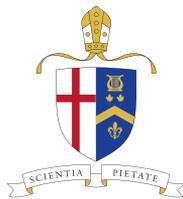


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from secondary school students

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Table of Contents

- 4 The Effect of School Start Times on Students' Sleep Quality
Tayeeba Ahmed
- 23 Parental Perceptions of E-Cigarette & Vaping Usage Among Single-Sex,
School-Going Adolescents in Toronto, Canada
James Crossland
- 33 Spatial Cognition in the Courtroom: A Quasi-Experimental Study of the
Influence Canadian Courtroom Design Has on Jury Cognition
Connie Zhang
- 50 Rural and Urban Dialect Perceptions of Kentucky High Schoolers
Emma Fridy
- 60 Effect of Musical Properties on Cognitive Abilities of High School Students
Rida Bonday
- 70 Life Satisfaction Domains and its Correlation to the Academic Achievement of
Bergen County Technical High School - Teterboro Students
Katrina Gonzales
- 80 The Birthplace Effect in Canadian and American Sprinting
Max Livingston
- 89 The Impact of Carnosine on Myosin ATPase Activity: A Possible Intervention
of Systolic Heart Failure
Nari Kim
- 102 Detection of Genetically Modified Organisms (GMOs) in North America in Tofu:
A Quantitative Experimental Case Study on the Accuracy of Non-GMO labels
Ziyu Han
- 116 Comparing the Anti-Drug Abuse Act of 1986 to the Boggs Act of 1951 and the
Narcotic Control Act of 1956 in Levels of Severity
Norah Khadraoui

Editorial

Research, it can be said with the utmost degree of certainty, is one of the core guiding acts of human life. It is critical to the improvement of our quality of life and is our main mode of cultural and scientific development as a species. Everything we have created and everything we will ever create has its roots in the research process as research is among the most natural human instincts. From the moment of birth, our existence is a constant series of new discoveries with each revelation pushing our understanding of the universe surrounding us just a little bit further.

When the human race took its first steps, they simultaneously began to conduct the earliest forms of research, determining the most significant information to their own survival and the furthering of their species. Since then, our momentum has never lessened as all of us are constantly testing new theories, new ideas, and, whenever possible, pushing the boundaries of human understanding ever further. However, while our societies push for advancement has remained a powerful force of progress, it is clear now how unequivocally necessary research is to our future as a species.

Our world is poised between a variety of crises including famine, global warming, and political unrest on a previously unparalleled scale. These issues make it immediately very clear that our old solutions are woefully inadequate for dealing with and solving these issues. Research for the sake of knowledge is valuable, but its value extends so far beyond the frame of the theoretical that it is truly the pathway to our future. This brings us to the mission of this journal. We feel that there is nobody better to lead humanity into the future than those who will be inhabiting it. For this reason, we seek to display and publish the invaluable research conducted by brilliant young individuals from around the globe. These people saw in the world around them a gap in our understanding of the universe and decided that they would be the ones to fill it. This act is one of great value and is certainly worthy of recognition. So with that, we invite you to explore these works and watch the world change around you.

The Editors

James Crossland
Daniel Crosner
Max Livingston

Nicholas Ploughman
RJ Steele

The Effect of School Start Times on Students' Sleep Quality

Tayeeba Ahmed

The insufficient amount of sleep adolescents are obtaining has been seen to have various negative effects on their academic performance and social wellbeing. Through a two-part, mixed method approach, a survey based upon the comprehensive sleep quality assessment—The Pittsburgh Sleep Quality Index—along with a voluntary interview, was provided to participants from two public high schools in the northeastern region of the United States. Each of the schools with differing starting times in order to determine the effects a delayed school start time has on high school students' sleep quality. Upon calculating the sleep scores of the participants of each school, it was found that students attending school with a later start time do have significantly better sleep quality than that of their peers from the earlier starting high school ($p < 0.05$). This study demonstrates that sleep is critical for student success. Among broader implications, a policy change accommodating the wellbeing of students could be highly impactful.

Keywords: Sleep quality, adolescents, school start time

Introduction

The sleep patterns of high school students in the United States is a significant topic that affects the entirety of the country. Currently, the American Academy of Sleep Medicine recommends that middle school and high school start later than 8:30 a.m. so that adolescents are able to obtain a healthy amount of sleep each night (Brown and Caterino, 2013). Contrary to this, schools in the United States are most commonly seen to start earlier than this suggested time, most often before 8:00 a.m. A lack of sleep and improper circadian schedule is harmful to adolescents especially as they are still not biologically developed; students who lack sleep tend to perform worse in school, experience numerous health issues spanning weight gain and acne, and are significantly more likely to get into car accidents (Wahlstrom, 2016). The clear issue with adolescents not obtaining enough sleep due to their innate biological rhythms has negatively impacted their academic performance at school and their everyday social lives, making the subject of students' sleep a topic of great concern.

To carry out this research, a survey and corresponding optional interview were created and distributed to two suburban public high schools located in Long Island, New York. Each school had a different school starting time—the earlier starting school began at 7:50 a.m. and the delayed school at approximately 8:59 a.m. The survey provided to the participants was a pre-existing survey, The Pittsburgh Sleep Quality Index (PSQI), an effective public survey in which the sleep patterns and overall sleep quality of an individual are able to be measured (Buysse, 1989). In addition to questions from The Pittsburgh Sleep Quality Index (PSQI), other basic questions were asked regarding the student's grade and age. Students from each school were provided with the same survey, and upon completing the anonymous survey, had the option to volunteer for an interview regarding sleep and sleep habits. The collection and evaluation of data from various school starting times was essential in assessing the overall sleep quality of high school students in order to better aid teenagers.

Review of Literature

It has been established that many adolescents, specifically at the high school level, suffer from sleep deprivation. According to the 2013 Youth Risk Behavior Survey (YRBS), a national survey given to high school students in the United States, 68 percent of students have admitted to sleeping fewer than seven hours on a school night. In contrast, the American Academy of Sleep Medicine (AASM) recommends that adolescents (13 to 18 years old) sleep between 8 to 10 hours per day (Paruthi, S. et al, 2016). Various research journals, such as the American Journal of Pediatrics, state that a later school start time needs to be implemented to truly assist teenagers academically and physiologically. As reviewed below, many studies in this field of research have already examined the impact of delayed school start times on various aspects of a student's academic performance and various aspects of sleep quality. However, no study has yet linked the connection between the sleep quality of those in delayed school start times as opposed to normal start times, which my study does.

School Start Times

An experimental research study published in the *Journal of Pediatric Adolescence* concluded that a delayed school start time positively impacted students sleep, mood, and behavior in a public high school in Rhode Island in which the researchers obtained permission to delay the school start time by 30 minutes. It was found that by starting school at 8:30 instead of 8:00 am, students were found to be less depressed, had an average of 45 more minutes of sleep a night, and had fewer tardies compared to prior to the change in start time (Owens, Belon, and Moss, 2010). The findings presented in this research agree with a similar experiment that not only had a much greater, more diverse sample size, approximately 9000 students, but also spanned three years. The results of the research indicated that at least 60 percent of the students who attended Jackson Hill High School were found to have obtained a mean of 8.2 hours of sleep per school night compared to a mean of 7.5 hours they obtained prior to the change (Wahlstrom, et al., 2014). Although this is not the ideal amount of time adolescents require to maintain a healthy lifestyle, it is much better than the

amounts teenagers usually get (Wolfson and Carskadon, 1998). Students in schools with later start times have seen better grades in their core subjects, higher GPAs, better performance on standardized tests, improved attendance, and fewer tardies (Wahlstrom, 2016). It is clear that later school start times improve students' academics in varied measures and behaviors, advantages that they would not have attained with the regular starting time for schools. Overall, one could generalize, based upon the previous studies, that delayed school start times have a positive impact on one's academic position, disregarding socioeconomic standing, race, or other dividing factors.

Sleep Quality

Along with improving one's academic performance, a delayed school start time also positively affects various aspects of sleep such, as sleep duration. For the purposes of this study, sleep quality will be defined as a measure of seven components: "subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction over the last month" (Buysse, 1989). Many previous studies have attempted to measure the construct of sleep quality holistically. However, few have managed to cover all seven dimensions put forth by Buysse. Most researchers studying this field have only focused on one component—primarily sleep duration—by implementing their own research method into the research design. Additionally, when measuring factors involving students' academic performance and their home life, most researchers use the Teen Sleep Habits Survey. This is not an effective method to research a student's behavior, especially when it involves sleep quality as the survey mainly focuses on school-related activities as opposed to questions inquiring about the various aspects of sleep quality (Boergers, 2014). As I have mentioned before, most studies completed regarding this topic have found a correlation between a later school time and an increase in sleep (Owens et al., 2010). Individually, most of the components of sleep quality have been researched when tested among adults, by combining all of the components and implementing them through an accurate survey, experimental errors that may have occurred for other researchers may not happen.

THE EFFECT OF SCHOOL START TIMES ON STUDENTS' SLEEP QUALITY

Therefore, the only medically approved practice of assessing individuals' overall sleep quality is by administering the Pittsburgh Sleep Quality Index (PSQI) as it is the only survey that measures all seven components of sleep (Buysse et al, 1989). The Pittsburgh Sleep Quality Index (PSQI) is rated on a scale of 0 to 21; 21 indicating the poorest quality of sleep and 0 indicates the best quality of sleep (Buysse et al, 1989). A score of 5 or more is a general indicator of poor sleep quality; individuals with scores greater than or equal to 5 are urged to see a licensed medical expert (Buysse et al, 1989). As mentioned above, changing even one component of sleep quality—such as the amount of sleep students are able to get with a delayed school start time—has been shown to benefit students in a multitude of ways. Completing a comprehensive study on the differences in sleep quality between various schools, each with different starting times, is significant in assessing the perspectives on student productiveness.

Circadian Rhythm

Biologically, teenagers are not able to go to sleep at the same time as adults (Wolfson and Carskadon, 1998). During adolescence, a teenager's circadian rhythm—which is essentially an internal body clock—is pushed back approximately a few hours, which mean that teenagers physically want to go to sleep later and wake up later (Wolfson and Carskadon, 1998). According to Mary Carskadon, director of Chronobiology at the E.P. Bradley Hospital and Professor of Psychiatry and Human Behavior at Brown, “Psychosocial influences and changes in bioregulatory systems controlling sleep may limit teenagers' capacities to make adequate adjustments to an early school schedule” (Carskadon, 2007). This implies that many students do not perform as well academically as they could due to their age.

Furthermore, the sleeping schedule of adolescents can cause something known as circadian misalignment. It can be defined as having an irregular sleep and wake schedule, and bad sleeping habits (Crowley, 2007). These aspects are, once again, encompassed in one of the seven aspects of sleep quality: habitual sleep efficiency. The fact that students' sleep schedules are not aligned with their school start times indicates that most students currently suffer from circadian mis-

alignment. However, misalignment of the circadian rhythm has shown to be easily remedied. By setting a proper sleep schedule and abstaining from activities that may harm one's sleep schedule (such as avoiding one's phone, avoiding the usage of technology, and staying awake at times that go against the natural circadian rhythm), circadian misalignment can be easily readjusted (Crowley, 2007). In the case that circadian misalignment is not addressed, long term problems regarding an individual's health such as cardiovascular disease may occur (Wolfson and Carskadon, 1998). Factoring in the other biological changes that occur during adolescence such as hormonal changes during puberty, stress, and social dilemmas, teenagers are getting far less sleep than they require.

Call to research

After examining the research surrounding the effects of later school start times on students performance, there was a clear gap in the discussion of students' sleep quality as opposed to academic performance. The problem of a low duration of sleep present in high schools raises the question: To what extent does a delayed school start time impact the overall sleep quality of public high school students in the United States? As I have discussed above, studies have examined delayed school start times' effects from various perspectives; academic performance and the different aspects of sleep quality. For example, it has been established that a later school starting time leads to longer durations of sleep, as “each half-hour increase in start time [...] was associated with 11.36 more minutes of weeknight sleep” (Paksarian et al., 2015). However, there has not been a study that links all of the aspects of sleep quality and public school start times. In other words, the topic of sleep and its effects, especially when it concerns teenagers, is a complex issue that lacks more longitudinal data. Essentially, the cross-sectional study mentioned above is just a snippet in time, but does not assess long term efficacies of change in school start times. It only measures the immediate impact of the length of sleep that students obtain following a change in school start time. Thus, the research regarding these two subjects is incomplete, leaving a gap in knowledge concerning how school start times truly affect high school public students' sleep quality.

Methods

To examine the relationship between high school start times and a teenager's sleep quality, a descriptive research procedure was used through a two-part, mixed method approach. Initially, the Pittsburgh Sleep Quality Index was provided to two public high schools located in the northeastern United States, followed by interviews conducted on volunteering participants. It is significant to note that although the research centers on examining a connection between school start times in the United States and students' resulting sleep quality, only two different schools in the northeastern region of the country were able to be surveyed and interviewed. Also, the survey groups could only be selected through the implementation of convenience sampling as there are currently a limited amount of high schools in the United States that implement a later school starting time. Only approximately 7% of high schools implement a starting time after 8:30 A.M. in the United States (CDC, 2015). Therefore, in order to get an appropriate sample size, I had to utilize convenience sampling.

The survey, which was distributed via Google Forms, was used in this research design as it would be able to effectively measure students' sleep quality quantitatively and effectively connect it with their school start time. Along with asking questions directly from the Pittsburgh Sleep Quality Index, questions identifying the population's demographics, such as age and gender, were also included. Both the survey and interview were reviewed by the Institutional Review Board (IRB) in order to ensure the participants' safety and overall ethicality of the research.

By implementing a survey, the research becomes more applicable when comparing students' sleep quality throughout the country. In order to get the most accurate data regarding school start times effects on sleep quality, the survey (see Appendix A) was given to two schools in the northeastern region of the United States, each starting at a different time. The schools that were chosen to be a part of the research were selected based upon when their first class started. Therefore, the schools that were chosen had a one hour difference in their school start times—8:59 a.m. and 7:50 a.m. This research can best be replicated in a residential area located in the northeastern region of the United States.

Considering the current body of knowledge, the only survey given to teenagers in high school when attempting to measure sleep habits is the Teen Sleep Habits Survey, which I have acknowledged in the literature review. The purpose of this pre-existing survey in a research study has been to measure the correlation between academic performance and sleep habits (Boergers, 2014). This method of distributing a survey that is already public and known to be credible assists the researcher in focusing on the results of their data more so than having to spend time formulating the questions. Completing studies using pre-existing surveys, such as the study completed using the Teen Sleep Habits Survey, was beneficial to the scope of the research. However, my current research design would not allow me to use the Teen Sleep Habits Survey as it does not measure sleep quality only. This is why I chose to implement the PSQI, although it has not been applied to teenagers in a formal study regarding school start times and students sleep quality, it has been shown to effectively examine the sleep quality of all age groups (Taras, 2005). The process of utilizing the research method with a different concept is proven to allow me to effectively research and analyze the effect school start times have on the sleep quality of high school students.

The survey itself (see Appendix A) was created primarily using questions from The Pittsburgh Sleep Quality Index (PSQI), a pre-existing public survey that effectively assesses sleep quality over the course of a month (Buysse, 1989). As I have defined above, sleep quality encompasses seven different components, and the PSQI is able to quantify and measure those components. Questions in the PSQI were given a four-point answer scale and asked the respondents questions about their sleep habits, such as if they wake up during the middle of the night, to assess sleep quality. Following the PSQI section of the survey, a free response section was created focusing on sleep quality in relation to school start times. The participants were asked about their perceptions on later school start time, how it would affect them (or how it already affects them in the case of students who already attend schools with late school start times) and various other questions regarding school start times effects on sleep quality. The survey was implemented anonymously, though if the student wanted to participate in the interview, they were asked to leave an email with which I may contact them. All of the students who participated in the survey did

THE EFFECT OF SCHOOL START TIMES ON STUDENTS' SLEEP QUALITY

so anonymously and voluntarily, which is significant regarding the ethical aspect of implementing a survey on students and interviewing individuals.

The second part of the mixed method approach encompassed an interview (see Appendix B). After taking the survey, the participant was able to choose if they would like to participate in an interview in which I asked them questions about school start time and sleep quality more in depth. The interviews were structured and all participants were asked the exact same questions in the same order listed in Appendix B. Applying interviews was beneficial as it allowed me to put together qualitatively the different aspects of this research. Although the school start times were controlled (the survey was given to only two schools, each with varying school start times), the topic of sleep quality is dependent on the person. Therefore, with interviews, I was able to connect the quantitative data found from the mainly multiple choice questions in the survey to the mainly qualitative and anecdotal responses from the interviews.

Questions in the interview spanned from the participant's daily schedule to a discussion on their circadian rhythm. These questions asked about students' variations in sleep habits on weekends and weekdays, their methods of waking up and going to bed, and their perceptions of their sleep quality as well as of their peers. The questions were worded in a way in which the researcher would be able to see connections between the PSQI, sleep quality, and the interview questions, which spanned teenagers and school start times. An example of this can be seen in a question in the survey asking, "During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?" and various other questions regarding academic performance and engagement students as a result of the amount of sleep they are currently getting. Again, the survey, which uses multiple choice questions, is best used in addition to free answer responses from a smaller population to best examine the connection between school start time and sleep quality of students in the United States.

Following the collection of the data, each participants' survey response was calculated in order to find a representative PSQI score for the participants. The individual PSQI score for each participant will then be averaged to find a representative score for each school. The interview questions will be compared to the PSQI

scores to see if the responses correlate with the quantitative data. In terms of analytical strategy, the data will be analyzed using descriptive statistics. A t-test will be performed in order to test the validity of the quantitative data while the qualitative data—the responses—will be validated depending upon the conclusion of the data analysis.

Results

The surveys yielded results from high school students from over 2 different starting high schools across located in the northeastern United States. There were a total of 240 respondents to each survey, 115 participants from the 7:50 a.m. starting school (47.9%), and 125 students from the 8:59 a.m. starting school. A total of six students, three randomly selected from volunteering participants of each school, were chosen to partake in the follow-up interview. The questions, as mentioned in the previous section, primarily centered around one's sleep quality and opinions about one's school start time, while the interviews discussed the qualitative reasoning behind the average calculated sleep score. Once again, the research was carried out with the intent of finding a possible correlation between school start times and students sleep quality.

Prior to calculating the sleep scores of students from their respective school, the responses had to undergo a process of data correction. Exclusion criteria was applied to responses consisting of unrealistic numbers or responses that were incomplete. Inclusion criteria accounted for all responses that were completed and "normal." For example, an individual who purposely slept during the day and was awake throughout the night was excluded as their response was not ideal for the purpose of the research. Overall, only four participants were excluded from the data integration. These participants were excluded as they had abnormal sleep schedules. The other excluded participants had responses that were physically impossible (i.e., one participant claimed they got more hours of sleep than the total amount of time they were in their bed while the other participant stated they did not sleep). Below are the calculated average PSQI scores of each school as a whole. Once again, the PSQI scale goes from 0 to 24, a score of 5 or above indicates poor sleep and a score of anything below 5 indicates good sleep quality.

THE EFFECT OF SCHOOL START TIMES ON STUDENTS' SLEEP QUALITY

Table 1.

<i>Total PSQI - 8:59 A.M.</i>		<i>Total PSQI - 7:50 A.M.</i>	
Mean	9.5	Mean	12
Standard Error	0.4	Standard Error	0.49
Median	9	Median	11
Mode	8	Mode	10
Standard Deviation	4.45	Standard Deviation	5.21
Minimum	1	Minimum	0
Maximum	24	Maximum	23
Count	121	Count	114

Figures 1a and 1b (pictured below) represent the average amount of times students felt that they could not get to sleep within 30 minutes over the course of a one month period. As seen in the data, a larger percentage of students from both schools felt that they could not fall asleep within 30 minutes. This data was cross-referenced with the free response question asking the participants how long it took, on average, for them to fall asleep which suggested students' inclination to fall asleep later due to their naturally delayed circadian rhythms.

Figure 1a. 8:59 starting school
 ...Cannot get to sleep within 30 minutes

125 responses

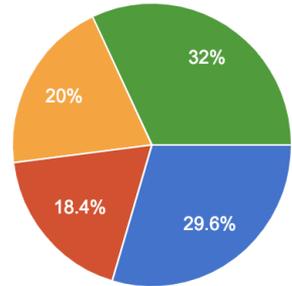
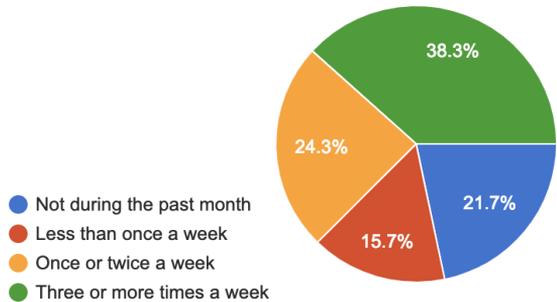


Figure 1b. 7:50 starting school
 ...Cannot get to sleep within 30 minutes

115 responses



THE EFFECT OF SCHOOL START TIMES ON STUDENTS' SLEEP QUALITY

Another significant question regarding the scope of the research and overall data can be seen in the question asked in Figure 2a and Figure 2b (pictured below). It asked, "During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?". This question has significant implications on the social

and functional life of adolescents, based on their social habits and nutritional wellbeing. As seen in the responses, both schools are seen to have a variety of different responses suggesting that school start time is correlated with these behaviors as they are directly influenced by students' sleep habits.

Figure 2a. 8:59 starting school

During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?

125 responses

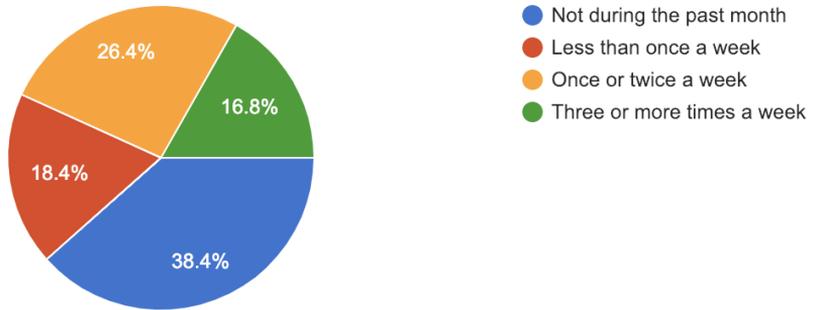
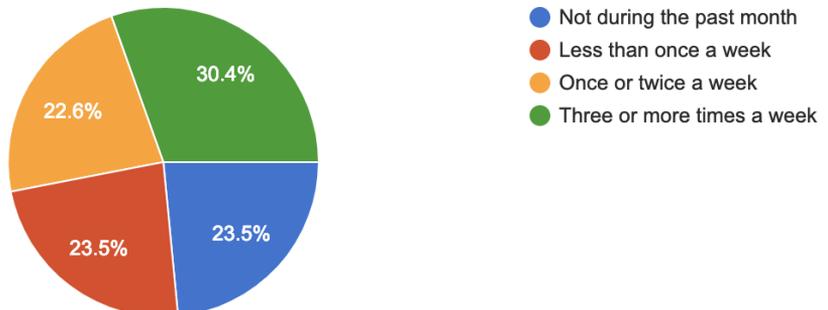


Figure 2b. 7:50 starting school

During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?

115 responses



THE EFFECT OF SCHOOL START TIMES ON STUDENTS' SLEEP QUALITY

Once again, Figures 3a and 3b ask similar questions regarding the influences that one's sleep may have on their productivity and social life. Both schools had the majority of responses leaning to experiencing a lack of enthusiasm more than once or twice a week. As seen in the interviews (Appendix B), the data suggests that

students from both schools suffer from some degree of depression, which will be further discussed.

Figure 3a. 8:59 starting school

During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done?

125 responses

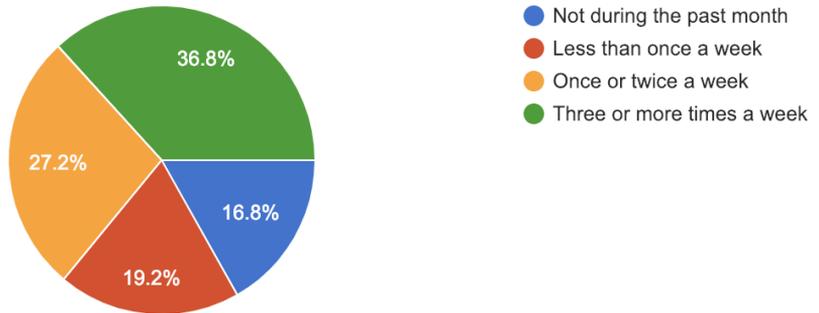
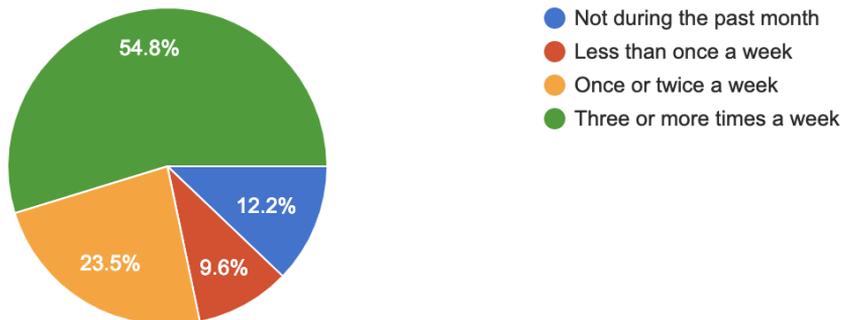


Figure 3b. 7:50 starting school

During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done?

115 responses



Analysis

Currently, the research indicates that a delayed school start time indicates a greater sleep quality than attending a school that did not implement a late school starting time. It can be seen that the mean PSQI score of the later school starting time is 9 while the earlier starting school has a mean sleep score of 12. As I have mentioned prior, a score of 5 or above indicates poor sleep quality. Interestingly, it is found that a later school start time does not correlate with adequate sleep quality, it only suggests that students from later school start times have *better* sleep quality than their peers at the different schools. Also, as seen in the mean score of each sleep component, the 8:59 A.M. school had an overall better score for each individual aspect of sleep quality. The previously established research conducted regarding sleep habits and various isolated components of sleep quality further validated the findings present in the data.

Naturally, with the established data, it was significant to continue by implementing descriptive statistics in order to prove the validity of the research. An F-Test Two-Sample for variances was implemented followed by a two-variable t-test assuming unequal variances (see Table 2, Table 3, Appendix C). The data was proven to be statistically significant with the p-value derived from the t-test being 0.000105, smaller than the threshold alpha reference value of $p=0.05$ when determining the accuracy of data. This indicates that the null hypothesis, school start time has no relation with sleep quality was rejected. The alternative hypothesis, that school start time does make a difference in students' sleep quality was true as seen in the different mean values. Due to the fact that the two research groups were isolated primarily by their difference in school start time, it can be said that a later school start time is the reason for the differences in sleep quality.

