniper specialists rely on the biotransformation enzyme glutathione S-transferase (GST). GST is an expensive phase II biotransformation enzyme because the conjugate contains three amino acids. We used the liver cytosolic fractions to measure variations in GST activity levels through absorption spectroscopy. While on juniper diets, both juniper specialists down-regulated their GST activity, while both non-juniper feeding species upregulated their GST activity. The down-regulation of GST by juniper specialists likely conserves nitrogen, which is scarce in the juniper foliage. Utilizing nitrogen sparing biotransformation pathways may represent an integral step in woodrats' adaptation to diets low in nitrogen and high in terpenes.

Presenting at Kasem Cares Aging Conference on Elder Financial Abuse

Author: PAULA HARBATH
Mentor: MARK ADAMS

Kasem Cares Conference on Aging
COSTA MESA, CALIFORNIA (April 21 – 24, 2016)

The American population that is elderly, defined by being 65 or older, is growing exponentially and at high risk for financial exploitation. This paper addresses the various aspects of Elder Financial Abuse through theories and methodologies that have been taken from gerontology, sociology and women and gender studies. It also describes typologies of abuse and how to identify elders at risk including information on alcohol and the effects it has on aging adults. Several individual stories are told, bringing this sad crime to a personal level. A reflection and survey on a creative project addressing Elder Financial Abuse that was presented at the Pleasant View Library in South Ogden, Utah is included. The reflection addresses observations throughout the facilitation of the project and tells stories of victims of financial exploitation. The survey evaluates if the awareness of Elder Financial Abuse can be raised through education, support materials and a PowerPoint presentation titled "Who's Watching the Back Door?"

Actual and Perceived Effectiveness of Mnemonics among Traditional and Non-Traditional Students

Author: CASSITY HAVERKAMP
Mentor: SHANNON McGILLVRAY

Rocky Mountain Psychological Association
DENVER, COLORADO (April 14 – 16, 2016)

Recent statistics suggest that over 70% of students enrolled in college courses are classified as non-traditional students. Non-traditional students include those meeting one of seven characteristics: delayed enrollment into postsecondary education; attends college part-time; works full time; is financially independent for financial aid purposes; has dependents other than a spouse; is a single parent; or does not have a high school diploma. Memory differences have been documented between traditional and non-traditional students, and this has obvious implications for learning and higher education. One factor that can increase learning and memory is the use of mnemonic strategies, or aids that increase the likelihood of remembering. However, no research yet exists on the similarities and differences between traditional and non-traditional students in regards to mnemonic effectiveness and also beliefs of the effectiveness of various mnemonic strategies. Participants were shown 4 word-pair lists with 15 unrelated word pairs (e.g., room-pig) and were asked to use a different mnemonic strategy on each list. Prior to the start of the list, participants were instructed on which mnemonic device to use (verbal repetition, interactive imagery, creating a short sentence, or taking the first letter of each and thinking of a related word pair) in addition to being asked about how many word pairs from each list/ mnemonic strategy they thought they would be able to remember (i.e., how effective they thought the strategy would be). Verbal repetition consisted of rote rehearsal of the word pairs, and this served as the control condition. Interactive imagery included creation of a mental image or picture with both words (e.g., imagining a pig in a room). Creating a short sentence consisted of coming up with a sentence that included both words (e.g., the pig was locking the room.). They were also asked to create a novel related word pair from the first letter of each unrelated word (e.g., Rhubarb Pie). After a brief distraction, participants were given a cued-recall in which they were shown the first word and had to recall which word went with it. Results show that both groups had significant overconfidence when using verbal repetition and the related word pair strategies and significant underconfidence when using the interactive imagery and short sentence strategies. Also, findings indicate that non-traditional students may be less able to differentiate which strategy is likely to lead to better memory performance when compared to traditional students.

Temperature Changes Due to Empathetic Responses

Author: LAUREN HOMER
Mentor: LAUREN FOWLER

Rocky Mountain Psychological Association
DENVER, COLORADO (April 14 – 17, 2016)

Empathy is the ability to comprehend and relate to the emotions of others. This ability can have far reaching effects on the way people feel, as well as their reaction to others' behaviors. Prior research has shown women, more so than men, have stronger feelings of empathy and are able to recognize these feelings and share them with others. (Luo et al., 2015). Other studies suggest that race can have an effect on the strength of empathic response (Xu et al., 2009). Cooper et al. (2014) found that empathy can affect peripheral physiological responses, but they did not consider race or gender variables. The design of this study is intended to assess whether gender and race affect physiological empathetic responses. Participants will view, either face to face or via video, an individual who places their hand into cold water. While viewing this scene, participants' hand temperature will be measured to determine if any changes occur in response to seeing another's hand temperature change. Data collection are ongoing, but results are expected to show that watching another's temperature change will elicit a similar response in the viewer. Furthermore, women are expected to show more empathy and racial differences will be reported. These findings will unlock an understanding of how gender and racial differences can affect how our bodies respond to one another at an unconscious level through empathy.