Interestingly, it is found that a later school start time does not correlate with adequate sleep quality, it only suggests that students from later school start times have better sleep quality than their peers at the different school. It was found that the 8:59 school had an average of 6.1 hours of sleep, while the 7:50 school had an average of 5.7 hours of actual sleep. This is nowhere close to the recommended amount of time of 8 to 9.5 hours of actual sleep that teenag-

ers are supposed to obtain a night. A possible cause of these factors may due to the fact that most of my participants stated that they were—or still are—in accelerated classes, 90% for both participating schools. This suggests that these students take on a heavier workload with various Advanced Placement courses or partake in gifted programs which naturally indicates more work needed to be completed after the school day. This data leads one to ask how the sleep quality of students in honors programs compares to that of students in normal/regents programs? When analyzing one component of sleep quality, sleep duration, it is clear that the 7:50 schools are lacking in the amount of time they spend in bed and the amount of time they actually get to sleep in comparison with the 8:59 school.

Alarming, many of the participants, when asked what prevents them from sleeping, stated that technology and social media was a main factor in their lack of ability to sleep. Additionally, many participants stated that mental issues, the most common being stress, anxiety, and depression was another reason as to why they could not fall asleep. Various PSQI questions, such as those asked in Figures 2a and 2b above, ask about social interactions with friends and enthusiasm levels throughout the day correlate with the free response questions regarding reasons as to why students could not focus and sleep as well. For example, as seen in the Figures above, a large percentage of students stated that they were affected by a lack of sleep socially three or more times a week. Distributing this survey not only unveiled a previously unknown correlation between sleep quality and school start times, but seemingly has created a connection between teenagers and an increase in mental disorders that will require further research.

Interview Analysis

The interview responses, collected from a total of six individuals, further discussed the overall sleep habits of students. With the intent of maintaining anonymity, the 7:50 interview participants will be referred to as Participants A, B, and C while the 8:59 interview participants will be referred to as Participants D, E, and F. Nearly all of the participants, excluding E, believed that a later school starting time would be beneficial to overall performance academically, socially, and physically. E stated that although they personally are not affected by their later school

THE EFFECT OF SCHOOL START TIMES ON STUDENTS' SLEEP QUALITY

starting time, they know their friends greatly benefit from it in regards to the amount of sleep they get. Participants A, B, and C stated that if they had a later school starting time, they would benefit by getting more sleep, be able to have more time to prepare for school and do homework, and be less stressed due to school. Overall, every interview participant came to a general consensus that a later school start time would benefit the overall success of students. When asked why they thought this, they responded with thought-out responses spanning mental health, more time to study/complete schoolwork, and obtaining better sleep quality.

It is important to note that the students seemed to be aware of the fact that using technology would be harmful to one's circadian rhythm. The participants all stated, however, that they still needed technology to complete their schoolwork as required by the school. Most students were aware of the fact that they had disrupted sleep schedules but that they could not do anything about it due to their workload and responsibilities outside of school. However, students from the 8:59 a.m. starting school were significantly less aware of the amount of technology that they used prior to when they start feeling tired due to the fact that they were aware that their school start time allowed them to adjust to their natural circadian rhythms more efficiently.

Discussion

Limitations

Moreover, the survey distribution was distributed online using Google's online service, Google Forms. This suggests that low-income students or students without access to technology did not have access to the survey. However, both high schools have resources and technology at the students' respective schools that allowed them to participate in the survey thus minimizing this potentially limiting factor. Additionally, the sample size of each school was quite large and the interview data was extensively compared with the survey data, which indicates a high quality of accurate responses. Furthermore, one has to realize how personal sleep is to each individual, no one will have the same sleep patterns or sleep caused side effects.

This means that sleep quality may not be affected for certain individuals because they are accustomed to their current sleep schedule. This research design was created with the intent to minimize the number of outliers by allowing for a greater sample size and conducting interviews on a large number of students.

Implications

The results of the research further adds to the preexisting body of knowledge centering around the sleep habits of teenagers. With the results of this paper showing that a later school start time suggests better sleep quality among high school students when compared to students of an earlier school starting time, it makes one ask why school start times of later than 8:30 a.m. are not implemented throughout the United States? By implementing changes into seemingly insignificant factors of the high school education system, such as school start times, students will be able to see a greater change in not only their academic performance, but also their social lives. Maximizing students' success while in school suggests a greater potential for further success and better control of their circadian cycle in the future. A productive workforce, which education is intended to create, is imperative in furthering the success of the country as a whole. With further implementation of later school start times across the United States, students are expected to exponentially obtain better levels of sleep quality that actually align with their circadian rhythm and further benefit all stakeholders involved.

Conclusions

A multifaceted issue, the topic of high school starting times has been widely debated on both the local and even the federal level. With this new conclusion, the evidence further suggests that a later school starting time is greatly beneficial to students. Although some research has stated that a later school starting time would be inconvenient for transportation reasons and after-school activities, in the case of the later starting schools, students there have been able to cope with the differences in scheduling. A minor adjustment period for transportation will surely benefit the overarching challenge of getting students and parents

adjusted to a newer method of transport.

For further research, which cannot be collected currently without extensive district permission, it is suggested to conduct the same experiment with only one school. Collecting the sleep qualities of students of an early starting school and then implementing a later school start time to the same school followed by distributing the same survey again would allow researchers to study the effect of a changed school start time on the sleep quality of the same population and sample group. Also, although this research was carried out in the northeastern region of the United States in two schools that were located in residential areas with the presupposition that the results would be the same throughout the country, it would be greatly beneficial to repeat the same procedures in various other areas in America. Completing this research as well would further add to the pre-existing body of knowledge centering on the sleep patterns of high schoolers.

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Appendix A

Survey Questions

- I agree that taking this anonymous survey is voluntary and that the participant (you) has the right to withdraw at any time. (If you are below 18 years of age, you are agreeing that you have parental consent to take this survey.)
 - What is your gender?
 - Are you in an accelerated/honors program?
 - What grade are you in?
 - What time does your school start every morning?
1. When have you usually gone to bed?
 2. How long (in minutes) has it taken you to fall asleep each night?
 3. What time have you usually gotten up in the morning?
 4. A. How many hours of actual sleep did you get at night?
B. How many hours were you in bed?
 5. During the past month, how often have you had trouble sleeping because you..... (choices included, "not during the past month," "less than once a week," "once or twice a week," and "three or more times a week")
 - A. Cannot get to sleep within 30 minutes
 - B. Wake up in the middle of the night or early morning
 - C. Have to get up to use the bathroom
 - D. Cannot breathe comfortably
 - E. Cough or snore loudly
 - F. Feel too cold
 - G. Feel too hot
 - H. Have bad dreams
 - I. Have pain
 - J. Other reason(s), please describe, including how often you have had trouble sleeping because of this reason(s):
 6. During the past month, how often have you taken medicine (prescribed or "over the counter") to help you sleep? (choices included: "very good," "fairly good," "fairly bad," or "very bad")
 7. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity? (choices included: "very good," "fairly good," "fairly bad," or "very bad")
 8. During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done? (choices included: "very good," "fairly good," "fairly bad," or "very bad")
 9. During the past month, how would you rate your sleep quality overall?(choices included: "very good," "fairly good," "fairly bad," or "very bad")

THE EFFECT OF SCHOOL START TIMES ON STUDENTS' SLEEP QUALITY

Free Response Questions

- Do you believe your schools start time has an effect on your sleep quality?
- What are your opinions on later school start times (when school starts on or after 8:30 am)?
- Do you believe that a delayed school start time positively affects students? If so, in what ways?

Note: Bullets indicate questions NOT a part of the PSQI

Appendix B

Interview Questions/Responses

Before we begin, I'd like to state that partaking in this survey is voluntary and that the participant (you) has the right to withdraw at any time (If you are below 18 years of age, you are agreeing that you have parental consent to take this survey). If you do not feel comfortable answering any of the questions below, feel free to disregard it. If you do not feel comfortable taking the survey anymore, you are able to stop.

Please answer each question in as detailed a response as possible. Thank you for your cooperation.

Describe your daily routine, from when you get up to when you go to bed. (morning routine, school day, extra curricular activities, sports, jobs, etc)

- A: In the morning, I wake up from my alarm at 6:30, brush teeth, put contacts in, wash my face by 6:45, eat breakfast at 7 and leave for school at 7:45. After school I usually tutor until 3:15 and then head home if it's not spring sports season or if I don't have a club or honor society meeting. Recently, I started SAT prep, which ends at 9:30.
- B: I wake up around 6 am-- depending on how much homework I need to do in the morning (this can range from 4:30- 7:00 am). On the average day I spend periods 2-4 in school, take a period of lunch during which I either do more homework or patron our local businesses. I return to school for periods 6-9, then either participate in a

club or go to work as a receptionist for a hair salon. After work or extracurriculars, I either go for a run (in warmer weather) or go to the gym (in the bitter cold). After that I either go home or hang out with my loved ones.

- C: Wake-up time varies depending on the day, no later than 6:15 a.m. I typically arrive at school around 7:30, except for on Wednesdays and Thursdays when I arrive at 7:00. I have lunch every other day, and aside from that have no free periods. I'm an active member of cultural society and up until this past week had been staying at school almost every day until at least 5:30. I don't play any sports, but other extracurriculars tend to keep me in school until approximately the same time year-round. I get home around 6:00 and do my school work, eat dinner, and sleep, which also varies depending on the day. I typically get between 4-6 hours of sleep.
- D: I wake up around 6:00 a.m. and get to school early to hang out with my friends. After school is over, I go to musical rehearsal and stay usually until 6:00 p.m. I fall asleep between 9:00 p.m. and 10:00 p.m.
- E: I usually get up at 6:30, then classes after school 4 days a week for 1.5 hours. I go to sleep at about 11:30.
- F: I wake up from 6:45AM to 7:30AM and go to school after having breakfast. I return home from 4 to 6. When I get home, I first have a snack and then do homework. I play piano and finish homework. Sometimes, I draw or write. I usually sleep at around 12.
- What are your opinions on a later school start time?
- A: I think a later school start time is in the best interests of everyone, considering past research. Sleep is extremely necessary and beneficial especially for teenagers but current scheduling makes it difficult and almost discourages proper sleep. I'm not sure how accurate this is, but I've read somewhere that teenagers are naturally more inclined to go to sleep at later times (Those winter track meets).
- B: I think it's silly we don't start later.
- C: A later school start time would be extremely beneficial to most teens, as the biological clock is at its latest during this time. However, with sports and extracurriculars, I understand why this may be difficult to implement.
- D: I think it's a great idea, since it gives us time to sleep in if needed or just hang out with friends in the morning if you don't have clubs or extra help.
- E: Right now I think it's not necessary for a later school start time (high school). The current start time in Jericho is reasonable, also prepares us for college or jobs later on.
- F: I think that having a later start time has been extremely beneficial for me in terms of getting work done and being able to make it to school on time every day.

THE EFFECT OF SCHOOL START TIMES ON STUDENTS' SLEEP QUALITY

Do you think it is beneficial for you in terms of getting the amount of sleep necessary for teenagers?

A: Yes, this would allow more teenagers to achieve better quality of sleep by giving them a more optimal schedule for adolescent sleep habits

B: Yes, it would be highly beneficial if that time was truly used for sleeping.

C: I think that getting proper amounts of sleep is imperative, as teenagers are still growing. Getting sleep is necessary for proper growth development, and much of the necessary growth happens during adolescence.

D: A proper sleep schedule is important for teenagers since I believe your body functions better on a solid routine and a good amount of hours spent sleeping is beneficial for one's physical and mental health.

E: Yes, sleeping is overall more important than staying up late for school, we would get overstressed and essentially mental illness etc.

F: Yes.

What do you think sleep quality is, in your own words?

A: I feel that sleep quality is the benefit one gets from the conditions of their sleep.

B: Sleep quality is a measure of how long you remain at rest, without interruption. If you wake up a lot during the night, are restless, or have a lot of trouble falling or staying asleep, your sleep quality is poor.

C: Sleep quality not only entails getting the right amount of sleep, but sleeping at proper times and being able to sleep without feeling stressed or anxious beforehand. Having burdens on your mind prior to falling asleep makes the task difficult and could decrease your quality of sleep, causing frequent interruptions to your sleep as well as a difficulty being able to sleep in the first place.

D: (Not answered)

E: How one's sleeping status is, in terms of deepness, and if one's resting well or feeling good.

F: Sleep quality is how well someone sleeps, measured by the level of benefits they receive from their sleep.

Do you believe that the quantity of sleep you get is correlated with the quality of sleep you get? How so?

A: Yes, but this is probably different for everyone because different people need different levels of sleep. When I sleep too much, like on a vacation, I don't feel as good as if I get an ideal amount of sleep like 9 hours.

B: Well, the more time you spend trying to sleep, the more sleep you are likely to get and therefore the quality of your sleep will likely be better.

C: Yes; to an extent, sleep quality and sleep quantity

correlate. As someone who frequently functions on little amounts of sleep, I can easily say that though you may feel rested to an extent, there is a significant lack in one's ability to function properly for extended periods of time without getting adequate amounts of sleep.

D: (Not answered)

E: Not really. I think sleeping too long even has a negative impact, but having the right sleeping hour is right.

F: I think that I sleep best in specific time intervals, such as 30 minutes to 2 hours and 6 or 8 to 10 hours. I think it's just because I am used to sleeping for that interval of time. Somehow, I always feel tired after sleeping 7 hours, though.

Do you believe that a later school start time leads to better sleep quality? Why?

A: Yes, because it would align better with the schedules of teenagers, which ideally should be the people schools are designed for

B: Yes, there is more time to sleep and less stressors.

C: Yes; having a later school start would allow for students to sleep later according to their biological clocks while still getting the rest necessary for them to complete tasks and focus properly. By starting later, teenagers can sleep in a bit more, giving them more of the rest they require.

D: I cannot speak for myself on this matter, however there isn't much difference between the sleep schedules of my friends in the middle school and those in the high school.

E: No. It may even cause students to sleep later which doesn't help with anything.

F: I think that since most teens sleep later at night regardless of school start times, having a later start time will help them receive more sleep and therefore better sleep quality.

How do you feel when you wake up for a normal school day?

A: Pretty good every day, it might take some time to get out of bed but not too often

B: Terrible. Anxious. Bitter. Sleep deprived.

C: It is an extremely difficult task to make me wake up in the morning before school. I have many, many alarms set to wake myself up early, which often makes me more tired due to frequent interruptions to my sleep. I don't enjoy the process of waking up, and it is easily one of my least favorite things to do, though I actually work better in the early morning than at night.

D: Mostly energized and prepared to seize the day ahead.

E: Depends on when I slept and woke up, if later I would

THE EFFECT OF SCHOOL START TIMES ON STUDENTS' SLEEP QUALITY

feel okay but still tired. Sometimes it's even hard for me to get up at 6:30.

F: I feel tired.

Does the weekend bring any changes in your sleep quality?

A: Yes, I tend to feel more well rested on weekends.

B: The only day I get to sleep in is Saturday and it is a blessing. I usually stay up late Friday night and sleep like a baby through Saturday morning.

C: Absolutely; On Saturdays, I sleep in as long as possible and feel more well-rested than any other day of the week. On Sundays I wake up at 7 to go to church, but even then I feel more refreshed than I do waking up to go to school.

D: I have more freedom on the weekends to hang out with friends, so I usually end up going to bed slightly later, but not by much.

E: No. I sleep pretty late on weekends also due to homework and other activities. But I have the mindset that since it's weekend so it's fine, that's also why I sleep late on weekends.

F: I sleep longer and deeper. I usually have dreams during the weekends.

Do you wake up naturally on the weekends as opposed to on school days?

A: Only on Sundays, and I tend to wake up around 9 or 10

B: Yes, I wake up naturally and feel less groggy. I don't feel jolted awake.

C: I still need an alarm to wake up on Sunday mornings, but only one or two as opposed to fifteen for school days. On Saturdays I almost never use an alarm, waking up only when my body feels I've gotten an adequate amount of rest.

D: I wake up naturally every day.

E: On Saturdays no, but on Sundays yes. I would wake up pretty late because I sleep late.

F: I always use an alarm clock. On weekends, I sometimes can turn it off in the morning (if I don't have anywhere to go) and I go back to sleep. If that happens, I usually wake up at around 9:30.

Does the presence of an alarm clock affect your perception of your sleep quality?

A: Yes, I always feel better when waking up without one

B: Knowing an alarm will eventually blare in my ear makes me dread the morning. So, yes but not too much.

C: To an extent, it does. If I require many alarms to wake up, I wake up feeling more exhausted than I would waking up to a single alarm. Of course, the presence of multiple

alarms only exists because of inadequate amounts of sleep, which is also a symbol of decreased sleep quality in my opinion.

D: I don't use an alarm clock.

E: Not really, I don't usually use alarm clock but sometimes it's more effective for me.

F: I'm not sure at this point because I always use an alarm clock. I think that if I don't use one though, I'll end up sleeping for an extremely long time, like 10-12 hours.

(FOR STUDENT IN A LATER STARTING SCHOOL) Do you believe that attending a school in which you have a later start time is beneficial to you, specifically your sleep quality? How about your peers?

D: The difference is so clear with my peers, however I prefer the later start time and gives me more time to sleep in the morning.

E: In some extensions yes, I think then we can have a longer sleeping schedule without worrying about getting up late. But usually sleeping quality depends on your stress level.

F: Yes and yes.

(FOR STUDENT IN A NORMAL STARTING SCHOOL)

Would implementing a later school start time at your school benefit you, specifically your sleep quality? How so? How would it benefit your peers?

A: Yes it would, because it'd be more aligned to my schedule and allow me to get 8-9 hours of sleep more consistently and thus improve my quality of life consequently. My peers would also receive similar benefits considering many of us have very busy schedules and a significant amount of work to complete daily.

B: Yes, I would have more time to sleep, to prepare for the day, and more time to socialize and do things I want to do without having to sacrifice so much of my sleep time! The same goes for my peers. For the ones who work more than 20 hours a week I am sure the extra sleep is not only beneficial but crucial to their ability to function on a day to day basis.

C: Of course, it would benefit myself and my peers. If I could wake up later, naturally, as opposed to using multiple alarms to force myself awake, my levels of focus would be much higher than they are now, and I'm sure my grades would be better as well. A large problem I find common amongst myself and my peers is distraction during classes due to a lack of sleep. I have friends who sleep no earlier than 3 in the morning naturally, nearly every night.

Are there any reasons why you, or anyone, should be

THE EFFECT OF SCHOOL START TIMES ON STUDENTS' SLEEP QUALITY

opposed to a later starting school time?

- A: These times are what people are used to, they might align better with the job schedules of parents and their kids at other schools, and pushing back school start times would push back extracurricular times
- B: Some may argue that teenagers will only procrastinate more and ultimately not use the extra time for sleep.
- C: Personally, a later start time wouldn't harm me very much, aside from during tech week before a show, but to students who are active in sports such as track, who sometimes arrive home around midnight, a later start time would do more harm than good.
- D: Some people might argue that they may have more time to sleep in the morning, but less time at night to complete homework assignments and end up going to bed late either way.
- E: Yes, I think if then it's going to be really hard for me to adjust my sleeping schedule later on for jobs or college.
- F: I think the most popular reason is that we get home later in the day, but I still don't think it has a big impact on our life. If we have sports, we get home later anyway. In addition, teenagers tend to procrastinate and communicate a lot through social media at night so they usually don't sleep early anyway.

In a normal school day, do you ever feel tired enough that it affects your social life? How?

- A: Yes, but not often. Sometimes, I lose focus for a few minutes or just feel sluggish and unmotivated.
- B: YES. I am more irritable and have less desire to interact with my peers and teachers.
- C: During my lunch period, which only falls every other day and is sometimes the most socialization time I will have during a day of classes, you can often find me asleep at one of the tables rather than chatting with my friends. After long tech weeks, I sometimes fall asleep rather early from sheer exhaustion, meaning my friends who try to communicate with me over social media won't receive a response until early hours of the morning when they've been long asleep.
- D: No.
- E: Yes. There's one time I was really exhausted that I didn't want to talk to anyone, but one of my friends kept talking and I think I was being cold or a little mean, which I didn't mean to.
- F: Sometimes I don't feel like talking or joking around with my friends because I am tired.

Have you ever fallen asleep in class?

- A: Yes, 2 years ago

B: This year not so much, last year at least twice a day.

- C: Frequently, yes. I take my academics very seriously, and I'm in the top 5 of my grade, but I get such little amounts of sleep at night that I find myself dozing off during classes, which is counterproductive as I have to then catch up at night when I get home, thus causing a cycle of sleeplessness.
- D: Never.
- E: Yes, I slept at 3 one time and woke up at 6:30. I was super tired to open my eyes and fell asleep for only a few minutes.
- F: No, but I have come close to :) I've been called out by a teacher for "having a good nap"

Do you feel tired throughout the school day?

- A: Yes, typically around 12 p.m.
- B: This year not so much, last year at least twice a day.
- C: On occasion; certain classes are less dynamic than others, and as a result it's much easier to feel tired during those, but I usually only feel physically tired after extracurriculars.
- D: On very rare occasions.
- E: Yes, even among peers I would say most people are tired all days.
- F: Yes, but only during specific classes that I don't have to pay a lot of attention in or aren't very interesting to me.

Do you think that your grades in your first period class suffer as a result of any tiredness you may have due to lack of sleep? Do you believe that any tiredness you have, if you have any, affects your whole school day?

- A: I don't believe my grades in any class suffered but they could likely improve if I was getting good sleep consistently. I do believe tiredness interferes with my ability to focus, but not often.
- B: My first class of the day is second period and that has been a blessing. That period I usually do not feel tired, the weariness comes out during the day.
- C: Actually, my first period class is usually quite energetic, so although I feel tired on occasion, I typically make it through that class just fine. Other classes don't always fare the same - last year, I frequently slept during my sixth period class, and this year the same is true of fourth.
- D: Not necessarily, no.
- E: For my first period I think doesn't bother much, but around 10 to 12 I'm really tired to listen and eventually miss a lot of stuff.
- F: Not really because my first period class is important to

THE EFFECT OF SCHOOL START TIMES ON STUDENTS' SLEEP QUALITY

me, and I always have to pay a lot of attention to what is going on. Yes.

The circadian rhythm is essentially a regulating internal body clock. Partaking in certain activities, such as using electronics late, staying up late, etc, are said to affect one's circadian rhythm. Do you partake in any of the activities?

A: Yes, I often use my computer when I have to do homework late, but whenever I finish work early I turn everything off by 10. When I have more work to do, I often stay up until around 12:30.

B: I stay up late and use electronics all the way up until I am literally sleeping.

C: Much of my schoolwork is centered around electronics, so of course I'm typically on a computer until my work is done. My breaks are usually during meal times, but even then I'm directly in front of my computer. I don't have a habit of using my phone while trying to get to bed like some others do, but I tend to be active on my computer until I shower before bed.

D: No.

E: Yes, especially on school days, due to works or procrastination I would stay up really late sometimes.

F: I use my phone and laptop right before I go to bed. I have stayed up until 3 working, reading, or watching shows.

Do you know that these activities may negatively affect your sleep quality?

A: Yes, but I understand it's mostly just a result of bad time management

B: I did, but didn't give too much thought to it.

C: I've heard just as much, yes, but I really don't have much of a choice in this day and age, where everything we do is completely based on electronics. I'm always either working or helping others with their work via social media, which means I can't sacrifice the use of electronics for better sleep quality.

D: Absolutely, which is why I avoid them as best as I can.

E: Yes, even though it's aware that it can negatively affect sleep quality, but most of the times you really can't avoid that.

F: Yes. I rarely have time to do those things at other points throughout my week, though.

Are there any comments that you would like to make about school start times and the sleep quality of your peers?

A: I feel that in the long run a delay in at least 30 minutes would be more than worth initial issues because a high school should have conditions that are ideal for students.

B: SLEEP IS CRUCIAL. GIVE US THE MOST VALUABLE RESOURCE AND WATCH HOW OUR MOODS, MOTIVATION, AND GRADES BETTER!!

C: If I'm being honest, school is already early enough. Even if we can't make start

times later, I think it's about time we cut out the ridiculous zero-hour extracurriculars and meetings. Being at school for twelve hour increments is complete and utter madness, if I must be in school until 7:00 p.m., then the least a school could do for me is guarantee that I need not be in school until 7:50 a.m., not 7:00 a.m.

D: (Not answered)

Table 1

<i>Total PSQI - 8:59 A.M.</i>		<i>Total PSQI - 7:50 A.M.</i>	
Mean	9.5	Mean	12
Standard Error	0.4	Standard Error	0.49
Median	9	Median	11
Mode	8	Mode	10
Standard Deviation	4.45	Standard Deviation	5.21
Minimum	1	Minimum	0
Maximum	24	Maximum	23
Count	121	Count	114

THE EFFECT OF SCHOOL START TIMES ON STUDENTS' SLEEP QUALITY

E: I am really satisfied in Jericho High School start time, but still most of the students have bad sleep quality, and I think you can't change it just through changing the school start time.

F: My school starts at 9AM and ends at 3:30PM, and I think that it is an excellent system. I would tell my peers to try to keep their sleep patterns similar, even if they have to just wake up early to finish work. I'd rather sleep get home later, sleep at 12AM, and wake up at 6:45AM to finish things instead of getting home earlier, potentially sleeping at 11:30 (I'd probably still sleep at 12 ;-;) and wake up at 6 to get to school.

Note: Responses A, B, and C, are from students who attended the 7:50 A.M. starting school while responses from D, E, and F, are from the 8:59 A.M. starting school. The responses have not been edited.

Appendix C

Tables 1-3

Table 2

F-Test Two-Sample for Variances		
	<i>PSQI - 7:50 A.M.</i>	<i>PSQI - 8:59 A.M.</i>
Mean	12	9.5
Variance	27.19	19.79
Observations	114	121
df	113	120
F	1.37	
P(F<=f) one-tail	0.04	
F Critical one-tail	1.36	

Table 3

t-Test: Two-Sample Assuming Unequal Variances		
	<i>PSQI - 7:50 A.M.</i>	<i>PSQI - 8:59 A.M.</i>
Mean	12	9.5
Variance	27.19	19.79
Observations	114	121
Hypothesized Mean Difference	0	
df	223	
t Stat	3.95	
P(T<=t) one-tail	5.25E-05	
t Critical one-tail	1.65	
P(T<=t) two-tail	0.000105024	
t Critical two-tail	1.97	

Parental Perceptions of E-Cigarette and Vaping Usage Among Single-Sex, School-Going Adolescents in Toronto, Canada

James Crossland

This study explores parental perceptions of adolescent e-cigarette usage, specifically, examining adolescents who attend independent private schools in Toronto, Canada, in order to investigate if those of high socioeconomic status are more educated on the issue of increasing adolescent nicotine consumption. This study employs a quantitative, non-experimental research methodology through the use of surveys administered to parents who have a child at one of the two used independent private schools. This study finds that parents are largely unaware of the increasing e-cigarette usage within schools and more generally, across the globe. Additionally, it finds that parents are unaware of the health risks associated with e-cigarette usage. This study also finds a strong relationship between parental substance use and adolescents perceived risk of substance use. Mainly, it shows that if an adolescent has a parent who smokes or uses substances, that adolescent will have a positive view on substance use, resulting in a greater likelihood of usage in the future. These findings imply that governments and schools have not been effective in preventing this health epidemic and have not been educating parents and adolescents on the potential risks of e-cigarette usage and nicotine consumption.

Keywords: vaping, e-cigarette, adolescent substance use

Introduction

In recent years, the use of vaporizers (“vaping”) and e-cigarettes have become increasingly common among adolescents. This trend has received a large amount of interest from the media, academics, global health experts, and politicians. A study conducted by the Government of Canada published in 2018 found that 15% of Canadians aged 15 years and older reported trying or using an e-cigarette at least once, an increase from 13% in 2015 (Government of Canada, 2018). Vaping has become an increasingly important health issue, especially due to its addictive and toxic ingredients; a study conducted by Favrod-Coune and Broers (2010) found that nicotine use has been known to cause mental health and addiction problems later in life. This study only observes vaping e-liquid con-

taining nicotine as scientific evidence suggests there is a multitude of negative health effects related to nicotine use (Favrod-Coune & Broers, 2010).

The academic discussion around vaping is expanding. In particular, a large proportion of recently published studies observe prevalence rates in set regions or use a more media-forward approach, such as observing vaping advertising and representation in the media. For example, one study conducted by Chu et al. (2017) analyzed images and text posted by vaping companies on Twitter and Instagram specifically looking at product placement, follower activity, and participation with these advertisements.

Very few academic studies have been published regarding the question of parental perceptions and regulation of vaping within Canada, including what if any role parents play in vaping prevention. It is critical to examine all aspects and possible causes contribut-

ing to the increasing prevalence of vaping if government officials and global health experts are to reduce or prevent future consumption. It is important to examine parental perceptions of vaping, as parents have a significant influence on their children's development and regulatory skills (Kandel et al., 2015). The aim of this study is to examine parental perceptions of vaporizer use, and it aspires to provide a clearer glimpse into a possible cause of increasing consumption rates.

A majority of research exploring perceptions of e-cigarettes usage focuses on young adults and adolescents as their research subjects, exploring their perceptions of e-cigarettes. For this reason, this study will be basing its research methodology off studies in other fields that observe the parental perceptions of different activities that are similar to vaping, such as smoking conventional cigarettes or cannabis consumption. This study uses a quantitative non-experimental approach through surveys administered to parents who have a child attending a private independent institution, as surveys are an effective way to reach many parents to collect data efficiently. Additionally, other scholars in similar fields, such as those researching substance use, and parental perceptions in other areas, have used surveys, including that of Drouin et al. (2018), Popova & Ling (2013) and Brooks-Russell et al. (2018). With this data, this study hopes to provide a greater insight into parental perceptions of e-cigarette trends and how global health experts, policymakers and politicians can create strategies to address this growing public health issue.

Literature Review

Parental Perceptions & Substance Use

It is only in recent years that scholars have begun to observe and analyze parental perceptions of adolescent substance use. Looking at the role of parents in adolescent substance use makes sense, as parents have a considerable influence on their children's actions and development. For example, a study conducted by Pardini et al. (2008) that researched bidirectional parenting found that child behavioural problems have a large negative impact on parents' psychological well-being and parenting efforts, and if parents are in a worse mental state, they may be less persistent and

motivated in enforcing rules. Thus, behavioural issues in children necessitate a vicious cycle whereby they influence parenting negatively which can, in turn, lead to adolescent substance abuse. Another study conducted by Kiff et al. (2011) that examined the role of parents in the context of both child temperament and psychological development, found that children with high levels of frustration, low levels of self-regulation and high levels of impulsiveness were more affected by negative parenting, or less attentive parenting, which in turn, increased these characteristics. Furthermore, a study conducted by Piotrowski et al. (2013) concluded that if children inhibit self-regulatory deficits in their youth, they will be at a greater risk of these deficits worsening while transitioning into adolescent and adult years. Regarding substance abuse, a study conducted by Kiff et al. (2011) suggests that children with lower self-regulation levels have a higher chance of exploiting and trying substances. The existing literature regarding the relationship between parents and children's perceptions of smoking is best summarized within a study conducted by Kandel et al. (2015). The study concluded that there is a greater likelihood that children will have positive perceptions of smoking, including that it is unharmed, if their parents smoke tobacco in their presence. This, in turn, increases the likelihood that such children will smoke in the future. Conversely, the findings of this study suggest that if parents enforce negative beliefs on smoking, children will have negative perceptions of substance use, resulting in a lower likelihood of usage. Although not much research has been conducted on parental perceptions of vaping, one study conducted by Satghare et al. (2018) observed both parental and child perceptions of vaping and found that both groups had little knowledge on the topic and that parents believe vaping is a healthier option than conventional cigarettes. The remaining gap within this field of study lies within parental perceptions of vaping within Canada, specifically, those of a high socioeconomic class (SEC), as previous research on this topic conducted within Canada used subjects attending public schools who are generally of a lower SEC. It is important to continue to research on vaping trends and their possible causes, as many health experts believe vaping has become a health epidemic in the last decade. Observing parents, specifically those of a higher socioeconomic class, could shed further light on why there has been

an increase in vaping usage among adolescents in general—assuming the parents may be part of the cause—and would allow for policymakers and politicians to continue to combat this issue.

Youth & Vaping

The existing literature reveals that vaporizer and e-cigarette use among adolescents is increasing and smoking of conventional cigarettes is decreasing (Naskar & Jakati, 2017; Hyman & Brown, 2017). A study conducted by Hyman and Brown (2017) concluded that between 2013-2014, vaping incidence rates among middle school and high school students have tripled, increasing from 4.5% to 13.4%. Another study conducted by Owusu et al. (2017) that observed prevalence rates of vaping among school-going adolescents in Central Appalachia reported that, out of the 894 participants, 11% of subjects were current e-cigarette users, 36% had tried an e-cigarette once and 22% reported using both e-cigarettes and tobacco products. With the emergence of the internet and e-commerce, businesses have been able to communicate and sell products more efficiently to a larger audience (Hyman & Brown, 2017). Not only is it easier to purchase vapes, but it is also a more cost-effective option than smoking. The flavouring and design of vapes and e-cigarettes has made the products more appealing and attractive to adolescents (Measham et al., 2016). Vaping has also had a significant presence and impact on social media platforms. A study conducted by Emery et al. (2014) suggests that 86% of adults are aware of vaporizers and that 47% of those adults were informed through media outlets, specifically social media databases. As social media is constantly growing and becoming more integrated within people's daily lives, specifically millennials, adolescents will be more susceptible to developing substance patterns. The increasing usage of e-cigarettes may act as a gateway to other highly-concentrated nicotine substances, such as smoking conventional cigarettes. As Measham et al. (2016) suggest, the introduction of vaping containing nicotine at a young age will make young users develop a dependence that may result in the usage of other nicotine products such as conventional cigarettes.

Furthermore, a study conducted by Sijia Ying et al. (2018) suggests that e-cigarette advertisements within the media have an enormous impact on ado-

lescents who are already regular nicotine users. The study concluded that many vaping portrayals and representations within the media makes current adolescent smokers less likely to switch to a less harmful substance such as e-cigarettes as the media alters their perceptions of both smoking harm perceptions and smokers' vaping harm perceptions. These findings show how media alters perceptions of vaping and how adolescents who already use nicotine products, mainly conventional cigarettes, will be less likely to transition to a less harmful product such as e-cigarettes mainly due to the way in which vaping companies market their products. Although the existing literature regarding vaping is not vast, it is expanding, and as vaping becomes more prevalent with adolescents and youth, we are likely to see a growing global health issue within the coming years.

Health Effects

Vaping and e-cigarette usage involves the burning of a liquid, also referred to as "e-liquid" or "e-juice," which usually contains propylene glycol, vegetable glycerin, artificial flavouring and nicotine (Goniewicz et al., 2013; Pisinger & Dossing, 2014). A review of toxicology and chemical presence within these liquids reports that although no carcinogens are present, other chemical compounds such as nitrosamines and diethylene have been found within certain e-liquids and these have been proven to lead to many other health issues (Cheng, 2014). Furthermore, a study conducted by Rouabhia et al. (2014) found that exposure to second-hand e-cigarette vapors increased apoptotic cell numbers, or the amount of "dead cells," a phenomenon which has also been shown to be caused by exposure to tobacco smoke. So, even parents just using vaporizers around their child not only increases the chances of their child developing substance use patterns, but it also has direct negative health effects. Additionally, a study conducted by Hughes & Hendrickson (2018) found that even olfaction of e-liquid refill bottles or e-liquid fluids resulted in higher toxicity levels within both youth and adult cells. Just as the true negative health effects of smoking tobacco were only discovered decades after their introduction, the long-term health effects of vaping are not yet fully known, and this is a serious concern to parents and public health experts alike. However, the existing liter-

ature does suggest that nicotine use and the ingestion of nitrosamines and diethylene do have both negative mental and physiological effects. So, in summary, the existing academic conversation thus far suggests that from a current tobacco user perspective vaping and e-cigarette usage may be a less harmful option than tobacco ingestion (Rahman et al., 2016). From the perspective of non-tobacco users, vaping may cause subjects to develop a nicotine dependence, which in turn may result in them using other nicotine products such as cigarettes (Measham et al., 2016). As the existing literature suggests, vaping contains chemicals that have negative health effects, but the long-term health effects are not yet fully known.

Methodology

This study used a quantitative, non-experimental approach with distribution of surveys to parents across the Greater Toronto Area (GTA), as no known studies have been conducted regarding parental perceptions of vaping in Toronto, Canada. The survey was administered through the use of emails collected online from parents who had one or more children attending selected schools in the GTA, as this is an effective way to reach all subjects efficiently. The data was collected from parents of both male and female independent private school in order to determine whether there is a correlation between parents of a higher socioeconomic status (SES) and e-cigarette incidence rates. Parents willing and able to pay large sums of money for an independent school education are generally themselves well educated, as a study conducted by Jež (2017) shows a strong correlation between parents' education and income levels. If parents care greatly for their children's education, presumably they will be more aware and cautious towards their children's decisions and beliefs on issues such as substance use (Cui et al., 2002). Parents of students attending two different high schools across the GTA were surveyed as this allowed for a large enough sample size to fit the time restrictions. The schools were chosen so that they would not be too close in proximity in order to fully represent the whole GTA population of high SES. The survey was created using Google Forms and responses were coded using a similar structure to that of Kaufman et al. (2004), which analyzed usage pat-

terns among regular heroin sniffers. The participants within the survey were kept anonymous, so no data could be traced back to subjects. This study used surveys because other academics in this field used the same method. For example, a study conducted by Drouin et al. (2018) that observed parental perceptions of children's risk of tobacco administered surveys to 648 parents used this methodology. Another study conducted by Popova & Ling (2013) observed perceptions of the relative risk of tobacco and cigarettes among smokers in the United States administered surveys. The survey was administered to parents from one male independent high school and one female independent high school to ensure gender is equal relative to sample size. Sample sizes were chosen in order to take into account differences in school population, the one boy's school required that 20 parents be surveyed and the one girl's school required that 33 parents be surveyed. The survey was comprised of 14 questions as Poornima et al. (2016), which observed parental perceptions of passive smoking used a survey with fourteen questions. The survey's questions were mainly targeted to determine whether parents know what an e-cigarette is, if they believe e-cigarettes are harmful, and whether they approve of their children using e-cigarettes. These questions are similar to those used by other scholars who researched parental perceptions. It is important to acknowledge some limitations within the study to establish internal and external validity. As this study used distributed surveys to parents and parents were not forced to respond, the responses were voluntary, which may represent biases as those who responded may have a vested interest on the topic. Parents having strong previous knowledge of e-cigarettes and vaping may skew the results and, in turn, may cause the study to be unreplicable. Furthermore, some students may be on a scholarship. This would result in the loss of the socioeconomic factors, as the parents of the student on scholarship may be of a lower SES and may be less educated on the health effects of nicotine and e-cigarettes and, thus, less attentive to enforcing rules. Finally, not all parents that can afford independent school tuition are themselves well-educated, which may result in less persistent enforcement of rules and less parental monitoring (Leung et al., 1998).

Findings

Table 1 describes the school split between responses, including overall grade response percentages relative to the total sample population. The majority of parent respondents have children attending Female School 1 (62.3%) at 33 responses, with the remaining 20 responses or 37.7% having children attending Male School 1. The grade split follows between the overall sample responses with parents of grade 12 students at 19 responses or 35.8% of the overall sample population, parents of grade 11 students at 18 responses or 34% of the overall sample population, parents of grade 10 students at 8 responses or 15.3% of the overall sample population and parents of grade 9 students with 7 responses which amounts to 13.2% of the overall sample population.

Table 1

Sample Demographics (n=53) (# & %)

Grade	Male	Female	Total Response
9	2 (3.77%)	6 (11.3%)	8 (15%)
10	2 (3.77%)	6 (11.3%)	8 (15%)
11	7 (13.2%)	11 (20.7%)	18 (33.9%)
12	9 (16.9%)	10 (18.8%)	19 (35.8%)
Total:	20 (37.7%)	33 (63.3%)	53 (100%)

Table 2 illustrates parental perceptions of e-cigarettes and vaporizers in relation to any perceived health effects that such products pose. In terms of basic knowledge on e-cigarettes and vaporizers, a significant majority of 52 respondents, or 98.1% of the total sample population, have heard of an e-cigarette/vaporizer, with 1 parent or 1.9% of the sample population not having heard of an e-cigarette/vaporizer. Following knowledge on e-cigarettes and vaporizers, 48 respondents or 90.6% of the sample population answered that they would not assent or permit their child to use a vaporizer. Although an overwhelming majority expressed dismay towards the use of such products, a surprising 5 respondents, or 9.4%, approved of child substance use. Furthermore, 38 of

respondents (77.4%) answered “yes” to recognizing the negative health effects associated with nicotine consumption, 7 subjects (13.2%) answered that they were uncertain of the short-term health effects of nicotine and 8 subjects (15.1%) expressed they were unsure of the long-term physiological, psychological and mental-health related effects. Similarly, question four explores the health effects of nicotine but deviates from question three as it examines long-term perceptions, with 37 subjects (69.8%) answering that they understand the health effects associated with nicotine consumption with the remaining 16 subjects (30.2%) stating that they do not understand the long-term impacts of nicotine use.

Table 2

Parental Perceptions of E-Cigarettes, Vape Products & Health Effects

Have you heard of an E-Cigarette or Vape?

Yes – 52 (98.1%)
No – 1 (1.9%)

Would you be okay with your child using an E-Cigarette?

Yes – 5 (9.4%)
No – 48 (90.6%)

Do you know the health effects of nicotine?

Yes – 38 (71.7%)
Not Sure – 7 (13.2%)
No – 8 (15.1%)

Did you know nicotine use has been known to cause a number of both physiological and psychological/mental health-related issues later in life?

Yes – 37 (69.8%)
No – 16 (30.2%)

Table 3 examines parents’ preferred substance for their child’s use, comparing conventional tobacco cigarettes on the one hand and e-cigarettes and vaporizers on the other. The table also examines whether the parents themselves use either vaporizers or e-cigarettes. A total of 48 subjects (90.6%) responded that they would rather their child use an e-cigarette or vaporizer while the remaining 5 subjects (9.4%), interestingly, would rather their child use conventional tobacco cigarettes. Additionally, regarding parents’

substance behavior, 5 subjects (9.4%) reported that they use an e-cigarette/vaporizer themselves, with the remaining 48 subjects (90.6%) answering that they do not use an e-cigarette/vaporizer.

Table 3

Parents' Perceptions Of Health Effects Related To Substance Use & Parental Behavior

Would you rather your child smoke conventional tobacco cigarettes or use an E-Cigarette/Vape?

E-Cigarette/Vape – 48 (90.6%)
 Conventional Tobacco Cigarettes – 5 (9.4%)

Do you use a Vape or E-Cigarette yourself?

Yes – 5 (9.4%)
 No – 48 (90.6%)

Table 4 illustrates parental perceptions of prevalence and consumption rates of e-cigarettes and vaporizers among adolescents. Regarding consumption rates among adolescents worldwide, 45 subjects (84.9%) believe that rates are increasing, while 8 subjects (15.1%) believe they are not. Subjects presented an almost equal split in perceptions of use of e-cigarettes and vaporizers within schools their children attend. A total of 19 subjects (35.8%) answered that the use of e-cigarettes or vaporizers within the school their child attends is an issue, 23 subjects (43.4%) expressed uncertainty, and 11 subjects (20.7%) said that it is not an issue. Furthermore, parental perceptions of the Canadian Government's restrictions and prevention of underage vaping showed that a majority of 34 subjects (64.2%) are not informed of their actions, while the remaining 19 subjects (35.8%) expressed their familiarity with restrictions implemented to combat recent consumption increases among adolescents.

Table 4

Parents' Perceptions Of Prevalence & Consumption Rates Among Adolescents

Do you believe the rates of e-cigarette and vaporizer usage are increasing among adolescents in Canada, the U.S., the U.K. and worldwide?

Yes – 45 (84.9%)
 No – 8 (15.1%)

Is using e-cigarettes or a vape in school an issue at the school your child attends?

Yes – 19 (35.8%)
 Not Sure – 23 (43.4%)
 No – 11 (20.7%)

Are you aware of any laws the Canadian Government has been trying to enforce to restrict e-cigarette and vaporizer usage in Canada?

Yes – 19 (35.8%)
 No – 34 (64.2%)

Discussion

Parents Substance Usage Patterns & Restriction of Adolescent Substance Usage

The findings suggest a strong, direct correlation between parents substance usage patterns and restriction of adolescent substance use. Through a tracing of subject responses, it is possible to determine that all five subjects who used e-cigarettes themselves answered that they would be okay if their child were to use one (see Table 5). Therefore, parents who use vaporizers or e-cigarettes themselves are less likely to enforce rules upon their children, either because they perceive it as not harmful or because they perceive it as a better option versus conventional cigarettes. Additionally, 15 respondents (28.3%) were either not sure or were unaware of the health effects of nicotine, a remarkably high percentage given the significant amount of publicly available research on—and media coverage of—this topic.

Parents Lack of Awareness on Vaping Epidemic

A total of 16 respondents (30.2%) were unaware of the long-term effects of nicotine use, also a relatively high percentage. These results illustrate a worrisome lack of awareness of the health effects of vaporizer and e-cigarette products, and nicotine generally. It could be that parents' relative lack of awareness on the issue of substance use is mainly caused by the lack of teach-

ing by both schools and a lack of public education by governments, which may ultimately lead to less parental enforcement and, in turn, increasing usage rates of e-cigarettes and vaporizers among adolescents. More research clearly needs to be done in this area.

*Table 5
Tracing of Parents' Substance Use Rates & Perceptions of Health Effects*

Do you use a Vape or E-Cigarette Yourself?

Grade & Response #	Male	Female	Total
9	-	-	-
10	-	-	-
11	-	3	3
12	1	1	2

Would you be okay with your child using an E-Cigarette?

Grade & Response #	Male	Female	Total
9	-	-	-
10	-	-	-
11	-	3	3
12	1	1	2

Parental Substance Usage Patterns & Adolescent Perceived Risk of Substances

It can be inferred from the findings that there is a strong relationship between substance use and perceptions of health effects. Children with parents who use e-cigarettes will be at greater risk of developing patterns of substance use while transitioning into later adolescent years and early adulthood. This relation-

ship can be seen within a multitude of other studies such as that of Vuolo and Staff (2013). Specifically, among males, less parental regulation due to skewed perceptions of the health effects associated with nicotine consumption can also cause male adolescents to be more susceptible to other substances, while with females, parental regulation had a much less significant influence (Borawski et al., 2003; Gilman et al., 2009). Additionally, as discussed by Benzinovic & Malatestinic (2009), the level of exposure to substances, such as conventional cigarettes, alcohol and marijuana, had a much greater influence on females' perceptions of substances in comparison to males.

Parental E-Cigarette Usage as an Alternative to Smoking Tobacco & Potential Risks

Although e-cigarettes and vaporizers may pose fewer health risks and may be an effective way to creating a path to smoking cessation, which has been proven effective in-depth by Malas et al. (2016), parents who use e-cigarettes and vaporizers in order to quit smoking conventional cigarettes, may actually cause their children to be at a greater risk of using substances. Second-hand smoke alone within households has been proven to increase a child's chances of e-cigarette usage (Song et al., 2009).

Although parents transitioning to less harmful substances such as vaporizers and e-cigarettes is beneficial not only for them but for governments and healthcare systems, it may lead to increased usage and consumption rates among adolescents. Given the lack of research on the long-term health effects of e-cigarette usage, this is a serious concern that requires further study.

Parental Perceptions of Global Incidence of E-Cigarette Usage

Regarding perceptions of usage rates worldwide, as well as within the schools the subjects' children attend, there seems to be a salient unawareness of the issue of vaping. Many parents answered that their child does not use a vape, and that rates are increasing worldwide, but they are either unaware if, or do not believe that vaping is an issue at schools, when it clearly is. This trend shows that within this population parents believe that this issue does not exist within their com-

munity, and because of this they may feel as if they do not have to enforce rules as they hold the “my child would never do that” mentality. An acknowledgment of their child using an e-cigarette or vape would be an attack on their parenting skills and capabilities. This effect has existed within parent-child relations with substance abuse since conventional cigarettes were determined to be harmful.

Limitations

Fifty-three subjects were surveyed from two single-sex independent schools. More female school parents were included, which may pose a gender-based effect on overall responses and relationships. As discussed by Moon and Hoffman (2008), parenting differs depending on the gender of the child. Additionally, previously married or single parents with children who went through a divorce might also have an impact on the psychological development of that child (Sun & Li, 2002). Both parents and children who experience an event like a divorce are at a greater chance of developing substance abuse habits, although many other factors come into play in such situations (Needle & Doherty, 1990). Additionally, the small sample size of fifty-three subjects may have restricted a true illustration of social trends and parents perceptions of e-cigarettes. Another restriction to this study lies within the methodology chosen. A multitude of biases arise when using a survey as the basis of a study. Although they can be effective in fully representing subjects’ true intentions, many biases still remain. This survey was ultimately a voluntary response survey, meaning that those who have a vested interest in this topic would be more likely to respond. This may have an effect on the results, whether it be beneficial or harmful.

Future Research

These findings point to the need to further examine parental perceptions of adolescent e-cigarette usage. An examination of parents with children who attend public schools and who are of lower SES would provide a better understanding of differences of both parents use and perceptions of adolescent e-cigarette use. This research, if it presents similar trends, could

strengthen and validate the trends illustrated within this study. Overall, if the trends are uniform across both studies, it could lead to the conclusion that there is no causal relationship between SES and e-cigarette usage rates, showing that parents may actually be a cause of the increased consumption rates. Such a finding might also help inform the development of public policies to combat increased usage of vaping and e-cigarettes among adolescents.

These findings also suggest the need for further research into e-cigarettes and vaporizers and specifically, observing parental perceptions. The findings also suggest the need for more educational programs for parents and children to teach them about substance use. It highlights the need for independent schools to interact more with parents and maybe hold events or talks to discuss the issue of vaping within schools.

Finally, there is little research on the long-term health effects of e-cigarette usage; this should be a priority area for future research given the growing prevalence of vaping among adolescents.

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PARENTAL PERCEPTIONS OF E-CIGARETTE AND VAPING USAGE AMONG ADOLESCENTS

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Appendix A

Google Forms survey distributed to parents with children at independent schools in the GTA.

https://docs.google.com/forms/d/e/1FAIpQLSdxN8UmKa-ATRRiv5Kf-6fR4LJCqUW7X8LijuOyprC2twWdmA/viewform?usp=sf_link

Spatial Cognition in the Courtroom: A Quasi-Experimental Study of the Influence Canadian Courtroom Design Has on Jury Cognition

Connie Zhang

As efforts to reform the Canadian criminal justice system progress, there has been a rise in attention towards legal realist jurisprudence and the realm of legal architecture. This study aims to identify the degree of influence Canadian courtroom design has on a juror's perceptions of the defendant. Through a quasi-experimental research method, 44 high school students aged 14-18 served as jury members across a series of four trial recreations, each with a different layout. Afterward, they were then required to complete a post-test questionnaire. Three trials resulted in guilty verdicts, while one received a verdict of innocent. From the data gathered, it was concluded that the layout of Trial C had a significant degree of influence over a juror's cognition and worked to attract higher rates of innocent verdicts in comparison to other courtroom designs.

Keywords: courtroom layout, legal architecture, spatial cognition, Canadian criminal justice system, juror, trial

Introduction

The traditional courtroom trial is associated with ritualized events performed according to a socio-legal script comprised of legalese, strict procedure, and codes of conduct. Society tends to celebrate the modern trial as a rational process that is impartial and applicable across time and place. However, in recent years, this notion has been challenged by legal scholars (Wolfe, 1994). Due to the lawyer's obsession with the word, legal practice has been principally fixated on mediums of written judgment over other modes of cognition such as spatial or auditory comprehension. It is generally assumed that under equal circumstances, a judgment given in one place would be the same as judgment reached in another. This flawed conceptualization of the legal realm limits one's recognition of other influential factors existent in a trial, including the physical space in which these trials take place (Mulcahy, 2011). The spatial configurations of a

courtroom can play a vital role in the social dynamics and impressions of a trial. Every time a new physical barrier is installed, a section of the floor is raised, or the positioning of the defendant is rearranged, there is a potential of disrupting the fairness of a conviction.

In recent years, efforts to reform the Canadian criminal justice system have been set in motion. On March 29th, 2018, the government of Canada introduced Bill C-75. Proposed by then Justice Minister Jody Wilson-Raybould, it affirms to render the system "more fair, modern and efficient" (Harris, 2018). With amendments ranging from the Criminal Code to abolishing peremptory challenges, Bill C-75 strives to transform the justice system by eliminating unjust court proceedings that impact marginalized groups and increase its overall efficiency (Bill C-75, 2018, p. 302). Implementing research collected on the spatial design of the courtroom and its influence on the actors within it would potentially add to the already existing reform as it, too, threatens ideals of justice within the court.

As an academic field of study, the significance of legal architecture has been neglected. Research into courthouses has received slightly more attention from other disciplines which tend to focus predominantly on the aesthetic and historical backgrounds of courts. Despite the lack of research, it remains imperative to not only Canadians but to all citizens, that further exploration is pursued. The matter of how different people perceive courtrooms raises important concerns about the law across cultures. With the growth of immigration comes an increase in foreign individuals who approach international courts with varying ideals of justice. Although this paper only examines Canadian courtrooms, the breadth of this issue reaches across borders. If this phenomenon is left unevaluated, fundamental problems in the delivery of due process, justice, and the upholding of a defendant's civil rights have the potential of spreading.

Literature Review

One might expect social geographers and legal theorists to be more involved in the geopolitics of the trial as a prime site of state control, and while control of territory has been seen as fundamental to power dynamics in society, these disciplines have only recently turned their attention to the interface between law, place, and space (Mulcahy, 2011). While architectural historians have studied other public buildings such as churches, castles, or town halls, they have only surveyed the stylistic and symbolic elements of a courthouse, not its social significance (Mulcahy, 2011). Past research within the field of legal architecture has primarily evaluated courtroom design and its influence on a juror's cognitive processes. However, there is a limited amount of inter-disciplinary research that has been done in various courtrooms globally. The majority of this data has been collected come from studies concentrated in the United States (U.S.), the United Kingdom (U.K.), and Australia with a small focus on courtrooms in Canada.