Can Love Make Your Worries Disappear?

Author: CANDACE HORNE
Mentor: AARON ASHLEY

Rocky Mountain Psychology Association
DENVER, COLORADO (April 13-17, 2016)

In any given year approximately 5% of the U.S. population (Mortazavi, et al., 2014) experiences chronic anxiety which, when diagnosed, is known as generalized anxiety disorder. To feel a regular, uncontrollable (Kircanski et al., 2015), overarching sense of fear and concern is often debilitating (Mennin et al., 2015); affecting physical health, relationships, and even work responsibilities (de la Parra, et al., 2014). In fact, Rosner (2014) reports that anxiety disorders cost American society \$42 billion a year due to lost work time, medical treatment sought, and other factors. The purpose of this study is to explore the relationship between the magnitude and severity of worry an individual experiences as a function of their involvement in a romantic relationship or not.

The goal of the research is to gain a better understanding of the anxiety and the way it is related to other affective experiences. A thorough understanding of emotional interactions could lead to improved pharmacological and therapeutic treatment methods. Participants will complete the GAD-7, PSWQ, and STAI to establish level of worry, the PSL and CLS to indicate their level of involvement his/her current romantic relationship, and various demographic questions such as length of time in current relationship, gender, and religious affiliation. Data are being gathered from both an undergraduate population as well as from the local community through fliers requesting individuals who self-identify as having anxiety issues. It is predicted that there will be a significant relationship between an individual's level of worry, and their current feelings infatuation. It is also expected that involvement in a romantic relationship will result in lower amounts of worry than individuals who are not in a relationship. It is also expected that newer relationships will have a stronger effect on reducing the amount of worry and individual has.

Motivational Goals for Attending College and Intention to Persist

Author: MARIA HUERTA
Mentor: MELINDA RUSSELL-STAMP

Rocky Mountain Psychology Association
DENVER, COLORADO (April 13-17, 2016)

The sample was 283 students taking Intro Psychology from an open-enrollment university in Northern Utah. Students completed a questionnaire that analyzed persistence to continue, competence, need for relatedness, autonomy, employment, experience at the campus, involvement and demographics. Once the new semester started we checked which students enrolled back.

Self-Compassion and its Effects on Stress Responsive

Author: PARKER HUGHES
Mentor: SHANNON MCGILLIVRAY

Rocky Mountain Psychology Association
DENVER, COLORADO (April 13-17, 2016)

The current study examined the relationship between self-compassion, the ability to display compassion towards oneself, and the ability to cope with moderate physical discomfort. Self-compassion has been more formally defined as a combination of three aspects, those being self-kindness as opposed to self-judgment, common humanity as opposed to isolation, and mindfulness as opposed to over-identification (Neff, 2003). Previous research has found that women who have achieved greater self-compassion through training responded better than control and placebo groups to the Trier Social Stress Test on a number of biopsychological metrics (Arch et al. 2013). Coinciding with earlier work, it has also been demonstrated that self-compassion significantly predicted a lower physiological stress response after experiencing a standardized social evaluative stressor while in a laboratory setting (Breines et al., 2015). Provided that previous studies have focused on the dynamics of self-compassion and psychologically induced stress, we looked to inspect the relationship between self-compassion and physiologically induced stress. Considering the findings of previous research, it became our expectation that individuals who possess a greater level of self-compassion would demonstrate better responses to physically induced stress.

Our participants were recruited from the university's Psychology 1010 research pool. Participation in the study was limited to those between eighteen and sixty years old, in good overall health, and not having a history of high blood pressure, seizures, chronic pain conditions, Reynaud's disease, or any cardiovascular, neuroendocrine, respiratory, or gastrointestinal disorders.

In order to examine a relationship between self-compassion and stress, we used a two step process. First, participants were instructed to complete the Self-Compassion Scale, a twenty-six question survey addressing a number of attitudes one directs inward (Neff, 2003). Second, participants were subjected to the cold pressor test, in which their right hand was submerged wrist deep into four degree Celsius water for a period of up to three minutes (Silverthorn, 2013). Participants' heart rate, blood pressure, and pain rating on a scale of zero through ten (scored with the Wong-Baker FACES Pain Rating Scale) were recorded prior to the cold-pressor test, then at thirty seconds and one minute, forty-five seconds.

With the raw data at hand, the correlation between participants' Self-Compassion Scale score as well as their changes in physiological stress indicators can be examined. Even considering the basic nature of this research, a handful of useful applications can be eventually studied. The researchers can see this study as being potentially useful in developing programs that can aid individuals who suffer from pain conditions. While our participants likely did not directly benefit from the research, our results, as mentioned, may be able to contribute to a better understanding of the interrelationship between the attribute of self-compassion and coping with physically induced stresses.