Within this field, there are numerous works that analyze the ways in which members of the court have been, and continue to be, controlled in the courtroom. Through a micro-ethnographic research method, Dr. Lawrence Corrigan and Dr. Bruce Anderson of St. Mary's University, as well as Heather

Robertson, founder of the Robertson Maclean Design Company, concluded that the interior design and the visual artifacts within Nova Scotia courtrooms "play a significant role in the presentation of the law" (Corrigan, Robertson, Anderson, 2018). In addition, Linda Mulcahy, professor of law at the London School of Economics, utilized an inter-disciplinary analysis to focus on the courthouse design of criminal courts in England. Mulcahy offered comprehensive evaluations of the relationship between the physical space of a courtroom and its participants. In *Architects of Justice: The Politics of Courtroom Design*, she highlights the ability of courtroom interiors to "influence what evidence is forthcoming [and] the basis on which judgments are made" (Mulcahy, 2007). Furthermore, in her book, *Legal Architecture: Justice, Due Process and the Place of Law*, she analyzes significant courtroom elements such as the design of the defendant's dock, the partitioning of zones, the dematerialization of the court, and role of the public in trials—commenting on the growing sense of isolation that exists in modern courtroom designs and factors such as positioning, sight lines, and acoustics that are critical in a jury's assessment of a trial (Mulcahy, 2011).

The fostering of power differentials within the courtroom is largely a result of vertical height paradigms. The relationship between verticality and power hierarchies is examined in *Courtroom Design and the Politicization of Legal Space*, where Caitlin Stonham writes about the ways in which "seemingly neutral space can be deeply politicized and inherently riddled with power dynamics," nothing that the act of raising or removing a platform "has the potential to become the physical manifestation of hierarchy and power because in most regions of the world, success and power are measured on a vertical paradigm" (Stonham, 2017). Architecture and spaces contribute to social order and to political support for established hierarchies of status and power (Edelman, 1995). The extravagant design, formal setting, and symbols of the American court represent the 'drama' that is expected to take place, as well as the "hierarchy of power that exists between the judge, jury, prosecutor, defense attorney, defendants, and the public" (Edelman, 1995). Further investigations of verticality can be seen in the work by Dr. Moeller, Dr. Zabelina, and Professor Robinson, distinguished members of the American psychological community. Their research concluded

that “in spatial attention paradigms, more dominant individuals would systematically favor the vertical dimension of space more than individuals low in dominance” (Moeller, Robinson, Zabelina, 2008).

Within the study of legal architecture, research that exclusively examines the defendant’s dock is extremely saturated compared to other components of courtroom design. There is a wide range of views regarding the role a dock has in the courtroom. Scholars such as Dr. Lionel Rosen strongly oppose the dock and argue that it “disfigures the courtroom, mitigates against the presumption of innocence and is a mark of degradation” (Rosen, 1966). On the other hand, entrenched within the U.K. *Court Standards and Design Guide* is the belief that the court shall remain “committed to the presence of the dock” (Her Majesty’s Courts Service, 2010). Recently, there is a growing amount of literature that analyzes the influence the dock has on a juror’s objectivity and perceptions of the defendant. In *Just Spaces: Does Courtroom Design Affect How the Defendant Is Perceived?*, Blake McKimmie—Associate Professor at the University of Queensland—conducted an exploratory study with 258 individuals aged 18-82. Participants were presented one of four courtroom images with varying defendant positions and were asked to provide “qualitative descriptions of the defendant, the suggested crime they were charged with, and the defendant’s likelihood of guilt” (McKimmie, 2016). He found that “the defendant at the bar table was judged more likely to be guilty compared to the defendant in the dock guarded by a correctional officer or in the glass dock” (McKimmie, 2016). In another study conducted by McKimmie and his colleagues, they evaluated the positioning and structural design of the criminal dock in courtrooms in Australia—highlighting common challenges that arise in the modern use of the dock, such as the inability of the defendants to hear effectively, to adequately communicate with counsel, and to be stripped of their right to the presumption of innocence (Rossner, Tait, McKimmie, 2017). Many trials—which might be generally accepted to be fair—have taken place in cramped surroundings with poor acoustics and limited jury facilities (Tait, 2011). A fair trial cannot take place without meeting basic standards for the accused. Tait outlines these standards, which include the opportunity for the accused to “consult counsel in confidence, to hear the court proceedings, to have a place to sit with maxi-

imum standards of dignity, to appear unconstrained before a jury, and, more generally, to be presented in a way that preserves the presumption of innocence” (Tait, 2011).

Most developed societies assert that the public play a pivotal role in legitimizing legal proceedings (Mulcahy, 2011). Notions of open justice have become synonymous with the public as it provides important “checks and balances on the credibility of witness testimony and the partiality of the judge” (Mulcahy, 2011). However, others fear the public due to their unpredictability. Mulcahy comments on how the space of the courtroom has shifted from being a public, multi-purpose building which was heavily frequented, to one constructed to treat the public as visitors—marginalizing and transforming them “from active participants to docile bodies” (Mulcahy, 2011). Furthermore, due to the privatized design of courtroom interiors, trials are becoming “less accessible to the common people...resulting in procedural inaccessibility” (Spaulding, 2013). The partitioning of space in courtrooms has a profound impact on public participation in society and poses a risk to the lawfulness of the court.

Gap Analysis

Research into courthouses has received slightly more attention from other disciplines such as architecture or geography, which focus predominantly on the aesthetic and historical study of the court. In contrast, my research examines the socio-legal influences present in modern Canadian court design. Of the research that currently exists within this field, few works look at Canadian courts, and even fewer investigate the individual elements of a courtroom such as the role of the dock or vertical height paradigms. To fill this gap, my paper merges these isolated elements into one all-encompassing body of work.

Methodology

This study employs a quasi-experimental research method, utilizing a nonequivalent control group design. The quasi-experimental design uses “control and experiment groups too but does not randomly assign

participants to groups” (Creswell, 1963). The reason for selecting this methodology is to collect generalizable quantitative data. Since I am examining a spatial phenomenon present within Canadian courts, utilizing quantitative data analysis allows me to understand people’s cognition through objective measurement that reflects the general population.

After ethics approval from my school’s Internal Review Board, a series of trial recreations were conducted using students aged 14-18 from Appleby College, an independent high school in Oakville, Ontario, Canada. According to Appleby’s 2017-2018 prospectus, among the 762 students who attended the school this year, 48 international cultures were represented (Appleby College, 2018, p. 56). Having a wide range of cultural backgrounds and ethnicities to draw from allows for less bias and more applicable data.

Using a nonequivalent control group design, groups were selected without random assignment. Both groups were asked to participate in a test (mock trial) and post-test (questionnaire) but were subject to different treatments (Creswell, 1963). The treatment employed on all four groups took the form of varying courtroom design layouts (see Appendices A-D). For each of the four mock trials, the courtroom was modeled after a unique layout. The layouts were carefully curated with consideration of current courtroom designs from the most populous provinces from Canada’s West coast, East coast, and central regions: British Columbia, Nova Scotia, and Ontario, respectively. Quebec was intentionally excluded as they use a different trial system.

The test consisted of a series of four, two-hour long trial recreations. Within each trial, 10-12 participants were asked to be jurors. This is consistent with the number of jurors used in all Canadian criminal trials. During the trial recreation, jurors were evaluated on their subconscious spatial cognitive responses to their physical surroundings and whether or not courtroom design influenced how they perceived the defendant. Having signed a consent form, participants were fully informed of their duties as a jury member prior to the trial. However, the fact that they were being tested on their spatial cognition was excluded and was only disclosed following the completion of the study, as it could affect their cognitive focus and hinder in obtaining their true, subconscious responses.

The trial recreation itself was carried out by law

students at Appleby College. There were two rounds of trials. Trials A and B used the mock case *R v. Rogers*. During the second round, trial C and D used the mock case *R v. Delaney*. The cases were issued from the Ontario Bar Association, approved by the school board, and selected in coordination with Appleby’s law teacher. Despite having similar cases, the jury and courtroom configuration were different for each.

The post-test was a questionnaire covering basic demographic questions, questions about the verdict of the case, and questions prompting spatial analysis thinking. A variety of response formats were present in this questionnaire such as simple dichotomous, adjectival scales, 10-point Likert scales, multiple choice, and short answer. Although dichotomous variables produce nominable data, some answers lie on a continuum rather than one side or the other and limiting responses solely on dichotomous formats would result in important information loss (Fallowfield, 1995). Due to this, I also used continuous judgment formats. The 10-point Likert scale, adjectival scale, multiple choice, and short answers allowed for more accurate responses than a dichotomous scheme could provide because it gave participants more options and room for detail.

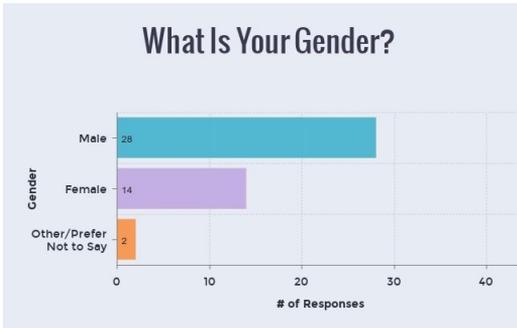
Findings. Analysis and Results

The data was gathered from 44 Appleby College students aged 14-18. Participants were divided across four trials. Trials A, B, and D had over a 50% majority of guilty verdicts. Trial A had a 70% majority, Trial B had a 75% majority, and Trial D had a 60% majority. Of the four trials, Trial C was the only trial to have had over 50% majority of innocent verdicts—receiving a 66.67% majority.

Gender

The gender breakdown of all 44 jury members is shown below. There were 28 male jurors, 14 females, and 2 jurors who identified as “Other / prefer not to say.” Doubling the number of males was done deliberately in attempts to accurately imitate the average jury’s male-saturated gender ratio found in most criminal trials.

Figure 1:



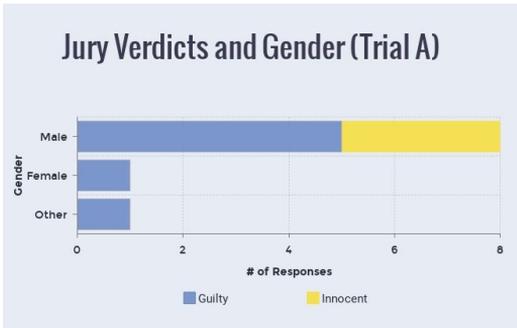
Juror’s Gender and Verdict:

For each of the four trials, the correlation between a juror’s gender and verdict are highlighted in the graphs below.

Trial A Results:

In Trial A, 62.50% of males and the two responses from females and those who identify as “Other” found the defendant to be guilty. There were three innocent verdicts, all of which were from male respondents.

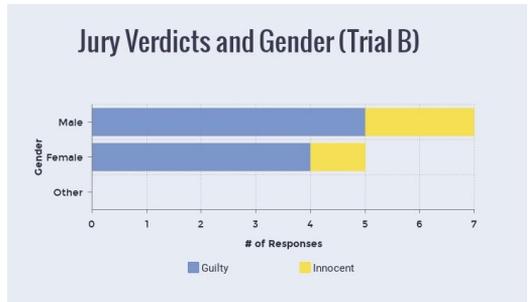
Figure 2:



Trial B Results:

Trial B’s results indicated that 71.42% of males and 80% of females gave guilty verdicts. The ratio between male and female responses evened out to a 4:5 ratio and although both genders gave innocent verdicts, males had twice the number of innocent votes than females.

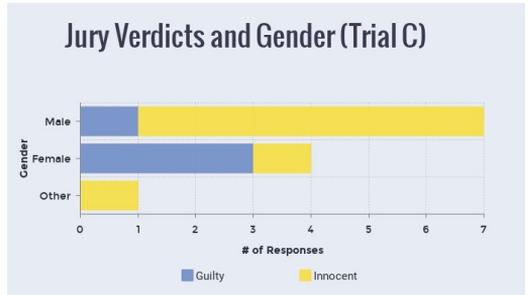
Figure 3:



Trial C Results:

In Trial C, the results showed a significant change in the ratio of guilty to innocent verdicts under the male and other categories. Of the responses, 85.71% of males, 25% of females, and the respondent who identified as “Other” found the defendant to be innocent. Female respondents had 66.67% more guilty verdicts than male respondents.

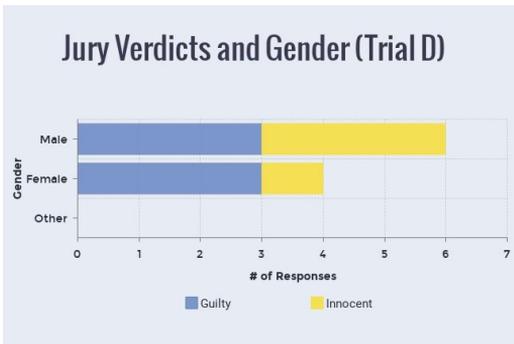
Figure 4:



Trial D Results:

In Trial D, the number of guilty verdicts between male and females were equal, as both had three guilty verdicts. The ratio between both group’s innocent categories was different, however; males had 66.67% more innocent verdicts than females.

Figure 5:



Analysis

From the data shown, there is a common trend across all graphs. Respondents under the male category have consistently produced a greater number of innocent verdicts than those in the female and “Other” categories. The number of innocent verdicts that females have given out—if any, have been a fraction of the number of innocent verdicts given by male respondents. These results indicate that males are more likely to issue innocent verdicts than females and support the findings of past studies conducted by Forsterlee and his colleagues. In their research, it was discovered that women tend to be more emotionally sensitive and sympathize with the victim, rendering harsher verdicts and punishments, whereas males tend to be more evidence-driven and identify more with the defendant, allocating more lenient verdicts (Forsterlee et al., 2006).

Juror’s Level of Physical Comfort and Verdict

The correlation between a juror’s level of physical comfort and their corresponding verdict can be seen below. The degree of comfort was measured on a scale from 1 to 5, 5 being the most comfortable.

Trial A Results

For Trial A, the courtroom was arranged so that jurors sat in hard plastic chairs. The results showed that the most common rating jurors used to describe their

level of physical comfort was a 2 out of 5. Of the total responses given, 70% were guilty and 30% were innocent verdicts. Responses rated 3 or lower received at least 50% guilty verdicts while responses rated at 4 or higher received no guilty verdicts.

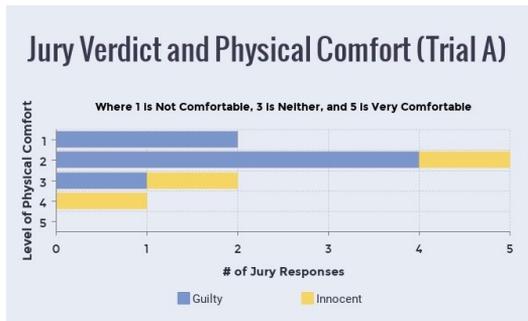
Figure 6:



Trial B Results

The type of seats used in Trial B were heavy wooden chairs. From this data, it is evident that the levels of comfortability and number of innocent verdicts drastically decreased. Respondents who provided ratings of 1, 2, and 4 had 100% guilty responses, while those who gave ratings of 3 had 50% guilty responses.

Figure 7:

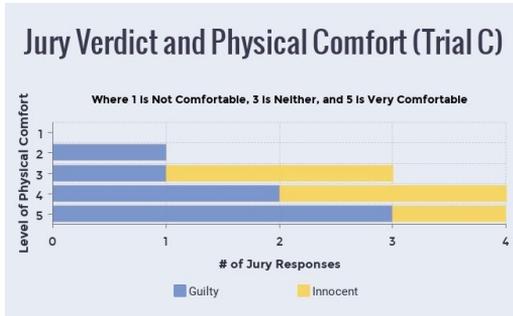


Trial C Results

Trial C provided jurors with cushioned chairs and received significantly higher ratings of juror comfortability and innocent verdicts. Of the total responses collected, 41.67% were innocent verdicts. The most common rating that was given was a 3 and those who gave this rating had 33.33% guilty verdicts. Individu-

als who rated 4 had 50% guilty verdicts and responses under rank 5 had 75% guilty verdicts.

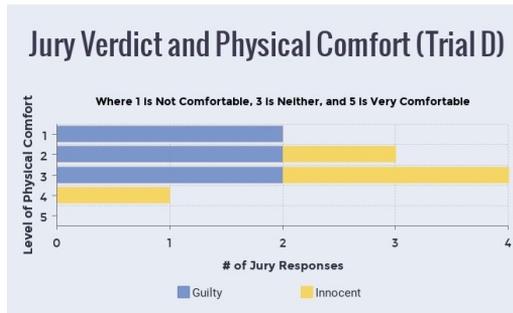
Figure 8:



Trial D Results

Jurors in Trial D were asked to sit in metal folding chairs. The most common rating given by jurors was a 3. The distribution of verdicts within this rating showed a 50% split between verdicts. Across ratings 1-3, the number of guilty verdicts delivered remained consistent, however, innocent verdicts did not. Level 1 had 0%, level 2 had 66.67%, and level 3 had 50% innocent verdicts.

Figure 9:



Analysis

From the results collected, there is a direct correlation between higher ratings of comfortability and innocent verdicts from jurors. This trend supports research founded in the current field of ergonomics, which states that high levels of comfortability enhance cognition, concentration, and critical thinking in professional environments (Bennett, Woodcock, & Tien, 2006). Across the trials, the number of innocent verdicts remains the same or increases as the levels increase, the exception is Trial C, where there is a decrease in innocent verdicts from level 4-5.

Distribution of Juror’s Viewing Time

For each of the four trials, the amount of time juror’s spent viewing various courtroom members was tracked.

Trial A Results

The results from Trial A indicate that the defense lawyers and the defendant were viewed by the majority of jurors for 15-30 minutes. The Crown prosecution was viewed by most jurors for a minimum of 15 minutes to over 30 minutes. Viewing time for the judge was evenly dispersed and ranged from a minimum of 10 minutes to over 30 minutes. In contrast, the “Other” category was not as focused on, since the majority of jurors spent only a maximum of 15 minutes viewing these items.

Figure 10:

How Much Time Did you Approximately Spend Focused on the Following? (Trial A)

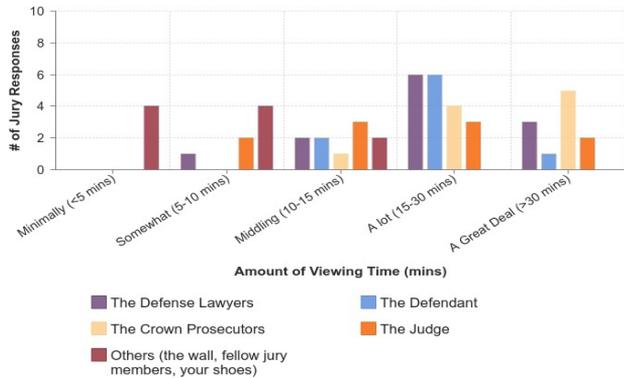
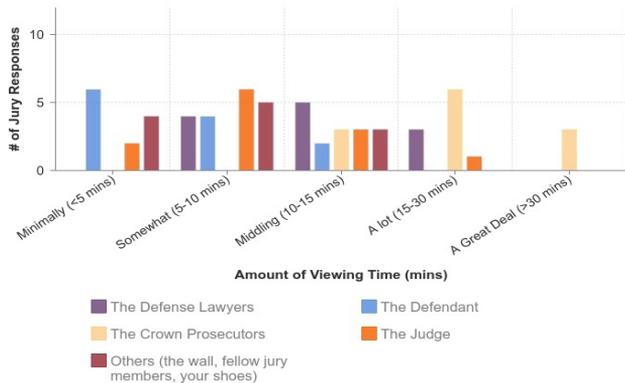


Figure 11:

How Much Time Did you Approximately Spend Focused on the Following? (Trial B)



Trial B Results

The results from Trial B reveal the viewing time for all components shifting to the left. The most prominent shift was for the defendant. The average viewing time for the defendant for the majority of jurors was under 5 minutes, with the greatest amount being 15 minutes. The most common time allotted to the judge was 5-10 minutes

and for the Crown prosecution, it was 15-30 minutes. Jurors viewed the defense lawyers and other components for the same amounts of time.

Figure 12:

How Much Time Did you Approximately Spend Focused on the Following? (Trial D)

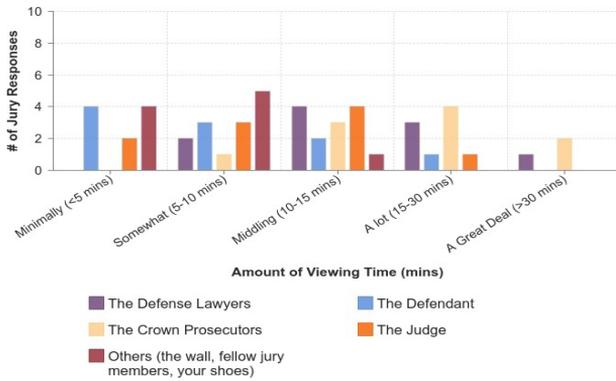
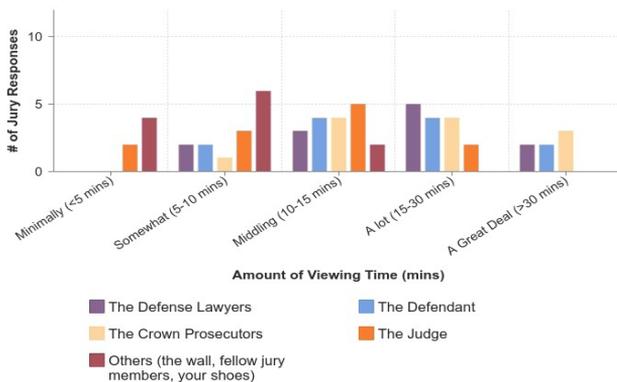


Figure 13:

How Much Time Did you Approximately Spend Focused on the Following? (Trial C)



Trial C Results

The data from Trial C shows that the viewing time across all components was relatively dispersed, with a slight spike within the 10-30-minute range for the judge and the Crown prosecutors. The only outlier was the time jurors viewed other components, which was slightly less than the average.

Trial D Results

Once again, the results for this trial indicate a rather even distribution of viewing times. Components such as the defendant and other components took up a maximum of 10 minutes, while the defense lawyer, the Crown prosecution and the judge were viewed by the majority of jurors for approximately 15-30 minutes.

Analysis

The two components that had the most drastic variations in viewing time across all four trials were the defendant and the judge. The data collected demonstrates how the physical placement of the defendant influences how long a jury views them. In Trial A, the defendant was placed directly across from the jury box, allowing for a direct line of sight (see Appendix A). The majority of jurors spent 15-30 minutes looking at the defendant. For Trial B, the defendant was positioned at the end of the defense lawyer’s desk and was out of the juror’s direct line of sight (see Appendix B). As a result, jurors were less inclined to look at the defendant and the majority viewed the defendant for less than five minutes. The defendant was placed at the back of the courtroom for Trial C, and although they were not in the jury’s direct line of sight, there was nothing blocking their view (see Appendix C). Data showed an increase in viewing time from jurors—ranging from 10-30 minutes. Lastly, Trial D placed the defendant’s dock beside the judge’s desk so that they were facing the exit and partially blocked by the judge (see Appendix D). Responses from this trial reveal a decrease in viewing time averaging around a maximum of 10 minutes. From this, it appears that sight lines have a significant influence on the amount of viewing time defendants receive in the trial.

Additionally, in Trials A and B, the judge’s desk was elevated on a 2-foot-high platform and for Trials C and D, the judge remained

on the same level as the other members of the court. Results from Trials C and D indicate that the average viewing time of the judge was from 5-15 minutes, whereas the average time for Trial A averaged 10-30 minutes and Trial B was 5-10 minutes. In a series of studies, Thomas Schubert analyzed the relationship between vertical positions and symbols of power, concluding that the concept of power is perceived by individuals on a vertical plane (Schubert, 2005). The findings show that there were no significant changes in viewing time across all four trials. This challenges the ideas put forth by the prevailing literature of this field, which suggests the viewing judge for judges would increase as their height did. These results indicate that higher platforms are needed to generate more disparate results and that an elevation of 2 feet does not significantly influence the degree of authority a judge has within the court.

Courtroom Descriptions

Jurors were asked to give three characteristics to best describe the courtroom. Responses were documented and the most repeated characteristics were organized in the table below.

Analysis

These results provided insight into what stood out and resonated with jurors during the trials. Trials A and D had a majority of characteristics oriented towards professionalism and seriousness, whereas Trials B and C gathered more responses linked to emotion. It is important to note that Trial C was the only trial to receive an innocent verdict and received responses that commonly described the courtroom to be comfortable and spacious, further revealing a relationship between increased comfort and innocent verdicts. This data can be used to support future findings as it offers a direct perspective on a juror’s spatial understanding of the room.

Figure 14: Courtroom Descriptions

Jurors were asked to give 3 characteristics to best describe the courtroom. Responses were documented, and the most commonly repeated characteristics were organized in the table below.

	Responses
Trial A	Jurors most commonly described the courtroom of Trial A to be professional, serious, interesting, tense, sophisticated and realistic.
Trial B	The most common characteristics used to describe Trial B’s courtroom were intense, heated, passionate, bias, focused, and emotional.
Trial C	The majority of responses for Trial C described the courtroom as spacious, emotional, captivating, comfortable, serious, and knowledgeable.
Trial D	The results indicate that jurors most commonly described the courtroom for Trial D to be professional, formal, quiet, serious, and organized.

Limitations

There are a few limitations that should be acknowledged. This study aimed to replicate a series of authentic criminal trials. However, given that these recreations were conducted as mock trials, there was a lessened sense of gravitas present due to the lack of consequence in the jury's final verdict. Additionally, the courtroom was reproduced as an approximation of a real courtroom, but this, too, reduced the stakes. Nevertheless, the layouts were organized to avoid any flawed deviations from the traditional layout.

Further, the average jury trial in Canada can take a week to several months to complete. The trial recreations conducted here were restricted to two-hour time blocks. The time constraint limited the accuracy of a true trial. Although jury verdicts in Canadian Criminal cases must be unanimous, the method used in this study was based on a majority. Unanimity takes longer to achieve and because the jury did not have unrestricted time to deliberate, they were, instead, allotted roughly 15 minutes to determine a verdict.

Participants in this study consisted of Appleby College students, aged 14-18. The majority of participants were aged 16 or older, which is fitting as the minimum age to serve as a juror in Canada is 18. Since my participants were from one school, there was no sense of anonymity between mock trial actors and jury members. This was taken into consideration and steps to ensure all jurors were as objective as possible were carried out in the form of a code of behavior conduct outlined in the juror's declaration of consent form. Lastly, although the four trials were split in half to carry out two different cases, they were similar criminal law cases to be as consistent as possible, though they were not the same.

Conclusion

The data from this study revealed that Trials A, B, and D had greater than a 50% majority of guilty verdicts, whereas Trial C had a 66.67% majority of innocent verdicts. The layouts that were created within this study aimed to manipulate three central elements of the courtroom: the placement of the defendant, the verticality of the judge, and the comfort of the jury members. These elements were varied across all four

trials and, through thematic analysis, the stark contrast in verdict outcome for Trial C in comparison to the other three trials is a central area of discussion.

Trial C's courtroom layout was most commonly described by jurors as emotional, captivating, and comfortable. It was designed in adherence to the layout of Ontario and BC criminal courts – with the defendant placed out of the juror's line of sight, near the back of the room, forcing jurors to turn their heads considerably if they wanted to view the defendant (see Appendix C).

In addition, although neither Trials C or D had an elevated judge's desk, they had opposing verdicts. This indicates there is no significant relationship between the verticality of the judge and the jury's verdict. Although this element is less substantial than the other two factors, it prompts a need for further research into height differentials in the courtroom.

The final element of the courtroom that was analyzed was the ergonomics of the juror's seats. All four trials had different chairs for the jury. As seen in the results, the highest ratings for comfortability was given to the cushioned chairs in Trial C. The trial with the highest rank in comfortability was also the only trial to receive majority innocent verdicts, which suggests that higher levels of comfort lead to boosted moods and higher rates of innocent verdicts.

From this, it is evident that changing the layout of all four courtrooms did, in fact, have a considerable influence over a juror's perception of a defendant and the trial's outcome; however, one layout, in particular, resulted in a significant change in the verdict. The courtroom layout used in Trial C posed a direct influence on the trial's final verdict. Therefore, a courtroom design created to most likely bolster higher rates of innocent verdicts would have the defendant at the back of the courtroom and would ensure the jurors are at a state of optimal comfort. Further research into the degree of elevation the judge's desk should be explored. In the future, this study should be held in authentic courtrooms with access to proper equipment and aim to further manipulate elements such as the color and lighting of a courtroom as numerous studies have linked the use of color and lighting in decoration to have varying effects on an individual's mood across different ages and genders (Yildirim, Akalin-Baskaya, & Hidayetoglu, 2007).

Since the courtroom is meant to be a site of objectivity, attempting to design a completely equitable layout is impossible as spatial cognition is inherently subjective. The best approach to reforming courtroom design is by analyzing what spatial elements within the court will sway jurors towards different verdicts. The findings within this study determined a layout that proved to increase the defendant's likelihood of obtaining innocent convictions. The implication of these findings is that if this approach to reform is considered by the Canadian government, architects will need to be more conscientious when planning the layout of courtrooms across Canada. By manipulating various courtroom elements, one generates the risk of designing courtrooms that compel jurors to be either guilty-leaning and or innocent-leaning. Legal architects must be cautious when proposing new courtroom designs and recognize the limits of crafting a completely objective courtroom. Given this, it remains imperative that the Canadian government continues its efforts in reforming this realm of the criminal justice system. Stripping Canadian courts of the inherent biases that are deeply rooted within these sites of justice is not only crucial in upholding a defendant's fundamental rights, but in maintaining the ideals of democracy, freedom, and equality that Canada is predicated upon.

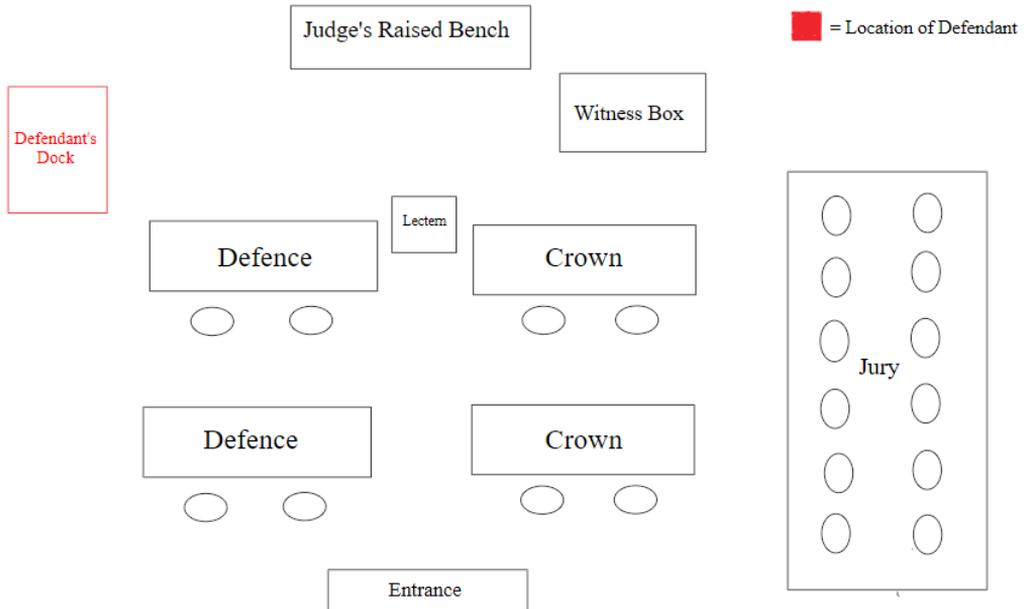
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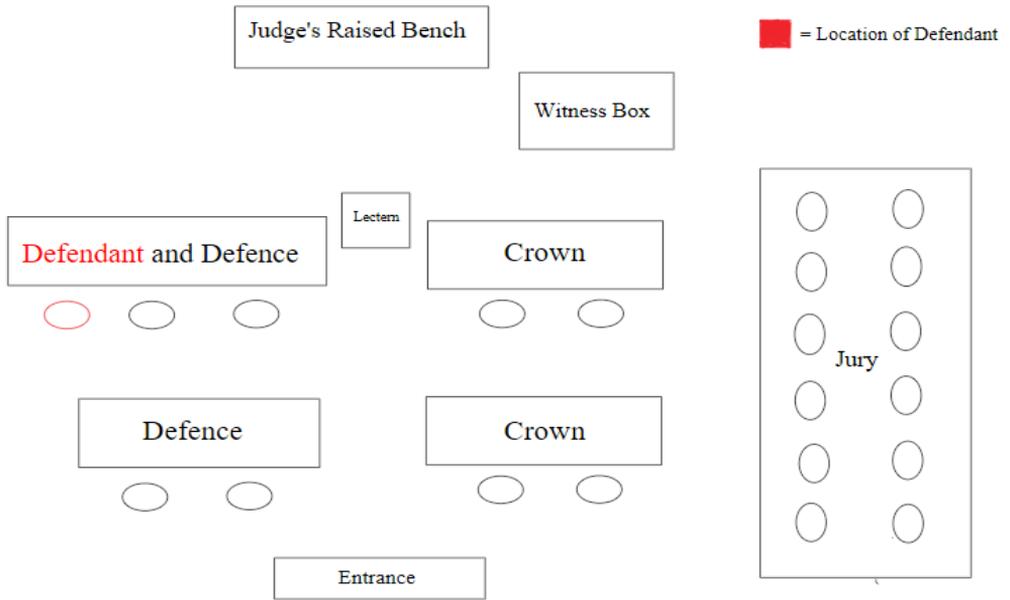
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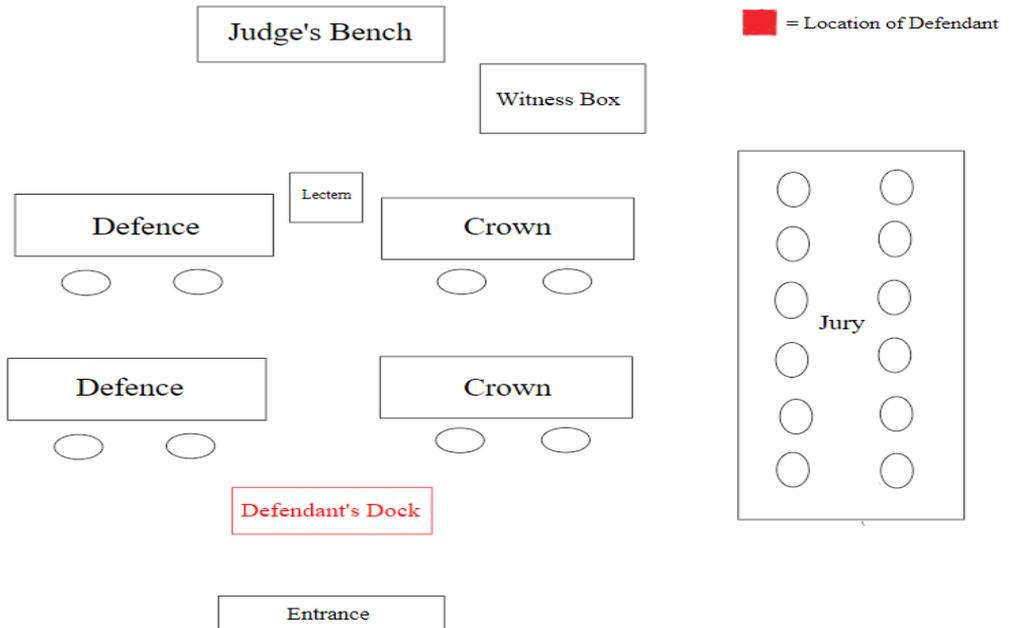
Appendix A – Trial A Layout



Appendix B – Trial B Layout

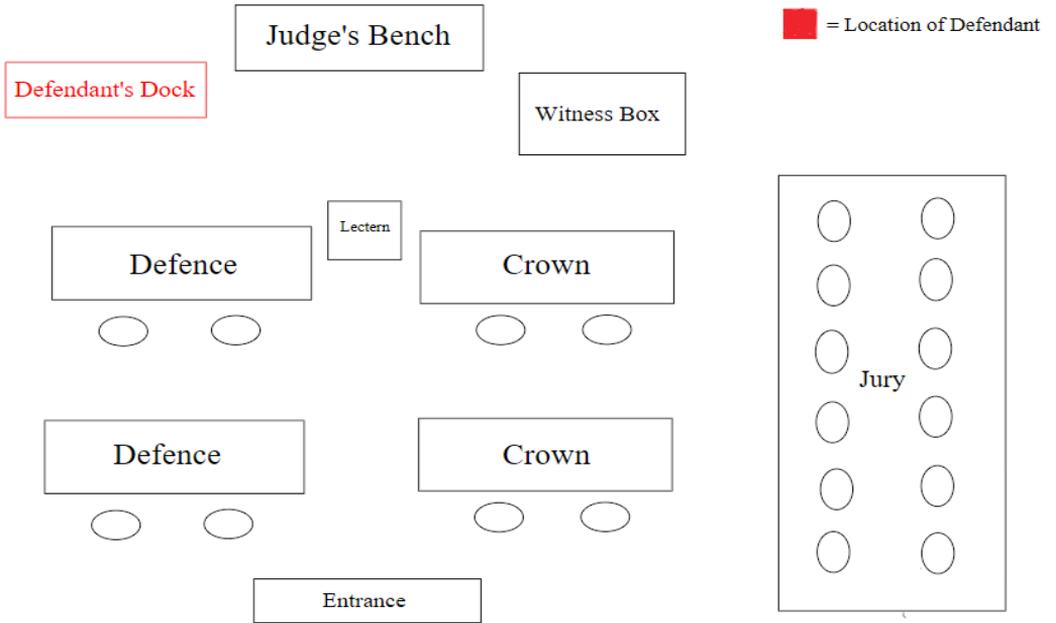


Appendix C – Trial C Layout



SPATIAL COGNITION IN THE COURTROOM

Appendix D – Trial D Layout



Appendix E – Questionnaire

Please circle the following answers:

What gender do you identify with?

Male

Female

Other/ Prefer not to say

What verdict would you give to the defendant?

Guilty

Innocent

In the space below, please give a brief explanation outlining the reasoning and thought process that led you to your verdict.

Use 3 words to describe the courtroom.

On a scale of 1 to 5, rank your level of physical comfort throughout this trial (1=not comfortable, 3= neither comfortable nor not comfortable, 5=very comfortable)

1 2 3 4 5

How much time did you approximately spend focused on the following?

	Minimally (< 5 minutes)	Somewhat (5– 10 mins)	Middling 10-15 minutes	A lot 15-30 minutes	A great deal (> 30 mins)
The Defence Lawyers					
The Defendant					
The Crown Prosecutors					
The Judge					
Others (the wall, fellow jury members, your shoes)					

How often did your mind wander to the point where you were not present or actively engaged in the trial?

Never

One or twice

Rarely

Frequently

Very frequently

Appendix F – Declaration of Consent Form

Declaration of Consent Form

Name of Child/Student: _____

I, _____ (full name), do hereby acknowledge, consent, and agree to all of the following terms and conditions listed below:

I understand that I am participating in a research experiment for Connie Zhang's AP Research Paper.

I understand that my identity will not be linked with my data, and that all information I provide will remain confidential.

I understand that my participation is voluntary, and that I am free to withdraw at any time, without giving any reason or receiving any resulting penalty.

I understand that by agreeing to participate in this experiment, I am expected to attend the full duration of the experiment (2 hours).

I understand that my role as a juror requires me to be as objective and impartial as possible throughout the duration of the trial and during the deliberation period.

I understand that by accepting to participate in this experiment, I am agreeing to behave and uphold a standard of professionalism and maturity.

I understand that in addition to my job as a juror, I must complete a short questionnaire that will be distributed after the trial is completed.

I have read and understood the above information and hereby give Connie Zhang my consent to use derived from this experiment in her research.

Participant Signature:

Date Signed:

Rural and Urban Dialect Perceptions of Kentucky High Schoolers

Emma Fridy

This research focuses on the previously unstudied dialect perceptions of Kentucky urban high schoolers as it relates to their rural peers. Focus groups and questionnaires were used to collect data with a grounded theory method being employed to analyze data. Students were asked their perceptions of topics relating to regional identity, linguistic variation, and prejudices, as well as how they, as a younger generation, view language and identity. The purpose of this research was to identify trends in urban high schoolers' perceptions of their rural peers. The research found many students held prejudices against rural students, and although they recognized the prejudices, they believed them to be true. The research further concluded that Louisville high schoolers perceive Louisville is a separate cultural and dialectal entity from rural Kentucky, and that rural Kentuckians are more likely than Louisvillians to be uneducated, ignorant, and impoverished. Furthermore, urban students think that rural Kentuckians have an overall negative view of Louisvillians, especially African Americans, stemming from a lack of communication and a difference in political and social values. These findings clearly point to the fact that urban students have negative views of rural citizens, and that Kentucky needs to address systematic social division within the state between urban and rural citizens, especially students.

Keywords: perceptual dialectology, Kentucky students, rural dialect perception, urban dialect perception, rural stereotypes

Introduction

The purpose of this research is to identify links between high schooler's perception of rural Kentucky dialect and how that affects their overall perception of students living in rural Kentucky. The research took place in Louisville, using high schoolers as participants, for which there is no previous research. In fact, Cramer has recently called for further analysis of border communities (where communities meet) as well as a need for a broader understanding of regional identity associated with language (Cramer, «Contest-

ed Southernness,» 166). Louisville fits that niche, as it is located on the border between the South and the Midwest.

A combination of focus groups and questionnaires was implemented, for which there is little to no precedent in the field of sociolinguistics or PD. The question explored was whether dialect affects personal perceptions, especially among Kentucky high schoolers. The significance of this research is that it will provide the academic community with a greater understanding of regional identity, linguistic variation, and prejudices, as well as show how a younger generation views language and identity. No research

has been done comparing these factors, much less with this sample, partly because the field of PD is so new. That makes this research foundational in nature.

This research shows that prejudices are prevalent within Kentucky's urban high schoolers, and that most urban students believe rural students to be ignorant, uneducated, poor, and conservative. Analysis also led to the conclusion that most of these prejudices were the effects of a serious lack of communication between urban and rural students. This research is integral to Kentucky's current very tense political situation between urban and rural areas.

Literature Review

Dialectology and Sociolinguistics

The idea of variation within languages is not new, nor is the intersection between variation in culture and language. However, over the past hundred years, great strides have been made in research regarding how geography, socioeconomic status, and ethnicity affect perceptions of linguistic variation. For example, in the 1960s and 70s, dialectology was found to be extremely useful in cohort with other linguistic traditions to further the study of language as a "socially situated vehicle of communication" (Sankoff, 171). The 1980s also brought great change to the field as dialectologists began branching out from simply documenting dialects and began researching linguistic variation "as a correlate or indicator of social variation and as a source of language change" (Nelson, 193). This change opened up new areas of research previously ignored such as inner-city dialects and the language of younger speakers, as experts wanted to document language change over time (Nelson, 214), as well as new fields of study such as historical sociolinguistics, mainly focused on Western Europe (Agar & MacDonald, 78).

About a decade after that revelation, a new wave of thought swept through the dialectology community: the idea that dialects are not inferior to standardized language nor are they any less structurally complex or effective for communicating. The new idea concluded that every form of speech is a dialect; it just so happens that one dialect was named Standard (Chambers & Trudgill, 3). It was at this point that dialectology and

sociolinguistics started to look nearly indistinguishable from one another, and where modern sociolinguistic research began. This concept is fundamental to this research as the students were evaluating another group of students that were ultimately deemed inferior along with their dialects.

Geography became an important factor in sociolinguistic research and the concept of a chain of mutual intelligibility was formed. Mutual intelligibility is when people speaking similar dialects (or even language) can understand one another. Essentially,

... dialects on the outer edges of the geographical area may not be mutually intelligible, but they will be linked with a chain of mutual intelligibility. At no point is there such a break that geographically adjacent dialects are not mutually intelligible, but the cumulative effect of the linguistic differences will be such that the greater the geographical separation, the greater the difficulty of comprehension. (Chambers & Trudgill, 5)

In modern society, with phone lines and the internet, regional dialects are moving closer to standard dialects (Wieling, 13) which can make this chain of mutual intelligibility irrelevant. However, this concept is still applicable on a dialect continuum. This continuum can also be social, and within Kentucky, the dialect change between urban and rural is very abrupt and sharp, which leads to a break in this continuum and a breakdown of communication.

This was also illustrated in Jamaica, where the lower class spoke Creole while the upper class spoke English, creating social tension (Chambers & Trudgill, 7). In the poorer neighborhoods, Creole was spoken and speaking either English or Creole identified closely with a socioeconomic status. Even in the U.S.A. today, this social factor is evident as the descendants of immigrants use their heritage language less and less in favor of English (Pégram 110). A continuum also exists among speakers of different ages, with more homogeneity among members of a family in older generations (Hamilton & Hazen, 102). Eva-María Suárez Büdenbender argues that this is also the case with dialect in Puerto Rico, where a sizeable portion of the population speaks Dominican Spanish. Majority speakers often cite dialect as the principal method of identifying Dominican immigrants, and Büdenbender's study found that negative stereotypes such as poverty and illiteracy were associated with a dialect,

with more weight being placed on heavier accents (Büdenbender, 110). Accents are only a part of dialect, but for many people, it is the most visible and easiest identifying trait of different dialects. Another clear connection between perceived socioeconomic status and language is the Fresa phenomenon on the US/Mexico border. The Fresa phenomenon is made up of young people living in Mexico but near the US border who are incorporating aspects of both American and Mexican culture into their everyday lives in order to be perceived as upper class. This is opposed to their peers, who primarily identify with Mexican culture. In this sense, speaking English is seen as a luxury for the upper class (Holguín, 36). On top of that, it has been found that in pre-revolutionary Cuba, English anglicisms had a direct correlation to the upper-class population—in other words, the rich people of Cuba were mixing English into their Spanish more than lower-class people (Sánchez & Antonio, 45).

Altogether, dialectology and sociolinguistics are far-reaching fields that deal with a number of complex variables, but the research in this paper will primarily focus on geographic distribution and socioeconomic status in relation to linguistic variation. Within Kentucky, there is a broken social continuum as well as severely different lifestyles between urban and rural students that stems from a difference in socioeconomic class and social views. This research explores how all of these factors work together to influence the dialect perception of Kentucky high schoolers.

Perceptual Dialectology (PD)

Penelope Eckert argues that there have been three major waves so far in terms of sociolinguistic research. These waves helped provide different levels of meaning to sociolinguistic variables (Eckert, 88). However, all three waves occurred before the field of PD had taken off. For the purposes of this research, PD is defined as “a branch of folk linguistics that attempts to redress the balance somewhat focusing on what non-linguists think, say, and understand about language and linguistic variation” (Cramer & Montgomery, 2). Even today, PD is a relatively new and emerging field. It is clear that extensive research has been done to show that geography and socioeconomic status play an important role in language variation, and that language variation is linked to culture and society. How-

ever, because of the delayed interest in PD, a large gap in knowledge exists when it comes to how geography and cultural aspects affect people’s perceptions of linguistic variation.

Another key factor in this discussion is identity, because how people perceive the language of others and of themselves often has to do with individual identity and group identity (Büdenbender, 110; Cramer, “Perceptions of Appalachian English,” 61-62). At one point, Coupland wrote an article in direct opposition to Trudgill’s statement “that identity is ‘irrelevant’ as a factor in his area of interest”, arguing that “to rule out all issues of identity, particularly in circumstances of demographic movement and cultural mixing, seems unnecessarily restrictive” (267). Identity can even come into play in situations like interviews, where men were found to respond differently (more politely) to women interviewers than other women participants were, and the phenomenon was so widespread in the South that it was named the Rutledge Effect (Bailey & Tillery, 390). One study went even so far as to assert its findings as “compelling evidence of such indissoluble bonds that link language and identity” (Brown, 285). Haller & Müller concluded that identity is directly related to attitudes, and therefore presumably to actions. They suggested further research on identity (28), which this paper will indirectly be dealing with as associated with the identities of the groups of people being sampled.

An expert in the field, Jennifer Cramer, has done extensive research specifically on the perception of speech within Kentucky, mainly focusing on Louisvillians’ perspective of Appalachian and Southern speech. She has found that Louisvillians routinely identify with the perceived “best parts” of Appalachian speech only (Cramer, “Perceptions of Appalachian English,” 62). Louisvillians also consider Appalachian speakers different from themselves, with an uneducated and incorrect dialect, although the Appalachian dialect is considered to be relatively pleasant. Louisvillians were also extremely accurate when denoting where Appalachia was, specifically within Kentucky. Louisvillians are aware of the negative image America has of Appalachia and seek to separate from that image (Cramer, “Perceptions of Appalachian English,” 61). It has also been found that mental dialect maps are extremely important for people to determine where their community lies, and where “other” starts

(Iannàccaro & Dell'Aquila, 276). These sources are significant to this research because dialect maps have already been created and analyzed, and clearly there is a divide between rural Kentucky and urban Kentucky.

Methods

This research builds off of previous research in the perceptual dialectology field. It does so by looking at a new category of participants: high schoolers. It also does so by moving past dialect maps and onto focus group analysis. A Grounded Theory Phenomenological approach was used to collect primarily qualitative, and some demographic, data from focus groups. Data were analyzed using the Grounded Theory technique and the software MAXQDA2018 in order to discern the overall perceptions of Kentucky high schoolers. Because the topic of Perceptual Dialectology (PD) is not one generally discussed by high schoolers, focus groups were used to facilitate meaningful conversation (Agar and MacDonald 78). Focus groups were also chosen because the topic discussed related to experiences and attitudes, which are well suited to focus groups (Kitzinger 302).

Two focus groups were conducted at an urban school in Kentucky. A phenomenological method revolves around deep analysis of a small sample size—in this case, ten students. A phenomenological approach also meant that questions could entirely be formulated beforehand because no assumptions about the results could be made. The focus groups were a loose format, allowing the students to talk about whatever came up, with the researcher simply guiding the discussion toward the research question. For full focus group transcripts, see Appendix B and Appendix C.

Focus groups were audio-recorded, each student was assigned a number before transcription for purposes of anonymity, and consent forms were obtained. See Appendix A for the consent form model. The sample was convenient, with a random sample being infeasible for high school participants, as they had to volunteer for the focus group during their study hall. The school was chosen because it was neither privileged or underprivileged and demographically diverse, with males and females being almost equally represented, and minority students representing 40% of the student population. Questionnaires were also

used because self-reporting has been found to be extremely accurate when talking about lack of bias, which is called for by a Grounded Theory Phenomenological method (Bailey & Tillery, 399). Questionnaires were used to obtain personal and demographic information, as well as level of linguistic education, which was expected to be zero. This was one of the only assumptions made because Grounded Theory calls for unbiased data. However, it was necessary. In the field of PD, participants usually have no linguistic education. Because the topic of PD is extremely nuanced and complex, a Phenomenological approach was necessary in order to reduce bias and to paint a full picture of students' attitudes and perceptions. Despite some literature fundamentally disagreeing with Grounded Theory (GT) Methods (Thomas & James, 790), mainstream consensus holds that GT is a respectable method if conducted properly, and due to the foundational structure of this research—no other research on this topic has been conducted surrounding high schoolers—finding a theory was especially relevant.

In order to find a theory, the focus groups were analyzed using the GT method of coding line by line before a process of memoing began that was recursive and cyclical in nature. Through this process, codes were organized into concepts and later categories in order to form a final theory. The purpose of this research was to assess perception and attitudes based on social factors. The open format of focus groups helped stimulate an environment for sharing attitudes and perceptions, and the demographically diverse students addressed social factors. As shown by the table below, the convenient sample was 70% white and 70% female, while Kentucky is 51% female and 90% white. These differences are a limitation of a convenient sample and should be taken into account. However, both sexes and multiple races were represented. See Table I for a full breakdown of demographics.

Table I
Focus Group Demographics

	Male	Female	Black	White
Focus Group 1	0	2	0	2
Focus Group 2	3	5	3	5
Total	3	7	3	7

Questionnaires helped to collect data students may not have wanted to share with the group and/or did not make sense to discuss (demographics, family history, etc.). Students had previously been assigned numbers and those were connected to questionnaires, which enabled the coding process to be anonymous while still knowing which student was which in the focus group and questionnaire. The questions on the questionnaire were piloted as focus group questions but were found to be awkward in a group and were moved to the questionnaire before the actual research was conducted. By using a Qualitative Phenomenological Grounded Theory method, the most substantive information was gathered as efficiently as possible, and the analysis of data was as significant as it could have been.

Results & Discussion

Perception of Rural Dialect

Students agreed across the board that the dialect of rural Kentucky was extremely different from that of Louisville. The perception of rural dialect centered around the fact that rural Kentuckians have a distinctive accent, with one student stating that, "if you go outside of Louisville, the language that you hear, it gets more countryish." Rural dialect was described as being less proper, less formal, and associated with Christianity and conservative political doctrine. One student summed it up by saying, "I think of Confederate flags, Republican, conservative." This finding supports Cramer's research findings that Louisville identifies as separate from the rest of the state of Kentucky (Cramer, "Perceptions of Appalachian English," 61).

One recurring theme within focus groups was that students acknowledged their prejudices were not founded in anything besides stereotypes and came to the conclusion that dialect doesn't define a person. One student related that "it has a prejudice to it, and it's hard to hear that, it's hard to hear someone and not have prejudice," while students across the board could not agree whether a person's accent defined them. The two general themes were that "your accent or anything shouldn't define who you are ... it's an impression of who you are, and it doesn't define you, but

it's part of who you are," juxtaposed with "it shouldn't define you, but I think it does define you." This expands with Brown's theory that language and identity are inseparable, inextricably linked (Brown, 285).

However, students felt that many of the prejudices were true. For example, the overwhelming consensus was that rural people are less educated and that their accent identifies them as such. However, students did admit that after they thought about it, rural people still seemed less educated, but students were unsure if they actually were less educated. Furthermore, students said that partially due to lack of education and also from lack of opportunity, rural people are more likely to live in poverty. Students also expressed that on top of lack of education, "people with more strong country accents, they are more ignorant," as they have not traveled or experienced the outside world. This revelation specifically helped to answer the research question as it was made clear that stereotypes of people are directly linked to their respective dialects.