Varying levels of ferritin within normal ranges affect hemoglobin and inflammatory markers in Division I cross-country runners

Author: BENJAMIN KEATON, JOSEPH FERGUSON,
Mentor: DAVID AGUILAR-ALVAREZ, RODNEY HANSEN

UCUR 2017, UTAH VALLEY UNIVERSITY (February 17, 2017)
NCUR 2017, UNIVERSITY OF MEMPHIS, TENNESSEE (April 6-8, 2017)

Purpose/hypothesis

We investigated how different levels of stored iron {ferritin} within normal ranges may influence hemoglobin production and inflammation markers in NCAA Division I cross-country runners. We hypothesize that in this unique population increases of ferritin will be associated with higher hemoglobin levels and a better inflammatory profile.

Methodology

Two weeks before the competitive season, 41 collegiate distance runners {Male : 19; Female; 22} were recruited to provide blood samples for analysis. All athletes were introduced to the study under identical baseline activity. Blood was collected from subjects and analyzed by complete blood count {CBC}. Cytokines were measured by magnetic multiplex panel for Luminex TM platform. Blood sample markers were further analyzed by gender subgroups and separated by high, medium and low ferritin levels, all within normal ferritin ranges. Correlations between inflammatory markers and CBC were also conducted. SPSS software was used to analyze the collected data.

Results

Significant increases in hemoglobin { $p=.02$ }, hematocrit { $p=.03$ } and Interleukin-5 { $p=.01$ } were found among participants in the high ferritin subgroup when compared to low ferritin subgroup. There was also a significant correlation between eosinophil and ferritin levels in male athletes { $r=.594$ }. These observations were not found in the female athletes, even between subgroups of varying ferritin levels.

Conclusion

Our results suggest that different levels within normal ranges of ferritin may play a role in modulating immune function and influencing hemoglobin production among male collegiate cross-country runners. Therefore, increased ferritin levels even within the normal range may provide overall improved athletic performance. Finally, it is possible that these observations were not consistent with the female population due to the great variability associated with menstrual cycle stage.

Analysis of Biodegradability of Roundup and Impact on Artemia

Author: KIMBERLY LOWDER
Mentor: NICOLE BERTHELEMY

NCUR 2016
UNIVERSITY OF NORTH CAROLINA AT ASHEVILLE (April 6-8, 2016)

The herbicide Roundup and its active ingredient, Glyphosate, are widely used for weed control. Once touted as a harmless and biodegradable compound, it now appears it may cause organ failure, cancer and genetic damages leading to failed or abnormal development. These chemicals end up into streams and lakes, including the Great Salt Lake where they adversely affect wildlife. In previous research, I found Roundup to be more toxic than initially advertised. Abnormal larval development and morphology in the control groups of previous experiments led to furthering this research. The goals of this project are to assess biodegradability and longevity of Roundup in aquatic environments and quantify the effect of exposure to Roundup directly or indirectly on survival, maturation and fertility of Artemia. **Materials and Methods:** For direct chronic exposure, Artemia larvae were raised in a controlled Roundup concentration. Mortality and maturation time rates were monitored. For indirect chronic exposure, Artemia larvae were raised in a container previously soaked in Roundup solution which was subsequently rinsed and filled with clean water. The number of eggs produced in the first brood was used as an index of fertility against the control larval group. The response to stress was assessed by quantifying the up-regulation of stress proteins using western blots. **Results:** Larvae developing in both the Roundup water and soaked Roundup container showed signs of malformation and morphological changes. The percent of normal larvae compared to abnormal larvae from the Roundup water, soaked in Roundup, and control group was 3.78%, 1.56% and 0.27% respectively. A slight upregulation in the heat shock protein Hsp70 was found. **Discussion and conclusion:** Roundup does appear to have the ability to remain concentrated in an environment by attaching to exposed surfaces.

Spin Arc Welding of Aluminum Alloys

Author: CHAD MALNER
Mentor: ANDREW DECEUSTER

FABTECH 2016
LAS VEGAS, NEVADA (November 15-19, 2016)

Modern manufacturing facilities are calling for new ways to cut costs while producing superior products. One of the fields that is looking for improvement in productivity and quality is welding. The science behind fusion welding has been in place for decades but companies are constantly striving for superiority over their competition. High speed spin-arc welding is a recently commercialized welding process that has been demonstrated to provide these benefits to industry, however being a relatively new process, little research has been performed. The purpose of this research project is to investigate the use of high speed spin-arc welding of aluminum alloys for the automotive, marine, and aerospace industries.