Another large theme that came up repeatedly in focus groups was that Louisville's dialect is completely separate from that of rural Kentucky. Students referred to this dialect as "city," and almost all students identified with the city dialect rather than with the rural. However, some students did identify with some parts of the rural dialects. A large part of this, according to students, is that everyone gets their dialect from their family, or the people they grew up around. One student, echoing the entire focus group said, "Family. I feel like all my stuff I be saying, see ... I be, come from my family. I pick up stuff, when you're young, when you're little, that's how you learn how to talk, that's how you learn how to walk." This particular student picked up the phrase "I be" from her family. For the students with parents or family from a more rural or Southern area, having more rural colloquialisms was not uncommon, as some students reported "slipping into accents," while the students with families from Louisville almost all completely identified with the city accent. In fact, across all focus groups, students brought up the idea that some people in Louisville exaggerated or even faked country accents, exemplifying how out of place country accents are in Louisville. However, most students were quick to point out that while country accents are rare in Louisville, you do encounter them when traveling around Kentucky and other parts of the South, and as such, students

expressed familiarity with the rural dialects. This supports general findings of Kentucky dialects, and the fact that Kentucky is situated on a border between the Midwest and the South plays a large role in the unique situation of the high schoolers.

One subset of students that had radically different views of rural peoples were the African American students, who expressed fear surrounding the attitudes of rural people towards different races and ethnicities. The African American students stereotyped those rural people as conservative and often racist. One of the first students to speak brought up that “nobody’s blind to what’s really going on in the world, let’s be real. Everybody knows what’s going on with the whole Black Lives Matter, all lives matter, on and on.” Later during the discussion of this topic, students were asked if they felt more unsafe around people with deeper country accents, and every African American student said yes. Students perceived rural Kentuckians as more likely to target a black person with hate as opposed to an urban person, with one student speculating this was “because they’re not surrounded as much by as many black people.”

Another common sentiment among African American students, although it was also present in white students, was the need to adapt their language, a phenomenon known as codeswitching. African American students cited using less slang, slurring fewer words, and trying to sound more formal, just to be safe around people with country accents. In contrast, white students reported doing the same things to their dialect, but for the purpose of improving prospects at job interviews or during the college application processes. It has been previously established that Standard English is required for most job opportunities and college interviews (Godley & Escher, 712)(Whitney, 68), and that “...many African American children are not proficient enough in Standard English to facilitate academic success and career mobility” (Taylor, 35). So the fact that African American students did not address codeswitching in that context, and instead exclusively in the context of avoiding hatred certainly speaks to how dire their perceived need to codeswitch is around rural people. This finding expanded on the relationship between dialect and personal perception. Clearly, African American students have prejudices against white rural people, and they simply use dialect to identify those people.

Black students also expressed resentment at being labeled “ghetto,” “ratchet,” or “thuggish.” These students felt like people with country accents were more likely to harm them, physically or verbally. Not surprisingly, the students who felt that rural people often label them negatively based on their accent consistently argued within their focus group that dialect should not define a person, particularly the intelligence level of a person. As one student put it, “you could still be smart, you could still be anything.” However, the students that expressed resentment at being labeled negatively based on their accent agreed that people with country accents are less educated, poorer, and more ignorant.

Overall, students expressed negative perceptions of rural students, including that rural students are less educated, poorer, and more likely to be racist. Students identified rural Kentuckians based on their accent, and students separated Louisville from the rest of Kentucky in terms of cultural aspects. This affirms Bündenbender’s theory that groups of people have negative stereotypes and are identified by their dialect as opposed to people simply disliking dialects because of the way that it sounds (110). Essentially, the students affirmed that they had negative views of rural dialects and rural people.

Perception of Rural Students’ Attitudes

The last section of each discussion was dedicated to how students thought rural students perceived them. Unsurprisingly, all students across all focus groups agreed that rural people do not like Louisvillians, and that general rural attitudes towards urban centers are negative. One student even went as far as to say “I know people in other parts of Kentucky hate Louisville.” The reasons range from the fact that Louisvillians don’t like the outdoors, to the fact that Louisville is significantly more Democratic/liberal than the rest of the state. Technology was also brought up, with some students arguing that rural Kentuckians do not like Louisville because we use new technology. However, all of these factors were combined into a concept dealing with a lack of understanding and communication.

Students cited rural Kentuckians as thinking “that since we’re from the city, we don’t understand them,” and that rural Kentuckians are not likely to visit cities

often, being more confined to their towns than urban students. Coupled alongside these conclusions was the concept that urban students perceive rural peoples as generally ignorant, in the same vein as the perception of lack of education previously discussed. One student stated, “I feel that people that don’t want to educate themselves or maybe are a bit more ignorant” in reference to rural people, and another student affirmed that “people with more strong country accents, they are more ignorant.”

The idea that rural people looked down upon African Americans was again brought up during this section of the focus groups. The fact that Louisville is significantly more Democratic than the rest of Kentucky was mentioned, along with the fact that African Americans overwhelmingly vote Democratic. However, it was concluded that the largest factor influencing this perception was ignorance, as urban students believed rural people to be ignorant of social problems such as racism, resulting in the perception that rural people are more likely to be hateful towards African Americans.

Overall, students perceived rural Kentuckians as having a negative perception of urban Kentuckians, primarily due to social and political values, as well as the perceived difference in lifestyles.

Theory

As perceived by high schoolers in Louisville, Kentucky, Louisville is a separate cultural and dialectal entity from rural Kentucky and rural Kentuckians are more likely than Louisvillians to be uneducated, ignorant, and impoverished. Furthermore, urban students think that rural Kentuckians have an overall negative view of Louisvillians, especially African Americans, stemming from a lack of communication and a difference in political and social values.

Limitations and Implications

While this research presents new information, it is important to note that with only ten participants across two focus groups, these results can not be generalized to the whole population, or even that of the South. This research pertains only to Kentucky, spe-

cifically to the regional perspective of Louisville high schoolers. While this research is unique and therefore draws significant conclusions, more focus groups would need to be conducted in order to generalize the theory presented. However, this does not discount the conclusions drawn, as there was enough data to reach a point of saturation.

A convenient sample was not ideal, as this may have biased the data in favor of those who are more comfortable with or care more about dialect perception and language. However, the themes represented in this sample are likely to be present in populations without said bias, as even though the general public is not aware of the study of dialect perception, every person has biases, however explicit or implicit, that would allow them to participate in focus groups similar to the ones in this project.

The sample was taken entirely from Louisville, and Kentucky does have two major cities: Louisville and Lexington. While these cities are culturally and politically similar, it is important to note that the findings of this research will by nature be more applicable to Louisville than Lexington. Furthermore, as the researcher was also from Louisville, it is possible that only Louisville-specific topics were discussed unknowingly. Conducting further research in Lexington would be extremely useful to support the findings of this research.

Though this study had some limitations, the data generated is still valuable in understanding the unique factors that influence dialect perception among Kentucky high schoolers. The data represented a foundational study in Kentucky student Perceptual Dialectology—no previous research has evaluated high school students’ perceptions of the issue. Understanding these perspectives is critically important as the tensions between rural and urban America become more prevalent, and in light of the fact that today’s students, will eventually be directing and voting for policy. If effective policies regarding state and local government in Kentucky are to be developed, students’ perspectives must be understood. This research provides a base upon which to further explore students’ dialect perception through additional focus groups and targeted questionnaires.

Future Directions

To allow for generalization of this theory to all Kentucky students, a future study will involve additional focus groups across more urban schools, especially in Lexington, and branch out into more rural parts of the state to gather the perceptions of rural students. Targeting future focus group questions to major themes that arose from this research and that will arise in further studies will allow the researcher to focus on the more important concepts and categories. Eventually, a theory will be generalized to all Kentucky students, and the state government, local governments, schools, and businesses, will be able to use this information to better accommodate dialects, as well as work to dispel some of the untrue prejudices against rural or urban students. Hopefully, this will help address the underlying problems surrounding the stigma of a rural or urban dialect.

Conclusions

The importance of this theory is seen in its application to current policy as well as to the previous perceptual dialectology research. The cultural divide is mainstream knowledge in Kentucky, with local news station WFPL writing a story entitled “Louisville, Not Kentucky: Dissecting The State’s Urban-Rural Divide.” The article addresses the political split between rural and urban Kentucky, but concludes with the statement that Louisville/Lexington and the rest of Kentucky have a “shared future,” evident by the fact that Louisville/Lexington rely on rural areas for fresh food and energy, while rural Kentucky depends on urban centers for economic activity. This “shared future” is the exact reason why the legislature of Kentucky, and of course, the citizens should come together to make policies that are in everyone’s best interest.

As evidenced by the recent teacher sick-outs within public school districts, this has not happened of late. In 2018 as well as 2019, Kentucky teachers, particularly urban teachers, have staged sick-outs, in which a large number of teachers call in as sick, and school is forced to cancel for lack of substitute teachers. From Jan 1, 2019 to March 20, 2019, teachers had six sick-outs, and the Courier-Journal, a local news source, reports that the reason for these sick-outs was to pro-

test anti-education legislation in the Republican-controlled Kentucky legislature. USA Today also reported that the state requested all the names of the teachers that participated in the sick-outs, escalating the already tense situation. The Governor of KY, who has the support of rural KY, has rallied against the teacher sick-outs, angering many urban teachers.

It is clear that the research presented here is part of a larger social trend that sees Louisville and Lexington as separate from the rest of Kentucky, and that political and social tensions are high in the state right now. Seeing as the students of Kentucky are the most affected by Kentucky’s education system, along with the fact that Kentucky’s youth will one day be making decisions as legislative representatives or even teachers, it is clear that Kentucky as a whole would benefit from the knowledge of its cultural and social divides. Hence, the findings of this research can be directly applied to the current situation within the state in order to direct policy and encourage the redressment of untrue or unfounded prejudices or assumptions regarding the rural and urban populations of Kentucky.

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RURAL AND URBAN DIALECT PERCEPTIONS OF KENTUCKY HIGH SCHOOLERS

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Appendix A

Dialect Perception Consent Form

You are being asked to take part in a research study of how high school students perceive language. You are being asked to take part because you are a high schooler at one of the schools participating in this study. Please read this form carefully and ask any questions you may have before agreeing to take part in the study.

What the study is about: The purpose of this study is to learn about the relationship between geographic distribution factors and dialect perception. You must be a student from a chosen school to participate.

What we will ask you to do: If you agree to be in this study, we will ask you to take part in a focus group. The focus group will include questions about your dialect (speech), your upbringing (cultural context), your perceptions of how other groups of people speak, where you live (rural v urban), language stereotypes you may have, and how much formal education you've had dealing with language. The focus group will take about one hour to complete. The focus group session will be recorded. I will also ask you to complete a questionnaire after the focus group which will take approximately 15 minutes. The questionnaire will cover demographics as well as final questions regarding your education and family.

Risks and benefits:

There is the risk that you may find some of the questions about your personal life and beliefs to be sensitive.

There are no benefits to you. This study simply wishes to learn more about the speech perceptions and patterns of high school students.

Compensation: None

Your answers will be confidential. The records of this study will be kept private. In any sort of report we make public we will not include any information that will make it possible to identify you. Research records will be kept in a locked file; only the researchers will have access to the records. If the focus group is

tape-recorded, it will be destroyed after it has been transcribed, which is anticipated to be within two months of its taping.

Taking part is voluntary: Taking part in this study is completely voluntary. You may skip any questions that you do not want to answer. If you decide not to take part or to skip some of the questions, it will have no effect. If you decide to take part, you are free to withdraw at any time.

If you have questions: The researcher conducting this study is Emma Fridy, and she is a student at [REDACTED]. Please ask any questions you at [REDACTED].

Statement of Consent: I have read the above information, and have received answers to any questions I asked. I consent to take part in the study.

Your Guardian's Signature _____

Date _____

Your Guardian's Name (printed) _____

In addition to agreeing to participate, I also consent to having the focus group tape-recorded.

Your Guardian's Signature _____

Date _____

Signature of person obtaining consent _____

Date _____

Printed name of person obtaining consent _____ Date _____

This consent form will be kept by the researcher for at least three years beyond the end of the study.

Effect of Musical Properties on Cognitive Abilities of High School Students

Rida Bonday

This research paper tests the hypothesis that the musical properties of tempo and/or pitch and cognitive abilities of high school students are causally related. All five treatment groups completed the same 20-question spatial-temporal reasoning test in 10 minutes and listened to versions of the same piece: K448. The control group listened to K448 unmodified. One tempo group listened to a slower-tempo version of the piece, and the other listened to a faster-tempo version. One pitch group listened to a lower-pitch version of the piece, and the other listened to a higher-pitch version. Four 2-sample t-tests demonstrated that the slow tempo group and both pitch groups did not score significantly better than the control group, while the fast tempo group did score significantly better than the control group. The conclusion section discusses scientific and educational implications of these findings and delves into future research objectives.

Keywords: cognitive abilities, spatial-temporal reasoning, tempo, pitch, music, brain.

Introduction

The relationship between music and the human brain has its roots in the adaptation of rhythmic recognition with the advent of bipedalism, which enabled early man to distinguish between the walking patterns of his fellow humans and those of other animals (Trimble, 2017). Music, like all other auditory stimulus, is processed by the temporal lobe, but recent research in the field of cognitive musicology suggests that the effect of music on the human brain may be more profound than that of other auditory stimuli. Even beyond music-induced foot tapping and other physical reactions to music, there is evidence that music could bolster the brain's intellectual capacity and have short and long term effects on the way the brain processes information.

Measuring the effect of music on the brain has

proven to be a difficult task due to the abstract nature of the construct to be measured: cognitive ability. With such an abstract variable comes the challenge of picking an appropriate system of quantification. Seeing as intelligence is defined not as the ability to perform any one task, but rather as the ability to apply foundational knowledge to an array of undertakings, it is important to select a measure of intelligence that comprises a skill set applicable across multiple fields and disciplines (Oswalt). A commonly referenced dependent variable in biomusicology is spatial-temporal reasoning, defined as the ability to mentally visualize and manipulate objects in space and time (APA Dictionary). Spatial-temporal reasoning is clearly critical for success in a variety of professional disciplines, and was the dependent variable used in a pioneering biomusicology study conducted by Frances Rauscher that introduced the Mozart Effect in 1994. The Mozart

Effect posits that listening to classical music yields optimal spatial-temporal reasoning performance as opposed to other genres of music (Rauscher et al., 1994). At the time, this research seemed to have far-reaching implications in education and in the workplace.

However, since its introduction in 1994, the Mozart Effect has been the subject of widespread criticism because researchers who repeated the experiment were unable to replicate its results, and other studies conducted under similar conditions found that other genres of music were more effective than classical music in stimulating the brain's intellectual capacity (New York Times, 2018). Here lies a gap in the research: music appears to have some impact on the brain, but the specific impact has yet to be identified by biomusicologists. Notably, previous research on the relationship between music and cognitive abilities focuses on the differences between genres of music in comparison to silence or in comparison to other auditory stimuli, but it remains unknown what exactly it is about music that stimulates the brain's information processing capabilities.

At this point, it is worth looking at the situation from the point of view of a musician to add to the conversation. Music is not defined merely by genres, but by intrinsic properties that distinguish one piece from another. Among the most fundamental of these properties are tempo and pitch, both of which have noticeable impacts on the sound and feel of a piece (The Elements of Music). Existing research on music and the brain has not taken into account the variety that these properties bestow upon music. This consideration led me to an important question: to what extent do varying musical properties impact cognitive abilities? My study examined the effects of varying tempo and pitch of the piece K448, also known as Mozart's Sonata for Two Pianos in D Major, on spatial-temporal reasoning test scores of high school students. Modified tempo and pitch specifically are meaningful relative to the original piece because, of all the musical properties, they have the most discernible effects on a given piece of music; these effects are obvious even to someone with no musical training, as compared to more complex qualities such as rhythm or tone color. The concepts behind this study have potential implications in education, particularly for students and teachers to determine what qualities background music for studying and test-taking should have.

Literature Review

Counterarguments

Laurel Harmon, a researcher in educational psychology at Western Connecticut State University, provides an important counterargument to much of the field research done in cognitive musicology. This counterargument was critical to the formation of my research question. Her study consisted of two experiments. In the first experiment, the researchers hypothesized that participants who listened to Mozart would score significantly higher on a listening comprehension test than participants who listened to rock music or silence (Harmon, 2008). In the second experiment, the researchers hypothesized that participants who listened to rock music would have lower reading comprehension scores than participants who listened to classical music or silence. Interestingly, an ANOVA (Analysis of Variance) test indicated that the results for both experiments were non-significant. The results of this experiment are debatable due to possible bias in the experimental design. Subjects could have ascertained which group they were in based on what music they were listening to (or based on the fact that they were listening to silence), especially if they were familiar with the concept that classical music is most conducive to studying and comprehension. While this bias undermined the reliability of the experiment's results, there was still a lesson to be learned here for when I set up my own experiment: because I played the same piece for all groups, and because the changes in tempo and pitch were difficult to ascertain for subjects who were unfamiliar with the piece, my experiment was single-blinded. Single-blinding is an efficient way to avoid bias on the part of the participants. The counterargument to the Mozart Effect presented by this study was useful to me because rather than testing the effect of classical music versus other genres on cognitive abilities, I aimed to pinpoint the specific properties of classical music that are conducive to learning. These properties can be highlighted and manipulated in any genre of music, not just classical music, so my results could conceivably be applied to other genres of music.

In agreement with Harmon's dismissal of the Mozart Effect, a study published by the University of Tsukuba in Japan explored possible potential relationships

between emotion and concentration (Mori). Music that appeals to emotional extremes rather than being neutral can impact the subjects' perception of their performance on the given task. For example, happy music can make subjects feel like they are performing better than they really are, and can cause them to lower the level of effort they put into the task. At the other end of the spectrum, sad music can make subjects feel like they are performing worse than they actually are, stressing them out and distracting them. The study randomly assigned subjects to one of three groups: the control group took the test in silence, one experimental group listened to songs of their preference, and the other experimental group listened to unfamiliar music. The results were that the control group made the most mistakes on the test, the group that listened to unfamiliar music made fewer mistakes, and the group that listened to preferred music made the least mistakes. The study, although published by the University of Zurich, is questionable because by allowing subjects in the preferred music group to listen to any music they would like, the researchers introduced an additional variable to their study. The results seem to show that listening to unfamiliar music is not as optimal for concentration as listening to preferred music; however, this is more likely because of the variation in musical properties between pieces rather than because of the subjects' familiarity with the background music. To avoid this added variation in my research project, rather than having vague categories such as "preferred" and "unfamiliar" for background music, I played the same piece for all subjects and I only manipulated the musical properties of tempo and pitch. This way, I had complete control over the independent variables in my study.

Expectation and Attentiveness

A study published by Elsevier Clinical Psychology explores the brain's response to dissonant harmonies that defy subconscious expectation of what will happen next in the music. Participants were presented with excerpts from classical piano sonatas that were taken from commercial CDs, and continuous electroencephalograms were recorded by the researchers (Koelsch, 2002). The control group was presented with expected chords at the end of chord sequences, and the experimental group was presented with un-

expected chords at the end of chord sequences. The results were that unexpected chords elicited negative responses in both hemispheres of the brain, with notable negativities in the right temporal lobe. This study was useful to me in my experimental design because it illustrates that expressive music with noticeable melodies can distract participants from the task at hand instead of helping them. To avoid this problem, I used a piece with subtle melodies that was neutral rather than very expressive.

Expanding on the idea that expectation has a strong impact on hemispheric brain activity, an article by the Stanford Medicine News Center details the findings of a Stanford study that monitored participants' brain activity while a piece by an obscure 18th-century composer was played for them (Stanford Medicine, 2007). The results were that brain activity in regions associated with attentiveness peaked in the moments between movements. This occurred because of subjects' anticipation of what would happen after the transitioning silence between movements, even though they were unfamiliar with the music they were listening to. The article includes a video of a participant's hemispherical brain activity, with the number of seconds until the transition shown at the bottom of the screen. Subjects in the study showed improved attentiveness, but they were only listening to music and were not performing another task in the foreground. In my study, the music is in the background while subjects complete a spatial-temporal reasoning test. To avoid drawing subjects' attention to the transitions between movements, as was seen in the Stanford study, I will play a single continuous piece instead of a piece with multiple segmented movements.

Other Auditory Stimuli

Michael Widerman, a psychologist at George Mason University, explored the effect of different pre-testing auditory stimuli on participants' recall of studied material. All participants studied the same long reading comprehension passages and vocabulary words before being tested (Widerman, 2013). Participants were randomly assigned to one of two groups: the control group studied in silence while the experimental group listened to self-selected music. The dependent variable was cerebral blood flow velocity, which indicates levels of sustained attention over

a period of time. The results were that there was no statistically significant difference between the groups, although post-test surveys indicated that the self-selected music group struggled to focus on the test and were listening to the music instead. There is one notable flaw in the experimental design of this study: by allowing subjects in the self-selected music group to listen to music of their own choosing, the researchers introduced an additional variable to their study, similar to Mori's study. This added variation could be one of the reasons for Widerman's inconclusive results. To avoid confounding variables associated with self-selecting music, I did not allow subjects to self-select lyrical music in my study, but instead used an obscure classical piece with subtle melodies and minimal distracting factors.

Concurring with Widerman's findings that the effect of music on test scores is unclear, a study published in the *American Journal of Undergraduate Research* explored the effect of different pre-test stimuli on participants' performance on a spatial reasoning test. The control group sat in silence, one experimental group listened to Mozart, and the other experimental group played active games (Gonzalez 2003). The study outlines that the purpose of assigning groups this way is to test the impact of a phenomenon known as "arousal effect" on spatial reasoning performance. The "arousal effect" posits that improved cognitive performance after listening to classical music, such as Mozart, may be due to the subjects' personal enjoyment of the music rather than due to subconscious interactions between music and the brain. Thus, the study included active games as one of the experimental groups to see if that group's performance would be affected by the subjects' enjoyment of the physically stimulating activities. The results of the study were that both the Mozart group and the active group performed better than the control group on the spatial reasoning test, and both experimental groups had similar results to each other. The study did an excellent job of controlling the effects of unknown variables and performing insightful statistical analysis on their results. This study is critical for my research and experimental design because it alerted me to the fact that if I play well-known classical music in the background for all treatment groups, the "arousal effect" may skew the results because of the subjects' personal enjoyment of the music. To minimize the effect of personal enjoyment, I will play

an obscure piece that is unlikely to be recognized by subjects and that will not have familiar melodies and motifs to distract them.

Summary

Existing research in the field focuses on independent macroscopic variables when attempting to evaluate the potentially causal relationship between music and heightened cognitive abilities. Keeping in mind the shortcomings of previous studies—such as loosely defined auditory stimuli that allow subjects to pick their own background music or that categorize music only by genre—I narrowed the lens of my study to acutely assess the impact of specific musical variables—tempo and pitch—on cognitive abilities. To avoid having subjects' personal preferences or subconscious following of the plot of a musical piece skew results, as seen in the arousal effect, I played an obscure song in the background while subjects took their spatial reasoning tests. I performed statistical analysis tests on the results to ensure that if I rejected my null hypothesis, it was because the difference between the control and experimental groups was too large to be explained by randomness alone.

Methods

Study Design

This study sought to uncover the relationship, or lack thereof, between manipulated musical variables—tempo and pitch—and the cognitive abilities of high school students. The study was analytical in nature and aimed to test the alternative hypothesis that one or both of the aforementioned musical variables would have an effect on cognitive (spatial-temporal reasoning) abilities, as opposed to the null hypothesis that none of these variables would affect cognitive abilities. The study was experimental in nature, as I conducted randomized controlled trials; I directly manipulated the independent variables, while keeping all other conditions constant to minimize the effect of confounding variables. I gave all subjects the same spatial-temporal reasoning test, an example question of which is shown in Figure 1 (Newton).

Which pattern can be folded to make the cube shown?

36)

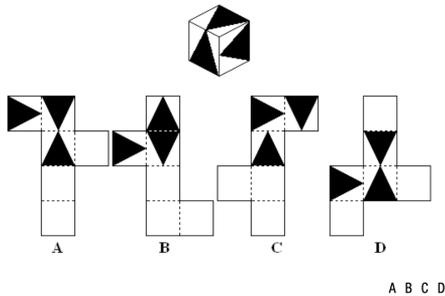


Figure 1 (above): An example of the types of spatial-temporal reasoning questions subjects saw on their tests. (Answer: A)

Ethical Consideration

I cleared my research with the Institutional Review Board. No sensitive information was collected from subjects; in fact, no personal information was collected from subjects at all. To ensure the privacy of each subject's scores on the spatial-temporal reasoning test, I numbered each test and informed participants that, should they wish to view their scores at a later date, they could ask to see the paper with their number on it. This way, I did not know who each test and score belongs to, but I could still categorize each test by its appropriate treatment group and include it in data analysis at the conclusion of the study.

Selection of Participants

This study was conducted in an empty classroom over the course of three Student Resource Time (SRT) periods in February 2019. When recruiting subjects, I visited high school classrooms that had potential participants and handed out information sheets that detailed the goal of the study and what subjects would be asked to do. At the bottom of the information sheet, I asked students four questions: (1) Name? (2) Email? (3) Are you a high school student? (4) Are you willing to make a total time commitment of 10 minutes for this study? I asked subjects to email their answers to me and include their first and last name in the email. My only inclusion criteria was that subjects answered "yes" to questions 3 and 4. For this study, I selected 75 participants who met the criteria.

Procedure

The study used a Completely Randomized design. To begin, I assigned each subject a number from 1 to 75. I randomly assigned subjects to treatment groups to equalize the effects of unknown sources of variation on the dependent variable of the test score. I used a random number generator to pick 15 subjects for the control group and 15 subjects for each experimental group. It should be noted that due to limited room capacity, the test could only be administered to one treatment group at a time. It should also be noted that all groups initially had 15 subjects, but four subjects had scheduling conflicts at their assigned time of test administration. To avoid losing the element of randomness, I used a random number generator to assign each of these four subjects to a new treatment group. Testing conditions were consistent for all treatment groups: all subjects were given 10 minutes to answer 20 questions, and took their tests in the same room with the same setup. The control group listened to Mozart's Sonata for Two Pianos in D major, also known as K448, in its original form without any modifications (Mozart). Experimental group 1 listened to K448 at 0.75x speed. Experimental group 2 listened to K448 at 1.25x speed. Experimental group 3 listened to K448 with the pitch modulated three half-steps higher. Experimental group 4 listened to K448 with the pitch modulated three half-steps lower. The purpose of experimental groups 1 and 2 was to assess the relationship between tempo and cognitive abilities, and the purpose of experimental groups 3 and 4 was to assess the relationship between pitch and cognitive abilities. YouTube's speed settings were used to alter the tempo of the piece, and Apple's GarageBand software was used to modulate the pitch of the piece.

Results

The mean score of each treatment group was compared to the mean score of the control group using a 2-sample t-test. Thus, a total of four t-tests were conducted. To conduct this statistical test, three conditions must be met. First, randomness must be involved in the study design. Second, subject test scores must be independent between and within treatment groups. Third, the data for the control group and the

treatment group it is being compared to must be approximately normally distributed. The first condition is met for all four t-tests because, as described in the methods section, subjects were randomly assigned to treatment groups. The second condition is met for all four t-tests because groups were sequestered from one another, and no cheating occurred in any of the treatment groups. The third condition is met by the control group because, as seen in Figure 2a, the NPP for the control group is approximately linear, suggesting normality, and the boxplot in Figure 2b indicates that there are no outliers.

Figure 2a: Normal Probability Plot for control group.

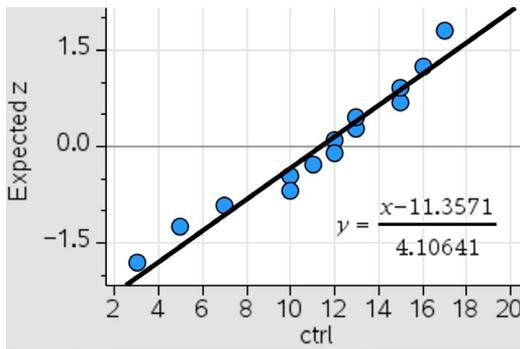


Figure 2b: Box Plot for control group.

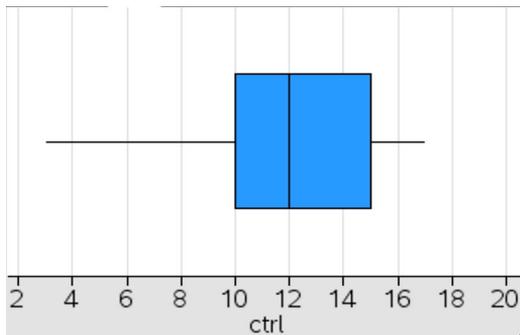


Figure 3a: NPP for slow tempo group.

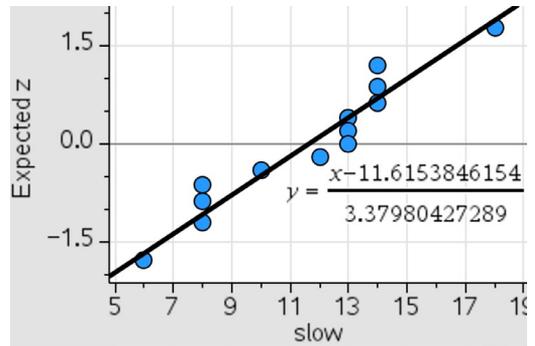
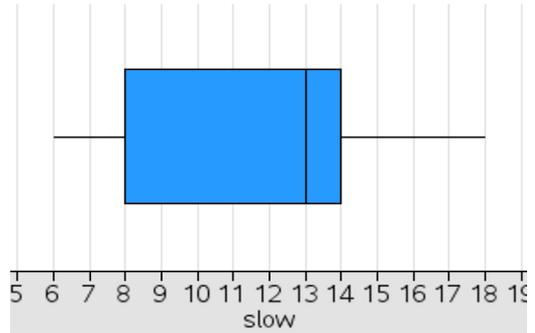


Figure 3b: Box Plot for slow tempo group.



Slow Tempo vs. Control. The third condition is met by the slow tempo group because, as seen in Figure 3a, the NPP for the slow tempo group is approximately linear, suggesting normality, and the boxplot in Figure 3b indicates that there are no outliers. To assess the difference between the results from the slow tempo group compared to control group, I conducted a 2-sample t-test for $\mu_{\text{slow}} - \mu_{\text{control}}$. With 24.66 degrees of freedom and a t-value of -0.178922 , I found that the P-value was 0.4297.

MUSICAL PROPERTIES AND COGNITIVE ABILITIES

Figure 4a: NPP for fast tempo group.

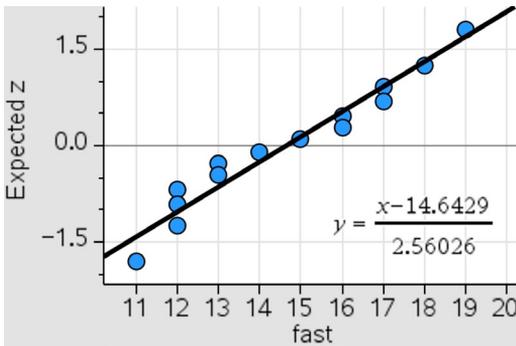
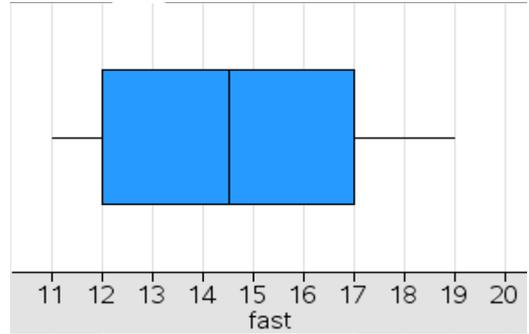


Figure 4b: Box Plot for fast tempo group.



Fast Tempo vs. Control. The third condition is met by the fast tempo group because, as seen in Figure 4a, the NPP for the fast tempo group is approximately linear, suggesting normality, and the boxplot in Figure 4b indicates that there are no outliers. To assess

the difference between the results from the fast tempo group compared to control group, I conducted a 2-sample t-test for $\mu_{\text{fast}} - \mu_{\text{control}}$. With 21.78 degrees of freedom and a t-value of -2.540521 , I found that the P-value was 0.009360.

		Test Scores (out of 20)				
		Control	Slow	Fast	Low	High
Subject	1	17	8	15	18	12
	2	15	13	17	13	14
	3	13	13	16	12	11
	4	10	14	16	8	8
	5	16	8	12	19	11
	6	15	8	13	8	16
	7	5	18	19	12	14
	8	11	14	14	13	16
	9	7	13	12	16	19
	10	12	6	17	16	16
	11	12	14	11	14	15
	12	13	10	18	14	10
	13	10	12	13	10	12
	14	3		12	17	11
	15				16	12
	16				11	12
	17				9	
	18				9	

Figure 5 (left): Data table with results from study. As described in the Procedure section, each group was meant to have 15 subjects, but some subjects had scheduling conflicts, and thus had to be randomly reassigned to another group.

Figure 6a: NPP for low pitch group.

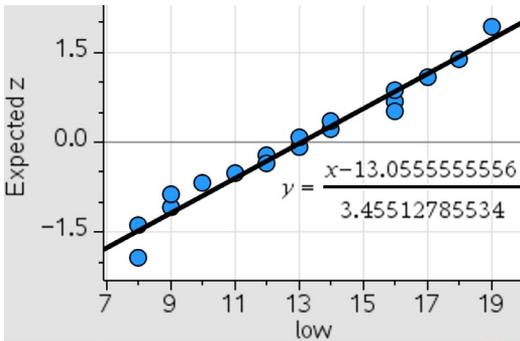


Figure 7a: NPP for high pitch group.

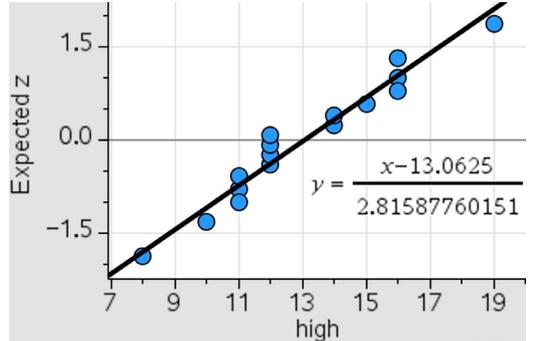


Figure 6b: Box Plot for low pitch group.

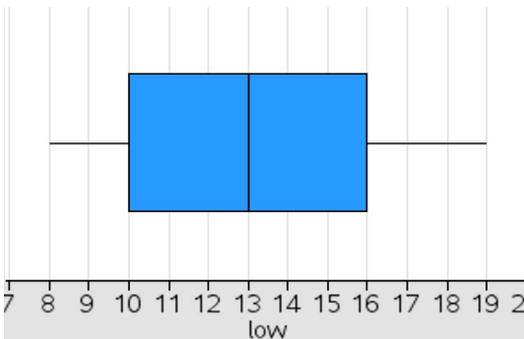
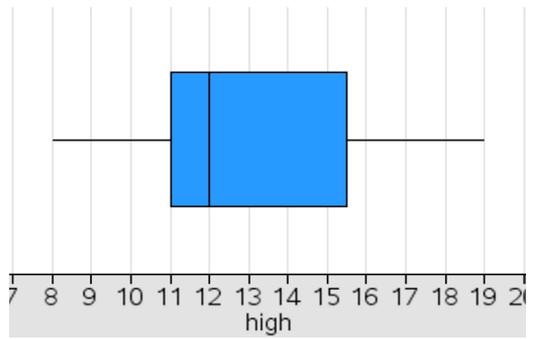


Figure 7b: Box Plot for high pitch group.



Low Pitch vs. Control. The third condition is met by the low pitch group because, as seen in Figure 6a, the NPP for the low pitch group is approximately linear, suggesting normality, and the boxplot in Figure 6b indicates that there are no outliers. To assess the difference between the results from the low pitch group compared to the control group, I conducted a 2-sample t-test for $\mu_{\text{low}} - \mu_{\text{control}}$. With 25.37 degrees of freedom and a t-value of -1.242770 , I found that the P-value was 0.1127.

High Pitch vs. Control. The third condition is met by the high pitch group because, as seen in Figure 7a, the NPP for the high pitch group is approximately linear, suggesting normality, and the boxplot in Figure 7b indicates that there are no outliers. To assess the difference between the results from the high pitch group compared to the control group, I conducted a 2-sample t-test for $\mu_{\text{high}} - \mu_{\text{control}}$. With 22.58 degrees of freedom and a t-value of -1.307931 , I found that the P-value was 0.1020.

Analysis

A significance level of $\alpha = 0.01 = 1\%$ was used for all 2-sample t-tests.

Slow Tempo vs. Control. I fail to reject the null hypothesis that there is no difference in test scores between the slow tempo group and the control group due to $P\text{-value} = 0.4297 > 0.01 = \alpha$. There is not statistically significant evidence to suggest that spatial-temporal reasoning test scores for high school students who listen to slow tempo music are greater than spatial-temporal reasoning test scores for high school students who listen to intermediate (unmodified) tempo music.

Fast Tempo Group vs. Control Group. I reject the null hypothesis that there is no difference in test scores between the fast tempo group and the control group due to $P\text{-value} = 0.009360 < 0.01 = \alpha$. There is statistically significant evidence to suggest that spatial-temporal reasoning test scores for high school students who listen to fast tempo music are greater than spatial-temporal reasoning test scores for high school students who listen to intermediate (unmodified) tempo music.

Low Pitch vs. Control. I fail to reject the null hypothesis that there is no difference in test scores between the low pitch group and the control group due to $P\text{-value} = 0.1127 > 0.01 = \alpha$. There is not statistically significant evidence to suggest that spatial-temporal reasoning test scores for high school students who listen to low pitch music are greater than spatial-temporal reasoning test scores for high school students who listen to intermediate (unmodified) pitch music.

High Pitch vs. Control. I fail to reject the null hypothesis that there is no difference in test scores between the high pitch group and the control group due to $P\text{-value} = 0.1020 > 0.01 = \alpha$. There is not statistically significant evidence to suggest that spatial-temporal reasoning test scores for high school students who listen to high pitch music are greater than spatial-temporal reasoning test scores for high school students who listen to intermediate (unmodified) pitch music.

Conclusion and Future Research Objectives

The results are statistically significant at $\alpha = 1\%$ and suggest that subjects who listened to the fast tempo

version of the piece performed better on the spatial reasoning test than subjects who listened to the unmodified piece. These results agree with Rauscher et al.'s original proposition that there is a link between music and spatial reasoning abilities, but this study supplements that finding by suggesting that there is a link specifically between fast tempo music and spatial reasoning.

If this study were to be repeated, one modification would be to have a larger sample size to confirm the results. Although the t-distribution used in statistical analysis increases the P-value as sample size decreases, thus minimizing the chance of incorrectly rejecting the null hypothesis, increasing the sample size would supplement the equalization of variability resulting from random assignment of subjects to treatment groups. Additionally, due to the abstract nature of the dependent variable of cognitive abilities, this study made use of spatial reasoning test scores as a way to quantify cognitive abilities, but there are other quantifying tests available to measure that variable. Repetition of this study could make use of multiple tests meant to measure cognitive abilities, such as quantitative reasoning, memory, and reading comprehension tests (Cognitive Ability Tests). Future versions of this study could also make use of a different piece as an auditory stimulus, whether it be a classical piece or a piece from another genre, provided that the piece meets the criteria outlined in the introduction of this paper.

The statistically significant results of this study open the gate to further research into the link between the properties of auditory stimuli and cognitive abilities. Noting the varying P-values obtained in the results section, which suggest that there were varying levels of significance among treatment groups, one question that can be explored further is whether combinations of altered musical properties have an impact on cognitive abilities. As an example, a control group could be compared to an experimental group that listens to fast tempo, high pitched music and to a second experimental group that listens to fast tempo, low pitched music.

This study takes the first step in attempting to answer the question of which specific musical properties—as opposed to which broad musical genres—augment cognitive abilities by singling out fast tempo music as a candidate for the ideal auditory stimulus

for studying and test-taking. Identifying this ideal auditory stimulus would forward the goal of the field of biomusicology to uncover therapeutic and educational connections between music and the brain.

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Life Satisfaction Domains and its Correlation to the Academic Achievement of Bergen County Technical High School - Teterboro Students

Katrina Gonzales

Measuring student levels of life satisfaction (LS), or their cognitive evaluation of their lives, is one way to integrate positive psychology practices in schools. Multiple studies in the field have analyzed whether a correlation exists between student LS and academic achievement. The purpose of this study is to determine whether the family, social, and school LS domains correlate to academic achievement, and if so, which correlation is the strongest. A survey was created and distributed to BCTHS students to gather data on the participants' satisfaction with the three domains and the grades they typically receive. The quantitative data was collected through a survey and analyzed using a multiple linear regression analysis. The results indicated that the three domains have little to no correlation with BCTHS students' level of academic achievement. Future research is advised to expand the current study by analyzing this correlation within all New Jersey high schools.

Keywords: life satisfaction, academic achievement, high school, correlation

1. INTRODUCTION & LITERATURE REVIEW

1.1 Subjective Well Being and Academic Achievement

A substantial body of research in the educational psychology field has accumulated regarding the integration of positive psychology practices in schools (Heffner & Antaramian, 2015). Positive psychology is a type of practice used to study the positive areas of life that enable individuals to function optimally (Gable & Haidt, 2005). One way in which schools can promote positive psychology practices is by using strength-based assessments—a type of approach used to measure levels of well-being.

Subjective well-being (SWB) is an example of a positive construct that is measured through strength-based assessments in schools. In his work, psychologist Diener (1984) defined SWB as the way in which people evaluate their overall lives; however, more re-

cent studies in the field have applied SWB in school contexts, defining it as a strength that is related to youth and adolescents' positive school experiences (Heffner & Antaramian, 2015). SWB has been associated with many beneficial outcomes. In terms of occupational success, those with high SWB perform better at their jobs and are more satisfied with their careers (Erdogan et al., 2012). Moreover, more attention is being devoted to youth and adolescents, as subsequent studies have reported a link between SWB and academic achievement.

For example, professors Duckworth and Quinn at the University of Pennsylvania observed that there is a reciprocal causal relationship between SWB and academic achievement (2007). In this longitudinal study, 257 students from ages 10-12 completed measures of well-being by filling out the Student's Life Satisfaction Scale (Huebner, 1991) and an intelligence test. Duckworth and Quinn collected report card grades of their participants and repeated the same procedure a year later. They found that even when controlling for IQ, age, and the previous year's grade point average

(GPA), students who reported higher SWB tended to get higher grades, and vice versa. These findings indicate that there is a strong reciprocal relationship between SWB and academic achievement. A 2018 study written by research associates in the department of psychology at various universities in Germany puts forth a slightly different perspective on this topic. In their meta-analysis that synthesized 47 studies with a total of 38,946 participants of varying ages, they found a correlation between SWB and academic achievement; however, this correlation was small in magnitude (Bücker et al., 2018). The findings of both Duckworth and Quinn (2007) and Bücker et al. (2018) show that through the years, there has been a present correlation between these two variables across a variety of age groups; however, even though several researchers have noted a correlation of any magnitude between SWB and academic achievement, these findings cannot be generalized, or are greatly limited in their applicability among distinct age groups. This is because certain components of SWB, such as life satisfaction, decrease during adolescence (Goldbeck et al., 2007). In other words, those in middle school may report higher SWB than those in high school and college. Therefore, this finding may serve as an explanation as to why the correlation between SWB and academic achievement was high in students of ages 10-12 (Duckworth & Quinn, 2007) but low in adolescents and young adults (Bücker et al., 2018).

1.2 Life Satisfaction and Academic Achievement

Based on the studies previously discussed, it is evident that the magnitude of the correlation between SWB and academic achievement is not explicit. One way to measure this correlation is to analyze the different components that compose SWB—*affective states* and *life satisfaction*. For *affective states*, positive affect refers to positive emotions (e.g., joy, happiness) and negative affect refers to negative emotions (e.g., sadness, anger). Furthermore, *life satisfaction (LS)*, which is defined as the cognitive evaluation of one's life, is regarded as the most stable component of SWB (Suldo et al., 2006). Therefore, a succinct review of the literature regarding LS and academic achievement is needed to improve the field's current understanding of this issue.

Contrary to the studies concentrating on SWB, the literature on LS offers more precise perspectives on this topic. In one recent study, Antaramian (2017) sent out a survey that collected GPA to measure LS and academic achievement among undergraduate college students. She found a strong positive correlation between these two variables. Her findings show that high levels of life satisfaction indicate higher GPAs as well as higher academic efficacy and lower academic stress. Although the number of participants was high (n=357), this study was conducted in a single mid-Atlantic university, so findings cannot be generalized to other schools and age groups again. Despite this, Antaramian (2017) still stirs conversation regarding LS and academic achievement, since this is one of the most recent studies that argued a strong positive correlation between the two variables. This argument, however, is not consistent throughout the literature. One study published in *Procedia*, a social and behavioral sciences journal, conducted a similar procedure as Antaramian (2017), but among students at a different university. This study found no correlation between the variables (Malik et al., 2013). Instead, the authors discussed reasons as to why their results demonstrated no correlation. They hypothesized that academic achievement is driven by personal factors instead of merely LS. For example, those that desire to earn good grades do not do so because they are satisfied with life, but rather, because they want to secure a good career and family path (Malik et al., 2013). From these two studies, it is clear that even when conducted on the same age group of students with the same procedure, results vary greatly.

1.3 Domain Satisfactions and Overall Life Satisfaction

Recent literature has shown that there is much ambiguity concerning the correlation between LS and academic achievement. The lack of consistent positive and negative findings call for a different way to study these variables. One way to analyze more closely the relationship between these two variables is to examine LS domains. In other words, LS domains are satisfactions in different areas of life that contribute to an individual's overall level of LS. A notable study conducted in 2005 first measured the correlation between LS and

academic achievement through specific life domains (Arthaud Day et al., 2005). Arthaud-Day, a professor in the Department of Management at Kansas State University, discussed how LS represents a cognitive evaluation of one's life, constituted by components of satisfaction in different domains of life; however, the importance of a specific domain to overall life satisfaction differs between populations (Arthaud-Day et al., 2005). In this study, Arthaud-Day et al. (2005) concentrated on the LS domains of undergraduate students in particular: family life satisfaction, social life satisfaction, and university satisfaction. Using student responses to a questionnaire asking questions regarding each domain and GPA as measurements, Arthaud-Day (2005) found that LS was most strongly correlated with social LS, followed by family satisfaction. This indicates that the more satisfied a student is with their social and family life, the more they will be satisfied with their life as a whole. This, in turn, increases levels of academic achievement as well (Arthaud Day et al., 2005); however, this conclusion cannot be generalized to all students because Arthaud-Day et al. (2005) focused on undergraduate students in particular. With this study in mind, it is clear that a more defined way of studying the correlation between LS and academic achievement is by analyzing each domain that pertains to students.

1.4 The Current Study

The current study aims to extend the research of Arthaud Day et al. (2005) by studying the correlation between LS domains and academic achievement in high school students. The previous research findings show that positive and negative correlations are not consistent through the literature on this topic. Due to the lack of studies that address this correlation via satisfaction domains, the current study will examine levels of family life satisfaction, social life satisfaction, and satisfaction with the school students attend in order to determine which of the three domains correlates the most with academic achievement. This study will aim to answer the research question: Which life satisfaction domain plays the most significant role in determining Bergen County Technical High School - Teterboro (BCTHS) students' level of academic achievement? In addition, the majority of research that studies college students, such as the previous

work by Antaramian and Malik's (2017) team, offers a range of perspectives on the correlation between LS and academic achievement, though these findings cannot be generalized to high school students. Therefore, this study filled the gap in the field that lacks research concentrating on high school students' LS at BCTHS, a magnet high school in New Jersey, and academic achievement. It also extended the work of Arthaud-Day et al. to see if their conclusions in 2005 apply to high school students today.

2. METHODS

2.1 Participants

The goal of this non-experimental correlational research study was to determine whether a correlation exists between each life satisfaction domain and the academic achievement of BCTHS students. This school belongs to the Bergen County Technical Schools District in New Jersey. Previous researchers have studied this correlation within university (Antaramian, 2017) or middle school students (Duckworth & Quinn, 2007), but the current study aimed to study this correlation within high school students in particular. Given the lack of studies in the field measuring LS per domain, the researcher decided to gather first-hand data instead of secondhand data. Students from this high school participated in this study by completing an electronic survey that assessed their domain satisfactions and level of academic achievement. Age, grade level, and student school identification numbers (IDs) were the only three types of student demographic information asked for in the survey.

2.2 Measures

An electronic survey was created and distributed by the researcher to gather data on the domain satisfactions and academic achievement of the participants. The survey was divided into four sections, measuring family LS, social LS, school satisfaction, and academic achievement, respectively. The researcher organized the survey in this way so that levels of satisfaction with each domain could be easily distinguishable and compared to each other.

Demographic Information. At the beginning of the

BCTHS LIFE SATISFACTION AND ACADEMIC ACHIEVEMENT

survey, the participants were asked to provide their age, grade level, and student identification numbers (IDs). Each student's ID number was provided by the school at the beginning of each student's freshman year. ID numbers were collected only so that a school psychologist could review the responses and offer help to students depending on the nature of their response. In other words, if a student indicated severe dissatisfaction with their life on the survey, then collecting for ID numbers allowed the school psychologist to offer them help. This was a requirement set by the school's Institutional Review Board (IRB). Although student ID numbers were collected, each response was still collected anonymously by the researcher because the researcher was not permitted by the school to have access to the students' ID numbers.

Life Domain Satisfaction. In the first three sections of the survey, participants were given various statements regarding their satisfactions with the three life domains. Participants were asked to rate their level of agreement with the statements using a 5-point Likert Scale (1 = Strongly Disagree, 5 = Strongly Agree). The statements used in the three sections are based on The Satisfaction with Life Scale (SWLS), a Likert-style scale that was developed in 1985 by Ed Diener, a psychology professor at the University of Utah and the University

of Virginia. The SWLS has been used heavily as a measure of overall LS in various studies in the field (Antaramian, 2017; Arthaud-Day et al., 2005; Steinmayr et al., 2016), but the scale was altered in the current study so that each item measured satisfaction with each individual domain. For example, one item in the SWLS is, "I am satisfied with my life" (Diener, 1985). In the current survey, this item for the family LS domain was changed to, "I am satisfied with my family life." Furthermore, the researcher altered each item to ensure that while levels of domain satisfaction were measured, the privacy of each participant would not be invaded. The survey consisted of only multiple choice questions so that no personal details of a participant's life would be revealed through open-ended questions. Table 1 lists the items used for each section in the survey.

The possible range of scores on the Likert scale is 13-65, with a score of 39 indicating medium satisfaction with the item. Scores that hover around this mean indicate a moderately low or high satisfaction with the item. Further, scores between 13-18 represent an extreme dissatisfaction with life as a whole, while scores between 60-65 represent extreme satisfaction with life as a whole. For the family life, social life, and school satisfaction sections, respectively, scores between 16-20 represent high satisfaction, while scores between

Table 1 - Survey Items Per LS Domain

Survey Section	Item
#1 Family Life Satisfaction	I am satisfied with my family life.
	In most ways, my family life is close to ideal.
	I enjoy spending time with my family.
	If I could live my life over again, I would change almost nothing about my family.
#2 Social Life Satisfaction	I am satisfied with my social life.
	I enjoy spending time with my friends.
	I am happy with the number of friends I have.
	I do not wish I had different friends.
#3 School Satisfaction	I am satisfied with the school I attend.
	I am satisfied with the amount of work my teachers assign me.
	I am satisfied with the teaching quality of my school's faculty.
	I am satisfied with the extracurricular activities and other opportunities offered to me and my peers at my school.

4-8 represent low domain satisfaction.

Academic Achievement. The survey included one multiple-choice question regarding academic achievement. Students were asked to indicate which range of grades they typically receive. Examples of answer choices included “Mix of A’s (A+, A, A-),” “Mix of A’s and B’s,” and “Mix of B’s (B+, B, B-).” Answer choices began with grades in the A range and ended with grades in the F range. Grade reports and grade point averages (GPAs) of the participants were not accessible to the researcher for the purpose of preserving anonymity; however, having the participants indicate themselves the ranges of grades they typically receive offered a more accurate representation of their level of academic achievement than self-reported GPAs.

2.3 Procedures

A survey measuring domain satisfactions and academic achievement was sent out to the BCTHS in Teterboro, New Jersey. Approval was given by the school’s administration and IRB prior to sending out the survey. Emails containing the electronic parent consent form were sent back to the administrators who granted permission for their students to participate. Parents provided their email and their child’s email in the parent consent forms. No names were collected to preserve the anonymity of the participants. Validation forms were automatically sent back to parent emails to ensure that only the parent provided consent. Student surveys, which included the above measures and demographic information, were then distributed to the participants whose parents signed the consent forms. In addition, the IRB required that the school psychologist review the responses. Student assent forms were attached at the beginning of the survey. All electronic data was contained in a password-protected laptop owned by the researcher.

2.4 Data Analyses

One month was allotted to gathering survey responses. After approximately one month, the researcher used a multiple linear regression analysis to analyze the quantitative data gathered from the survey responses. The purpose of choosing a multiple linear regression analysis was to identify the strength of the effects that each independent variable had on the dependent variable. The three independent—or explanatory—variables used in the current study were Likert scale scores of family life, social life, and school satisfaction. The dependent variable involved was academic achievement, measured by ranges of grades the participants typically received. A multiple linear regression analysis was used to determine whether there is a present correlation between each domain and academic achievement, and if so, which correlation is the strongest.

3. RESULTS

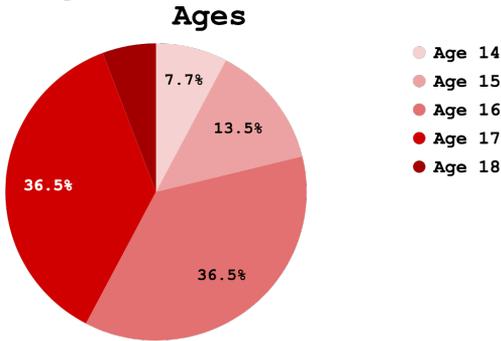
3.1 Demographic Data

The purpose of the survey utilized in this study was to measure BCTHS students’ levels of life satisfaction in three different domains and academic achievement. Out of the whole school, 52 students of varying ages and grade levels responded to the survey. The sample size consisted of adolescents, with ages ranging from 14-18 and grade levels ranging from 9th-12th grade. Other demographic information such as gender and ethnicity were not collected in the survey in order to preserve the anonymity of the respondents. Graphs 1 and 2 display the percentage of participants of each age and grade. The overwhelming representation from one grade level raises a limitation of the study, as the results do not account for all the students at BCTHS.