Introverts' and Extraverts' Physiological and Behavioral Responses to Aggression

Author: EMMA MARK
Mentor: SHANNON MCGILLIVRAY

Rocky Mountain Psychology Association
DENVER, COLORADO (April 13-17, 2016)

The present study examines the physiological differences of arousal between introverts and extraverts, as well as the level of behavioral aggression exhibited, in response to aggression. Students from Weber State University introductory psychology courses completed a questionnaire adapted from the Myers-Briggs Big 5 Personality Inventory to determine their level of introversion or extraversion. Once determined, subjects were connected to BioPacs to record heart rate (HR) and galvanic skin response (GSR) as a measure of physiological arousal. When connected, participants engaged in a speeded-reaction time test against what they believed were opponents. In reality, there were no opponents. In this task, participants responded to a stimulus on-screen as soon as it appeared. If participants were "too slow" (i.e., their opponent was faster) the "opponent" blasted them with a loud sound (maximum 96 dB) as punishment (the aggressive act). HR and GSR were recorded during these times. A random 12 of 25 trials were programmed as "too slow." After each trial, participants were given the chance to program the intensity and duration of sound their "opponents" received as punishment, measuring the participant's level of aggression (behavioral response) against the perceived aggression (sound blast). A higher decibel level indicated greater aggression. Consistent with past research, it is expected that extraverts will display higher levels of behavioral aggression than introverts (i.e., select higher intensities and durations of volume for the opponent). However, it is expected that introverts will display higher levels of physiological arousal (i.e., faster HR, greater GSR response) in response to an aggressive act.

Changing Attitudes about Harm Reduction

Author: JENNIFER MURPHY
Mentor: AARON ASHLEY

Rocky Mountain Psychology Association
DENVER, COLORADO (April 13-17, 2016)

The current study examined changes in attitudes regarding harm reduction after watching an educational video. Participants completed identical pre and posttests immediately before and after viewing an informational video which was approximately five minutes in length and gave information about harm reduction theory and practice. Both pre and posttests contained fifteen statements to be rated on a Likert scale. Statements used were taken from the Harm Reduction Acceptability Scale (HRAS: Goddard, 2003). Finally, participants answered a short demographic survey which covered prior knowledge of harm reduction, personal drug use, drug use among family members, age, race, and religious affiliation. The effect of information on attitudes toward harm reduction programs was assessed. Results showed no effect of information on attitudes, but significant differences across religious denominations.

Morphological Differences in Capsid Structure of Halophage in the Great Salt Lake

Author: BRENT NELSON
Mentor: MATTHEW DOMEK

American Society for Microbiology, Microbe 2016 National Conference
BOSTON, MASSACHUSETTS (June 16 – 20, 2016)

Bacteriophage lyse bacteria and play a crucial role in the recycling of nutrients in a halophilic environment such as the Great Salt Lake (GSL). A previous study showed that bacteriophage CW02, isolated from the GSL, was a dsDNA bacteriophage with an icosahedral head and a short non-contractile tail and belonged to the bacteriophage family Podoviridae. CW02 was also shown to share a conservative protein fold in a capsid protein originally identified in bacteriophage HK97. Very few bacteriophage isolated from the GSL have been assigned within the bacteriophage classification scheme. In this study we attempt to classify recently isolated bacteriophage from the GSL based on morphology using transmission electron microscopy (TEM) and molecular techniques. Bacteriophage were isolated from water and soil in or near the GSL. Bacterial lysate containing bacteriophage were centrifuged and filtered to remove bacterial debris. The sample was concentrated using 100,000 molecular weight cut-off filters. Samples were further purified by CsCl density gradient ultracentrifugation. Six bacteriophages have been imaged using TEM. TEM has shown all bacteriophage infecting *Salinivibrio costicola* bacterium SA-39 to be icosahedral with no detectable tail while bacteriophage infecting *S. costicola* bacterium SA-40 having a circular head with a long tail. This suggests that the structure and shape of the bacteriophage capsid play an important role in the specificity of the bacteriophage to host. Based on shapes found using TEM, the bacteriophage infecting SA-39 likely belongs to the Podoviridae group while bacteriophage infecting SA-40 possibly belong to either long-tailed bacteriophage families Myoviridae or Siphoviridae. At least one bacteriophage will be selected for further characterization using cryogenic electron microscopy. Such imaging will enable us to determine the 3D characterization of the capsid, more accurately place the bacteriophage into its proper grouping, and evaluate the bacteriophage for the presence of the HK97 protein fold.

Caching and Activity in Woodrats (*Neotoma* sp.)

Author: JENNIFER NICHOLS
Mentor: MICHELE SKOPEC

The Society for Integrative and Comparative Biology
NEW ORLEANS, LOUISIANA (January 3 – 8, 2017)

Woodrats (genus *Neotoma*), also commonly known as packrats, exhibit an interesting behavior of collecting and hoarding objects. These objects do not just include food and items for protection but items that seem to serve no function, such as shiny objects. While previous research indicates that different species of *Neotoma* vary in amounts of food and non-food items they cache little is known about activities role in this caching behavior. Activity or exercise and its influence on caching behavior was studied in a laboratory setting involving three different populations. The three populations studied included *Neotoma albigula*, and two populations of *Neotoma lepida* one from Lytle Ranch, Utah and the other from White Rocks, Utah. To test for differences in caching behavior in relation to activity, woodrats were placed in nesting cages that connected to a secondary area where they had access to a running wheel, rabbit chow (food), and jingle bells (non-food). Trials were run to test if different populations of woodrats altered their caching behavior based on the distance they ran. It was found that both populations of *Neotoma lepida* handled more bells than *Neotoma albigula* showing this species may have more of a drive to collect and cache non-essential items. On the other hand, *Neotoma albigula* cached more food than both populations of *N. lepida*, showing a greater drive to collect more essential items. In terms of activity level both *N. lepida* populations ran more on the wheel than *N. albigula*. Overall, access to the running wheels decreased caching of both bells and food in all woodrat populations demonstrating that having access to an energy outlet (running wheel) decreased caching behavior. Results may show that caching of non-essential items such as jingle bells may serve as an outlet for excess energy in woodrats. Caching and Activity in Woodrats (*Neotoma* sp.)

Impact of Pokemon Go on Steps Taken

Author: AMY ORR
Mentor: BARRETT BONELLA

20th Annual American Association of Behavioral and Social Sciences (AABSS) Conference
LAS VEGAS, NEVADA (January 29 – 31, 2017)

Obesity is a growing problem in the United States despite clear recommendations to increase physical activity. Novel approaches to encourage and measure activities have been created to help people get active such as the inclusion of accelerometers in smart-phones, advanced pedometers, and games that encourage exercise. Pokémon GO was one such game that gained extensive media attention and multiple reports of increasing activity in people. In order to test the impact of Pokémon GO on activity levels, five ABA single subject designs using college students were implemented measuring baseline activity against activity while using the app. Consistent patterns and statistically significant changes were not found, however, increases in activity were found on average in all but one participant. Apps such as Pokémon GO may warrant additional study over longer periods of time or with larger groups to test the significance it has on activity.

Band Gap Measurements of ZnON Films

Author: MEAGAN PARKER
Mentor: KRISTIN RABOSKY

The Four Corners and Texas Sections of the American Physical Society Joint Meeting
LAS CRUCES, NEW MEXICO (October 20 – 23, 2016)

Liquid crystal displays (LCDs) and organic light emitting diodes (OLEDs) use oxide based thin film transistors. Zinc oxynitride (ZnON) is candidate for next generation electronics in LCDs and OLEDs. Here we investigate the correlations between the composition of ZnON and its calculated band gap energy. The composition of our samples is found using energy dispersive x-ray spectroscopy. For the band gap measurements, we have designed and built our own ultraviolet-visible spectrophotometer (UV-VIS). Using the transmission data from the UV-VIS we calculated the band gap energy of the material. We will discuss the experimental methods used to achieve our results.

Uncovering Attitudes Towards Water at Weber State University

Author: KAREN ROBERSON
Mentor: CARLA TRENTELMAN

48th Annual Comparative Literature Symposium
LUBBOCK, TEXAS (April 21 – 24, 2016)

Universities across the U.S. are increasingly concerned about environmental sustainability and are developing action plans, yet water sustainability is frequently neglected. While the return on investment for energy-saving measures can make them low-hanging fruit, low prices for water can often make sustainability efforts in that realm seem out of reach. However, rising water stress in the American West demands that western campuses plan proactively for wiser water use. This qualitative research explores these dynamics using Utah's Weber State University as a case study, to develop better understanding of the drivers of campus water decisions. WSU is well-suited for this study, as sustainability has become an important campus-wide priority. Researchers collected data on perceptions and attitudes about water, water use, and conservation by conducting focus groups and semi-structured interviews across Weber State stakeholder groups, to explore how these beliefs, perspectives and attitudes inform institutional and personal decision-making about water use and management at WSU. We found that, while nearly unanimous support for water conservation was expressed, very little was known about what actions the campus was taking with water. This lack of knowledge was fairly uniform across all groups, including upper administration. Additionally, there was little understanding of the degree to which stakeholders support conservation measures (e.g. xeriscaping). We found that attitudes, social structure, policy, built and physical environment all have a role in campus decision-making about water.

Intrinsic Factor Inhibition Due to Use of Isotretinoin

Author: MAIKIE SENGDENG
Mentor: KENTON CUMMINS

The Annual Meeting & Clinical Expo of the American Society for Clinical Laboratory Science
PHILADELPHIA, PENNSYLVANIA (July 31 – August 5, 2016)

Isotretinoin (Accutane) is a therapeutic drug used for the treatment and prevention of severe acne. A previous study done on the effects of isotretinoin concluded that patients taking isotretinoin showed significantly prolonged activated partial thromboplastin times (aPTT). aPTT is a timed, clinical test assessing abnormalities in the intrinsic coagulation pathway. An in vitro study was formed using normal patient plasma was collected, treated with a standardized concentration of isotretinoin, and an aPTT was performed. Collected plasma was then pooled and underwent a factor assay. The factor assay uses reagent factor deficient plasmas (XII, XI, IX, and VIII), mixes it with pooled plasma and an aPTT is measured. This was performed on pooled plasma as a control and then treated with isotretinoin. Being an in vitro study, the isotretinoin used was in its parent form, not one of its metabolites. When treated with isotretinoin, results indicate significant prolonged aPTT times (p-values < 0.001) for factors XI and IX. No significant prolonged times for factor deficient XII and VIII, which suggest that isotretinoin had no inhibitory effect on these factors. Therefore, we conclude isotretinoin prolongs aPTT times by inhibiting factors XI and IX in vitro in the intrinsic coagulation pathway.

Density Functional Theory Investigation of Polycyclical Peroxide Stability

Author: CHARLES SIMON
Mentor: LAINE BERGHOUT

The Annual Conference of the Utah Academy of Sciences, Arts, and Letters
SALT LAKE CITY, UTAH (MarCH 10, 2016)

Polycyclic peroxide compounds have been of interest recently for their antimalarial activity. The synthesis of stable peroxide compounds can be challenging, thus making computational determination of the stability of promising compounds advisable. We use density functional theory to gauge the stability of one such peroxide, 2,3,10-trioxabicyclo[5.2.1]decan-4-ol. An intramolecular hydrogen bond between the two rings of this bridged bicyclic compound is anticipated to contribute to the stability of the molecule. Based on coordinate scans of the hydroxyl dihedral bond angle at the B3LYP/6-311+G(2d, p) level of theory, we estimate the strength of this intramolecular hydrogen bonding interaction at 8.6 kcal/mol, considerably above the 5-kcal/mol typical for R-O-H---O=C-R'. Decomposition of similar peroxide compounds proceeds via homolytic bond cleavage of the O-O bond. We will share our continuing work on this system including studies of the activated complex for homolytic peroxide-bond cleavage and the unusually large intramolecular hydrogen-bond energy.

A Walk in Someone Else's Shoes: Empathy Through Embodiment

Author: DAVID SLEIGHT
Mentor: AARON ASHLEY

Rocky Mountain Psychology Association
DENVER, COLORADO (April 13-17, 2016)

The purpose of this study was to evaluate the relationship between participant empathy scores and the type of engagement in the acting out of a date rape scenario (using dolls) that is designed to trigger an empathetic response. Date rape refers to a rape in which there has been some sort of romantic or potentially sexual relationship between the two parties Picoult (2006). For the experimental groups, participants were asked to read a script of a date rape scenario then asked to act out said scenario using two small dolls and a diorama of the environment where the rape took place as the researcher narrates. Once the scenario was acted out the participants completed a survey consisting of: date rape scenario follow up questions—which assess the participants' opinion of the male and female characters in the scenario; an empathy scale—which consisted of several sub scales; and a brief demographic questionnaire. The results of this study are in favor of our hypothesis, which is that a participant who takes on the perspective of an opposing gender through the reenactment process will then have more empathy for that particular character. Likewise, a participant who takes on the perspective of the same gender will have more empathy for the character that is the same gender of the participant.

Building and Caching Behaviors of Woodrats in a Laboratory Setting

Author: RYLEE SMITH
Mentor: MICHELE SKOPEC

The Society for Intergrative and Comparative Biology
NEW ORLEANS, LOUISIANA (January 3 – 8, 2017)

Woodrats (genus *Neotoma*) are well known for their building and caching behaviors and build elaborate structures called middens. In the wild, middens serve as shelter and a storage site for their caches. While the caching behavior of woodrats has been rigorously studied in captivity, building behavior studies are lacking. We wanted to determine if building and caching behavior could be empirically studied in a laboratory setting. Three groups of woodrats were used in the experiment: *N. albigula*, *N. lepida* from the Mojave desert, and *N. lepida* from the Great Basin desert. These species of woodrats are commonly found in desert terrain where resources are limited and all three display different midden structures in the wild. To test for differences in building and caching behavior the woodrats were placed in a nesting cage that had access to a secondary area that contained objects the woodrat could use for building or caching. The caching objects included jingle bells and rabbit chow (food) while the building objects included sticks and cotton nesting material. Each day the objects used or collected were counted and replenished. There were significant differences in building and caching behaviors between species. *N. albigula* favored cotton equally to sticks and bells, but favored sticks more than bells. Great Basin *N. lepida* favored cotton more than sticks and bells, which were favored the same. Mojave *N. lepida* preferred cotton more than sticks and sticks more than bells. We conclude that woodrats do display species specific building behavior in the laboratory. Additional information collected via remote video surveillance will reveal the amount of time devoted to building and caching activity.

Presentation at Association of American Geographers Annual Meeting

Author: SAMUEL STOUT
Mentor: BRYAN DORSEY

American Association of Geographers
SAN FRANCISCO, CALIFORNIA (March 29-April 1, 2016)

All is not quiet on the Wasatch Front: Measurements and mitigation of noise pollution from military air traffic. The impacts of noise pollution have been studied by environmental health researchers, but analysis by geographers has been limited. This study begins to identify the wide range of impacts from military air traffic and addresses various noise mitigation strategies. Preliminary results of noise level measurements surrounding Hill Air Force Base on Utah's Wasatch Front reveal that impacts are not confined to the area immediately surrounding the base. Noise levels were measured in a five square mile perimeter surrounding the base that will provide baseline data to assess various impacts of noise bursts exceeding 80 decibels. Problems associated with military aircraft training facilities are not unique to Utah, and can be studied from a broader regional perspective for the Western United States.

Influence of Lifestyle Habits and LDS Religion on Metabolic Syndrome Parameters in College Students at Weber State University

Author: WILLIAM SOULE
Mentor: DAVID AGUILAR-ALVAREZ

UCUR 2017, UTAH VALLEY UNIVERSITY (February 17, 2017)
Experimental Biology Chicago 2017, CHICAGO, ILLINOIS (April 22-26, 2017)

Objectives:

Lifestyle restrictions are present in the religion of the Church of Jesus Christ of Latter-day Saints (LDS), as described in the “Word of Wisdom,” found in Section 89 of *The Doctrine and Covenants*, which prohibits the “use of wine, strong drinks, tobacco, and hot drinks.” With this premise, we sought to determine if the LDS religion influenced metabolic syndrome (MetS) parameters among college students. Additionally, we sought to determine whether other lifestyle factors influenced MetS regardless of religion. Research Methodology: We assessed MetS parameters in 107 Weber State University student participants. Additionally, a 16-question survey was utilized to determine religion, meat and energy drink consumption, and the frequency of exercise and eating out. We separated men and women into subgroups to account for gender influences on MetS parameters.

Results: Participants who ate out more than 3 times a week presented higher blood pressure, waist circumference, and body mass index than those who ate out less frequently. In women: High energy drink consumers presented lower high-density lipoprotein cholesterol (HDL-C) than low consumers. LDS women presented a favorable MetS profile with lower triglycerides and higher HDL-C. MetS incidence was 2.3 times lower in LDS women (9%) compared to non-LDS women (21%). In men: High meat consumers presented lower HDL-C compared to low meat consumers. In contrast to the women subgroup, LDS men presented higher waist circumference and weight compared to non-LDS men.

Conclusions: The LDS religion may influence parameters of MetS in both genders. Among the lifestyle factors measured, eating out seems to have the greatest influence on MetS parameters regardless of gender in this population. The results of this study support the important role that lifestyle habits have on health markers.

Perceptions of Bullying: Connecting Elementary Students, Teachers, and Administrators

Author: BLAKE TUBBS
Mentor: AARON ASHLEY

Rocky Mountain Psychology Association
DENVER, COLORADO (April 13-17, 2016)

The purpose of this research is to assess perceptual differences and similarities that exist between experiences of elementary students (second grade), their teachers, and school administration about bullying at their school. This research will employ use of a semi-structured qualitative interview with each participant. Specifically, this research will seek to find where inconsistencies lie between the three groups outlined and where improvements can be made for the perception of bullying and intervention therein. The main researcher will do coding of interviews with Atlas.ti software (used to organize information. All coding and methodology will be verified through a research committee for reliability and validity.

PowerPlay Cryo-Compression Modality's Ability to Decrease Intramuscular and Skin Temperature

Author: MACKENZIE TUCKER
Mentor: JENNIFER OSTROSKI

Rocky Mountain Athletic Trainer's Association Annual Meeting and Clinical Symposium
ALBUQUERQUE, NEW MEXICO (April 6-10, 2016)

Previous research has found ice bags are more effective at lowering intramuscular temperature than other cryotherapy modalities (e.g., whirlpool, ice cup, slush bucket, gel pack), and that gel packs are a relatively ineffective intramuscular temperature cooling method. Recent studies have evaluated intramuscular temperature cooling decreases of ice bag versus common cryo-compression modalities (i.e., Game Ready); however intramuscular decreases elicited by PowerPlay have not been examined.

Our purpose was to evaluate rate and magnitude of cooling using PowerPlay with gel-pack option (PP-gel), PowerPlay with ice bag option (PP-ice), and control (no treatment) on skin and intramuscular temperature (2cm sub-adipose). We hypothesized that PP-ice would result in greater rate and magnitude of intramuscular and skin cooling compared to PP-gel, and that both PP-ice and PP-gel would cool more than control. Our design was a repeated-measures counterbalanced study in a University research laboratory. Our participants were 11 healthy college-aged participants (3 males, 8 females) without compromised circulation or injury. Participants underwent each treatment. Temperatures recorded at baseline and every 6 minutes during 30-minute treatment.

Our results for intramuscular temperature confirmed our hypotheses, in that PP-ice cooled faster than PP-gel from minutes 24-30, and PP-ice and PP-gel both cooled faster than control from minutes 18-30. For skin cooling, PP-ice cooled faster than control from minutes 6-30, PP-gel cooled faster than control from minutes 12-30. Our conclusion is that PP-ice produces clinically and statistically greater muscle and skin cooling as compared to PP-gel. PP-gel did not cool skin enough to induce skin analgesia (skin temperature of 13.6°C needed for analgesia) or cool muscle enough to promote desired physiologic effects of cryotherapy. Ice bag should be used instead of gel pack in a clinical setting where cryotherapy is indicated.

We were accepted to present a 15 minute oral presentation on our study at the Rocky Mountain Athletic Training Association (RMATA) conference in Albuquerque, New Mexico (April 7-10, 2016).

Determination of antagonism between NSLAB strains and *Lactobacillus wasatchensis* WDC04

Author: MARISSA WALKER
Mentor: CRAIG OBERG

American Society for Microbiology Microbe 2016
BOSTON, MASSACHUSETTS (June 15-20, 2016)

Lactobacillus wasatchensis WDC04 is part of the nonstarter lactic acid bacteria (NSLAB) cheese microbiota, originally isolated from "gassy" cheddar cheese. Recent evidence indicates WDC04 may be an important cause of late gassy defect in aged cheese. Controlling growth of this unwanted organism could be done by incorporation of NSLAB strains into cheese that inhibit its growth. Determination of inhibition between NSLABs and WDC04 was done using the agar-flip method. MRS supplemented with 1.5% ribose (MRS-R) and 4% NaCl and pH 5.2 conditions to mimic the environment of cheese. A lawn of WDC04 was swabbed on this media and incubated anaerobically at 25°C for 2 days or 4 days. The agar was flipped over and NSLAB cultures were swabbed and incubated anaerobically at 30°C/37°C for up to 5 days. Growth of NSLABs on agar without a WDC04 lawn (control plates) was compared. The reverse of this was then performed using WDC04 as a lawn and NSLABs on reverse side. *Lactobacillus curvatus* showed the greatest inhibition by WDC04 while *Lb. F19* and *Lb. rhamnosus* were most resistant. All challenge NSLAB strains showed decreased levels of growth compared to control plates. The second experiment showed *Lb. curvatus* was most inhibitory towards WDC04 while all other NSLABs didn't show a great difference. In the first experiment, most NSLAB cultures showed more inhibition by WDC04 grown for 4 days compared to 2 days. This probably allowed greater production of inhibitory compounds, especially if produced during the stationary growth phase. Compound diffusion into the media shows that inhibition was due to secretion of inhibitory compounds. In addition, several of the challenge NSLAB strains, while initially inhibited by the 4-day WDC04 culture, slowly grew as the incubation period was extended. This suggests that WDC04 compounds might extend the NSLAB lag growth phase while not completely inhibiting them. Examining the antagonism between NSLABs and WDC04 allows for selection of NSLAB strains that could inhibit this problematic bacterium during cheese ripening.

Long Duration Therapeutic Ultrasound on Pain from Lumbar Disc Herniation

Author: LUCAS WEJKURT

Mentor: JUSTIN RIGBY

American College of Sports Medicine

BOSTON, MASSACHUSETTS (May 31-June 4, 2016)

Recently, a new wearable long duration continuous low intensity therapeutic ultrasound device (LITUS) was introduced. LITUS is intended to reduce musculoskeletal pain and increase local circulation through intramuscular heating. The effects of LITUS on low back pain associated with a lumbar herniated disc are unknown. **PURPOSE:** The purpose of this study was to examine the effects of LITUS in alleviating low back pain associated with a herniated disc over an 8-week treatment period. **METHODS:** In an IRB-approved, 4 participants (M=2 and F=2, age=39.0±13.9 y, height=172.3±8.3 cm, mass=67.1±10.7 kg) were enrolled for a 9-week pilot study. Participants completed a pain diary throughout the trial and 50-point Modified Oswestry Disability Index (mODI) at baseline and after the treatment period. To assess baseline pain for each participant, the pain diary was completed for 1 week and pain scores were averaged for each question. After baseline measurements, participants were given an active ultrasound device to wear 4-hours each day. To determine differences in pain over the 9-week trial a one-way ANOVA was used. A paired t-test was used to determine differences in baseline and post-treatment mODI scores. **RESULTS:** Pain after flexion and extension range of motion decreased from 5.0±1.3 and 4.8±1.3 at baseline to 3.7±1.2 and 2.6±0.7 after 8-weeks of treatment, respectively. Overall greatest pain decreased from 5.5±0.7 to 3.5±1.5 during the 8-weeks of treatment. However, there was no significant difference in pain over the 8-weeks for all pain questions (Flexion: P=0.863, Power=0.175; Extension: P=0.712, Power=0.241; Greatest Pain: P=0.433, Power=0.377). The mODI decreased from 19.3±7.4 to 17.5±7.9 from baseline to post-treatment, respectively (P=0.213). **CONCLUSION:** Following the application of LITUS there was a decrease in pain when performing lumbar flexion and extension after treatment. mODI scores did show decreased ratings in disability from pretreatment to post. The results of this pilot study are encouraging but more subjects are needed to conclude the effects of LITUS on low back pain caused by lumbar disc herniation.