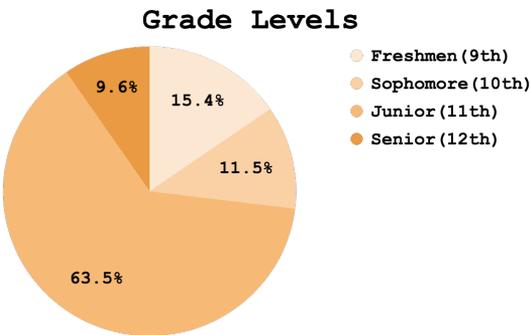
Table 2 - Survey Statistics for Domain Satisfactions

LS Domain	High LS (16-20)	Low LS (4-8)	Medium LS (9-15)
Family	59.62%	1.92%	38.46%
Social	80.77%	0%	19.23%
School	36.54%	3.84%	59.62%

Graph 1



Graph 2



3.2 Multiple Linear Regression Analysis

After gathering survey responses, the researcher added up each respondent's total Likert scale score from the three measured sections: family LS, social LS, and school LS. Scores between 16-20 represent high domain satisfaction, while scores between 4-8 represent low domain satisfaction. Table 2 displays the percentage of participants who revealed high, low, and medium satisfaction with the three domains.

The scores of each respondent were recorded into a spreadsheet along with their self-reported level of academic achievement, which was measured by the range of grades they typically receive (e.g., Mix of A's and B's). The response (Y) variable, in this case, was the student's level of academic achievement, and the predictor (X) variables were their scores for the family LS (X1), social LS (X2), and school LS (X3) sections. The researcher used the XLMiner Analysis ToolPak to perform a multiple linear regression analysis on the recorded data. Table 3 displays the summary output of the regression analysis.

Table 3 - Multiple Linear Regression Analysis

Regression Statistics		
Multiple R	R Square (R2)	Adjusted R2
0.3313	0.1098	0.0541
LS Domain	Coefficients ()	P-Values
Intercept	3.6765	0.0003
Family	0.0022	0.9474
Social	-0.0547	0.2372
School	-0.0709	0.0607

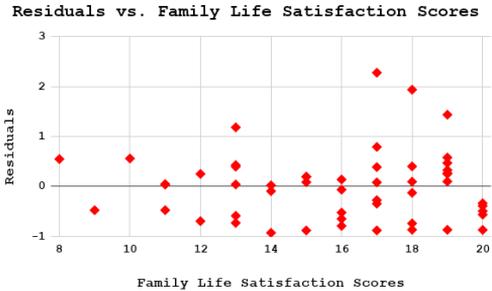
The data recorded in the spreadsheet generated a Multiple R-value of 0.3312. In regression statistics, the Multiple R-value indicates the strength and direction of the association between the three LS variables and academic achievement. A value of 1 would indicate a perfect positive relationship between each variable, whereas a value of 0 would indicate no association at all. In this case, $R=0.3312$ is closer to 0. This means that there is a weak relationship between the participants' levels of LS and academic achievement. Furthermore, the generated R^2 value is 0.1097. In other words, only 10.97% of the variation of academic achievement scores are explained by levels of family, social, and school life satisfaction. Not only that, but the Adjusted R^2 value is 0.0541. This means that only 5.41% of the variation of academic achievement scores are explained by each area of LS when sample size is taken into consideration. The R-values in the Regression Statistics table suggest a very weak correlation between the response and predictor variables. Table 3 offers an even clearer explanation for why that is. The coefficients indicate the type of relationship between each individual LS domain and academic achievement. The equation below was generated by the coefficients listed in the table. This equation is a regression line model that can be used to predict a student's level of academic achievement:

$$\text{Predicted Academic Achievement Score} = 3.6765 + 0.0022(\text{family LS score}) - 0.0547(\text{social LS score}) - 0.0709(\text{school LS score})$$

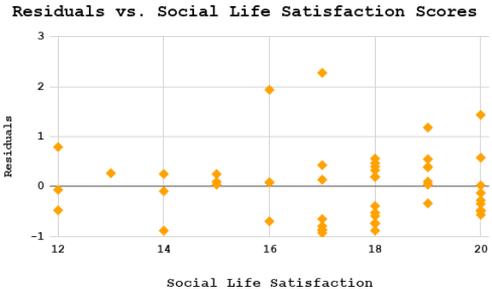
The family LS, social LS, and school LS coefficients were 0.0022, -0.0547, and -0.0709, respectively. Out of the three coefficients, only family LS is positive, whereas social and school LS were negative. This information would indicate that there is a positive correlation between family LS and the response variable, and a negative correlation between the other two domains and the response variable; however, each coefficient was extremely small. While a coefficient of 1 or -1 indicates a perfect positive or negative correlation, the generated coefficients were so small that they are closer to 0, which indicates no correlation at all. Graphs 3, 4, and 5 are residual plots that display the differences between the actual reported scores and the predicted scores of each respondent's academic achievement. $Y=0$ on each graph represents

the line of regression created from the equation above. In other words, if all the points on the residual plot lied on $Y=0$, then there would be a perfect correlation between the variables. In this case, the points in each graph are scattered randomly across the horizontal line, indicating that the correlation is weak.

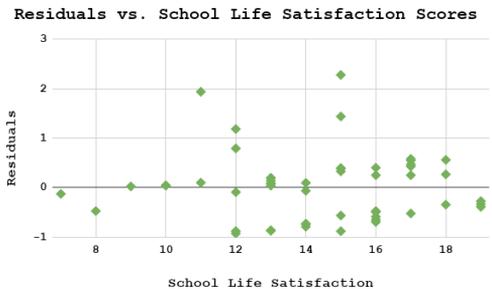
Graph 3



Graph 4



Graph 5



4. DISCUSSION

The current study investigated BCTHS students' satisfactions with various life domains and their correlations with academic achievement. For students, overall LS is comprised of their satisfactions with their family, social life, and the school they attend (Arthaud-Day et al., 2005). The researcher sent out a survey to BCTHS students in which they rated their satisfactions with the three domains and indicated the grades they typically receive. With the 52 responses gathered, a multiple linear regression analysis was performed in order to gauge whether a correlation exists between the variables, and if so, which correlation is the strongest. The results indicated little to no correlation between any domain and academic achievement.

4.1 Family Life Satisfaction

As displayed in Table 3, the correlation coefficient for the family life domain was 0.0022. This means that only about 0.2% of the scores for the family LS section in the survey impacted the collected academic achievement scores. In regression analyses, a coefficient of 1 would indicate a perfect positive correlation between the predictor and response variable. In this case, it is apparent that the coefficient for this domain ($r = 0.0022$) is very small and closer to 0 than 1. This value suggests very little to no correlation between family LS and academic achievement; however, family life was the only domain that positively correlated with academic achievement. This result sheds light on the positive aspects of having a steady familial support system. Perhaps the families of BCTHS students in particular strongly support their child through their academic careers. On top of that, spending time with family is typically more enjoyable and less stressful than time at school. The balance between supporting a child through their academics and making life less stressful than it is in other areas of life offers a reasonable explanation for why the majority of students reported high levels of family LS (59.62%) over school LS (36.54%). Keeping this in mind does not undermine the fact that the correlation between the variables is extremely small, which indicates no correlation; however, it can explain why family LS was the only domain positively correlated to academic

achievement.

4.2 Social and School Life Satisfaction

As opposed to the family LS domain, the social and school domains are negatively correlated with academic achievement. The correlation coefficient for the social and school LS domains were -0.0547 and -0.0709, respectively. Typically, in regression analyses, a negative correlation signifies that the response variable increases as the predictor variable decreases. In other words, the variables are inversely related. If the correlation coefficients were -1, then that would mean that academic achievement would always increase when satisfactions with social life and school decrease. Although a negative correlation is present between these variables, the coefficients ($r = -0.0547, -0.0709$) are so small that they both indicate no correlation to academic achievement, which is comparable to the family LS domain. One notable attribute of the results was that the majority of students were highly satisfied with their social lives (80.77%). Not only that, but 0% of participants reported low social LS. Although the correlation is small in magnitude, a reasonable explanation for why a negative correlation exists is because those that spend more time with their friends dedicate less time towards their academics. Perhaps spending time with friends is a way for students to de-stress and enjoy their lives outside of school. This could potentially distract students from achieving higher grades.

Unlike the social life domain, only 36.54% and 59.62% of participants reported high and medium satisfaction with the school life domain, respectively. In relation to academic achievement, the results indicate that the lower one's satisfaction with BCTHS, the better grades they receive. The percentage of participants who reported high and medium satisfaction with BCTHS is not necessarily low, but it is less than the percentage of those who reported high satisfaction with the other two domains. For the "I am satisfied with the amount of work my teachers assign me" item, students were particularly dissatisfied (69.2% of participants responded with a score of 1-3 in this item). This could offer an explanation for why overall satisfactions with this domain were lower than those with the other domains, as well as why it is negatively correlated with academic achievement. The high

amount of work assigned to students could possibly be too overwhelming, which explains why students are dissatisfied with the school. On the other hand, this amount of work could be beneficial for students to help them better understand the material, which explains why academic achievement scores increase. Regardless, the coefficients for both the social and school domains are very small, but these reasons shed light on why the correlations are negative.

4.3 Population Characteristics

Certain attributes of BCTHS could further explain why the results transpired in this way. Ranked as the 3rd best high school in New Jersey and the 58th best high school nationally by US News & World Report, BCTHS - Teterboro is recognized by its heavy workload and attention to academic achievement. Unlike traditional public schools, students who attend this magnet high school must apply and get accepted based on their academic merit. Only honors and primarily advanced placement (AP) courses are offered at this school - a characteristic that highlights the academic rigor that the school and its students hold. As participants in the current study only attend BCTHS, this could explain why the grades reported were quite high and why school LS was lower relative to the other two domains.

These attributes illuminate why the raw data resulted in this way, but it also explains why there was little to no correlation between each LS domain and academic achievement. For example, the current study's findings relate to a 2013 study that found no correlation between overall LS and academic achievement, but in undergraduate students (Malik et al., 2013). Although this study focused on overall LS instead of each domain, the authors offer a good explanation as to why no correlation exists. They argued that academic achievement is driven by personal factors instead of merely LS. For instance, one might achieve higher grades because they want to secure a successful future for themselves in terms of their career (Malik et al., 2013). Indeed, this could explain why little to no correlation exists between BCTHS LS and academic achievement. Perhaps the high academic quality of BCTHS is closer to a college level than other traditional high schools. The success-driven students of this high school could emulate the undergraduate

population of the 2013 study; however, the current findings still cause some confusion in the field. The little to no correlation found between variables contradict those of Arthaud-Day et al. (2005), who found a strong positive correlation between the domains and academic achievement in undergraduate students. More studies in the field on high school students, in particular, are required to gain a greater sense of this correlation and distinguish it from college students.

4.4 Implications & Limitations

The current findings have one main implication on the educational psychology field. In a 2005 study, researchers defined positive psychology as a field of study that focuses on the positive areas of life that enable individuals to function optimally (Gable & Haidt, 2005). Measuring an individual's subjective well-being (SWB) via strength-based assessments is one way in which positive psychology practices can be integrated in schools; however, due to the lack of agreement when considering the correlation between SWB and academic achievement, the current researcher decided to focus on LS, which is a component of SWB (Suldo et al., 2006). The little to no correlation found between LS domains and academic achievement sheds light on whether measuring LS is an effective way of integrating positive psychology practices in schools; however, the results gathered from BCTHS cannot be generalized to all high schools. For BCTHS in particular, these findings suggest its guidance department explore other ways in which students learn to focus and appreciate the positive aspects of their lives. To that end, students could possibly achieve higher academic scores.

Furthermore, there is a lack of research in the field focused on the different domains of LS, which prompted the researcher to fill this gap by gathering primary data; however, using a survey to collect data posed various limitations. First, the survey was voluntary and required participants to provide their student ID numbers. This was done so that a school psychologist could offer help to a student depending on the nature of their response. Although asking for student ID numbers rather than names helped each participant preserve their identity to the researcher, this may have dissuaded some students from taking the survey. A voluntary survey with this type of requirement most

likely impacted the sample size. Additionally, the researcher was not allowed access to the actual numerical GPAs of the participants. Student indication of the grades they typically receive was self-reported, which means they may not have been accurate. Finally, given the limited sample size, conclusions could not be generalized to the entire BCTHS student population. Regardless, the current study offered a perspective on the correlations between each life domain and academic achievement of BCTHS students.

4.5 Conclusions & Future Directions

Overall, this study found little to no correlation between any LS domain and academic achievement. It adds to the dialogue on this topic by suggesting that student LS does not strongly influence academic achievement. In order to revise and expand the current study, future researchers are advised to collect more demographic information (e.g. family income, ethnicity, gender). Perhaps these factors impact a student's level of academic achievement more than their satisfaction with life. Considering the perspective that academic achievement is driven by personal goals like securing a successful future for oneself (Malik et al., 2013), future researchers should see whether demographic factors inhibit an individual from achieving those goals. Another way to expand the current research is by studying the differences in LS levels and academic achievement between highly-ranked high schools and those ranked lower. A study on that topic would not only attend to whether highly-satisfied students contribute to a higher-performing school, but also add to the body of research that currently lacks related studies on high schools. Future researchers can expand the current study even further by analyzing the correlation between LS and academic achievement in all New Jersey high schools. Overall, the current study is one of very few that analyzes the correlation between LS domains and academic achievement in high school students. Given that this study was only conducted on BCTHS students, more studies conducted on a bigger sample could help the educational psychology field achieve a greater understanding of this phenomenon.

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The Birthplace Effect's Prevalence in American and Canadian Sprinting

Max Livingston

In this study, I assessed whether American and Canadian sprinters' birthplace population influenced their likelihood of competing professionally. The birthplace and birthplace populations of high-ranking athletes were extracted from the International Association of Athletics Federation website as well as Canadian and American census reports. Sprinter results were grouped in population-related categories and compared to general population representation. For American sprinters, results showed extreme overrepresentation among athletes from communities with less than 50,000 people. For Canadian sprinters, the greatest overrepresentation occurred among athletes from communities with 100,000 to 499,999 inhabitants. Analyses suggested that in America but not Canada, athletes are more likely to originate from smaller populated communities.

Keywords: Birthplace effect, sprinting, athlete performance

Introduction

The birthplace effect is a phenomenon in academia that demonstrates the impact of a hometown population on athletic development. The birthplace effect is prevalent across several athletic disciplines. Scholars have, for instance, discovered that athletes from communities with lower populations are often overrepresented in professional sport. Studies such as that of Côté, Macdonald, Baker, and Abernethy (2006), an analysis of 2240 professional athletes in four sports and Baker and Logan (2007), an evaluation of 1,013 professional hockey players, have confirmed the birthplace effect to significantly impact athletic development in a variety of sports. As a result of similar research, the birthplace effect is one of the most widely accepted ideas in athletic development.

Although most scholars agree that the birthplace effect acts as a predictor in athletic success, certain countries and sports are unaffected. For instance, Lidor, Arnon, Maayan, Gershon, and Côté, 2014, found that the hometown population of athletes to have little effect on representation in sport. These findings, along with others, suggest that the birthplace effect may

have no bearing on certain cultures and sports.

Prior to this paper, it was unclear whether or not Canadian and American sprinters adhered to the birthplace effect. Unlike in many sports, athletic development in sprinting remains largely under-researched. This is attributed to the popularity of performance-based research in sprinting. The technical aspects of sprinting have been researched extensively (Saltin et al., 1995; Young, 2006). This opened up the possibility of one of the world's most popular sports not adhering to one of the most agreed upon notions in athletic development.

In order to yield conclusive results as to whether sprinters adhere to the birthplace effect, I analyzed the hometowns of America and Canada's fastest 200m sprinters. Existing research on the birthplace effect is largely observational, cross-sectional, and longitudinal. For example, Bruner, Macdonald, Pickett, and Côté (2011), in an analysis of 566 professional hockey players, did not with their subjects, analyzed data from a representative subset and used repeated observations of the same variables over an extended period of time. For the purpose of this study, a similar methodology was used, analysing the birthplace

and birthplace population of Canada and America's highest ranked 200m athletes. The data was compiled and represented through charts, comparing athlete distribution to general population distribution. The athletes were chosen from the International Association of Athletics Federations' database, and the hometowns extracted through a third party athletics database called athletics.net.

Literature Review

Scholars have discovered that the birthplace effect often has a significant impact on athletic success in Canadian and American sports. For instance, hockey players across Canada and America are more likely to originate from communities with smaller populations. Baker and Logan (2007), found that hockey players from communities with fewer than 50,000 people are significantly overrepresented in the National Hockey League (NHL). Additionally, despite variations in Canadian and American results, they found that 77.9 percent of Canadian and American athletes originated from communities with fewer than 500,000 inhabitants. Canadian athletes were found to be less affected by the birthplace effect than their American counterparts. The greatest overrepresentation of Canadian subjects was from communities with 500,000-999,999 people. Further research on hockey has yielded similar results. One such study, conducted by Bruner, Macdonald, Pickett, and Côté (2011), examined 566 players in the World Junior Hockey Championship. They found that the birthplace effect was prevalent in athletes from every participating country. In regards to American Football, research conducted by MacDonald, Cheung, Côté, and Abernethy (2009), found the birthplace effect plays a determining role in those who pursue professional careers in the National Football League. A Monte Carlo Simulation² found an overrepresentation of players from communities with less than 500,000 people and

an extreme underrepresentation of players from communities with over 500,000 people. These results infer that generally, Hockey and American Football players adhere to the birthplace effect.

Broader analyses of American sports have reached similar conclusions. For example, Côté, Macdonald, Baker, and Abernethy (2007), found that the birthplace effect is consistent throughout baseball, basketball, hockey, and golf. Through Monte Carlo simulations, Côté et al. (2007) determined that athletes originating from communities with more than 500,000 people are statistically less likely to become professional. Additionally, the birthplace effect's Cohen's Effect³ size score was determined to be 3.51, proving the birthplace effect's influence on athletic development in North America. In regards to female athletes, studies conducted using similar methodology have generally been consistent with male research, implying that environmental factors are of importance in the birthplace effect (MacDonald, King, Côté & Abernethy, 2009). These results do not only reveal the impact of the birthplace effect in general, but also showcase patterns in American and Canadian athletic development. Similar results across various sports indicate that, regardless of the sport, both Canada and America use standardized development techniques. Not only is this interesting, but it makes the results of this study more significant, as they provide academia's first insight into whether sprinters adhere to the birthplace effect.

Scholars remain conflicted on whether or not the birthplace effect is applicable and prevalent among non-North American athletes. For example, a study conducted by Lidor, Côté, Arnon, Zeev, and Cohen-Maoz (2010) on the birthplace effect's impact on athletic development in Israel, had inconsistent results with existing North American literature. While Division 1 volleyball players adhered to existing research, Division 1 Israeli basketball players and soccer players were found more likely to originate from larger cities. Additionally, Ishigami (2016) found through a quan-

1. The International Association of Athletics Federations (IAAF) is the universal governing body of international sprinting. Professional sprinting results are recorded in their database, and sorted by fastest time. Every professional sprinting result is recorded by the IAAF yearly.

2. A Monte Carlo simulation is a technique used in academia to measure the impact of one variable on another.

3. The Cohens effect size is a measure of impact, which is commonly used in academia to determine how important a factor is in a final result. It is a mathematical formula developed by Cohen in 1988, that has been very popular in the academic community. A Cohen's effect score of >1 is considered to be impactful, while <1 is unimpactful.

tative cross-sectional study that the birthplace effect had no observed influence on Japanese professional soccer and baseball players. These papers illustrate how differences in the sizes and cultures of countries can make the birthplace effect less influential. Another more notable study examined the birthplace effect's impact on American and Canadian athletes and compared them to the results of German and British athletes (Baker, Schorer, Cogley, Schimmer, & Wattie, 2009). Through Monte Carlo simulations, Baker et al. (2009) determined that while the birthplace effect impacts North American athletes, it does not have a significant impact on Europeans. This provokes intrigue, as inconsistencies in findings across cultures imply that circumstantial and sociocultural factors buffer the birthplace effect. Further findings which further substantiate this claim, including Rossing, Stentoft, Flattum, Côté and, Karbing (2018). Through an analysis of 174,566 Scandinavian youth soccer and handball players, they found that other developmental factors, such as proximity to athletic centres, are more impactful than the birthplace effect. These differentiations in results signify that a variety of environmental factors determine whether a specific country and sport adheres to the birthplace effect.

Existing research in sprinting is primarily performance-based, analyzing technical instead of environmental aspects of development. Leading research in this field examines the optimization of sprinting. For instance, Van Schenau, de Koning, and de Groot (1994), who examined the optimal ways to sprint in various sports, by analyzing resistance and velocity in the ligaments and muscles of athletes. Further studies examining the optimisation of sprinting include Kukulj, Ropret, Ugarkovic, and Jaric (1999) and Smirniotou et al. (2008). In addition to these studies, a variety of research exists on the optimal recovery and training in regards to sprinting success (Semark, Noakes, Gibson, Lambert, 1999; Young, 2006). Despite being advantageous to the technical development of sprinters, existing research on sprinting views the sport as one-dimensional, and rarely have studies outlined environmental factors affecting sprinting development (Kukulj, Ropret, Ugarkovic & Jaric, 1999). Environmental factors affecting sprinting development including the birthplace effect have not been measured in a scholarly manner, leaving a gap in the current academic conversation, which this paper attempts to fill.

Methodology

This study examined a group of 445 American and 50 Canadian sprinters who competed professionally in the 2017 and 2018 outdoor track and field season. This ratio of athletes was chosen in order to represent the difference in population between Canada and the USA, with the USA having 8.9 times more inhabitants than Canada (Statcan, 2016; U.S. Census Bureau, 2018). The gender of athletes studied was male in order to cohere with existing research on the birthplace effect, which has, for the most part, examined male athletes. Data was extracted from the national rankings subset of the IAAF database, ensuring that all athletes had competed in professional meets during the 2018 IAAF outdoor season (IAAF 2018). Since the criteria of what makes a sprinter professional is somewhat unclear, and there is no consistent increase in athletes each year, the Canadian highest ranked 50 and American highest ranked 445 were analyzed. The 2018 outdoor season was chosen not only because of its relevance, but also because the vast majority of meets in athletics are held during the outdoor season. The IAAF was a justified choice, as they are Track and Field's largest international governing body. I selected sprinters from the 200m discipline because this, as the event is the most neutral sprinting distance. In general, athletes who compete in other sprinting distances such as the 100m and 400m dashes often compete in the 200m as well. In fact, every single member of the American and Canadian Rio Olympic 100m and 400m sprinters had professionally competed in the 200m dash (Olympics Canada, 2016). It was, therefore, determined to be a justifiable cohort. In order to determine the athlete's birthplace, a third party athletics database was used called Athletics.net, a database with 7.9 million running profiles (Athletics, 2018).

A cross-sectional, observational method was adopted, comparing Canada and America's population distribution to the distribution of athlete's city sizes. This was based largely off of existing field research, including that of Baker and Logan (2007), Cote et al. (2006), and MacDonald et al. (2009). American census statistics were extracted from 2000 in order to draw closer comparisons to the birth years of professional sprinters (US Census Bureau, 2000). Canadian statistics from 1980 were selected because of logistical restraints, as more relevant Canadian census reports,

including that of 1996, are not publicly accessible nor published online (Statcan, 1980). Canadian and American athletes were included in this study in order to gain a larger perspective into the sprinting community. Many existing studies on the birthplace effect, including that of Bruner et al. (2011), and Côté et al. (2006), use both Canadian and American athletes. Additionally, unlike some studies on the birthplace effect, this paper does not use measures of impact, such as the aforementioned Cohen's Effect Size or Monte Carlo simulations. These methods were determined to be unnecessary, as they are typically used when introducing a new theory or effect, in order to further illustrate its importance or lack thereof.

The study itself entailed determining the distribution of sprinter's birthplace population sizes and comparing the data to American and Canadian general population distribution. Population was used as the independent variable, and distribution of athletes was the dependant variable. This representation was used in the methodology of previous studies, making it a justified choice. In regards to American data, population was grouped in 9 categories, including under 50,000, 50,000-99,999, 100,000-249,999, 250,000-499,999, 500,000-999,999, 1,000,000-4,999,999 and over 5,000,000. These categories were determined to be reasonable, as they mirror census data recorded by the US Bureau of Statistics in 2000 (US Census Bureau, 2000). US census statistics from 2000 were determined to be relevant, as they are the closest possible to the average birth year of professional sprinters being 1996 (Olympic.org, 2016). Canadian data

was categorized into smaller population categories. These included under 1,000, 1,000-4,999, 5,000-9,999, 10,000-29,999, 30,000-99,999, 100,000-499,999 and over 500,000. These categories mirror census data recorded by the Statistics Canada in their 1980 census report. By using these categories, results were exhibited clearly, and in a visually appealing manner.

There are several limitations to this study. First, 495 athletes does not represent the entirety of Canadian and American sprinters. There are 2502 American and Canadian professional sprinters in the IAAF database, but this study lacked the requisite resources to study them all (IAAF, 2018). However, a reasonable sample size was extracted, with a proportionate amount of Canadian and American athletes. Another limitation had to do with the time period of the sample size. In the majority of studies analysing the birthplace effect, multiple years are selected in order to broaden the sample group. However, this aspect of research had to be omitted from this study, as it was too difficult to include. This is because unlike other sports which use draft prospects, sprinting does not have a designated amount of newcomers into the sport every year. This makes it too difficult to find new sample sizes every year while still using professional athletes.

Findings

Table I shows the representation of athletes from different community sizes, compared to the general American population. Of the 445 athletes surveyed,

Table I. American population, professional sprinters, and the relationship between the two.

City Size	a. American Population (%)	b. Sprinter Distribution (%)	Percentage Difference (%)	
>50,000	10.8	51.01	40.2	a. Metropolitan population distribution expressed as percentages of the greater American population. Taken from the 2000 US Census.
50,000-99,000	5.2	17.08	11.88	
100,000-249,999	10.7	11.91	1.21	
250,000-499,999	9.2	8.76	-0.44	
500,000-999,999	10.5	6.52	-3.98	b. Distribution of American professional sprinters by hometown population.
1,000,000-4,999,999	30.4	4.5	-25.90	
>5,000,000	23.3	0.22	-23.08	

the greatest overrepresentation occurred among athletes originating from communities with less than 50,000. When compared to US census data, athletes from this category were disproportionately overrepresented by 40.2%. The second highest overrepresentation occurred among athletes from communities with 50,000 to 99,999 people. Despite being the smallest cohort in American census statistics, sprinters from this community size were overrepresented by 11.88%, the second highest among sprinters. Athletes from communities of 100,000 to 999,999 people tended to be in line with American census data. There were only minute differences in representation among athletes and the US general population. Comparatively, athletes from communities with more than 1,000,000 people were significantly underrepresented. Despite representing 53.7% of the American population, only 4.72% of sprinters originated from these community sizes. These results showcased a pattern among community sizes, illustrating that smaller communities had larger representations among sprinters.

In regards to Canadian data, sprinters from communities with higher populations were overrepresented. The largest overrepresentation occurred among communities with 100,000 to 499,999 people, who despite only making up 13.3% of the Canadian population, represented 40% of Canadian sprinters. Communities with more than 500,000 were also overrepresented. These communities had the highest representations among Canadians and sprinters. The greatest underrepresentation in sprinting occurred

among communities with less than 1000 people, who despite representing 28.5% of Canadians, produced no professional sprinters. Communities with 1000 and 99,999 people were generally underrepresented, or relatively proportionate to census data.

Discussion

The results of this study provide strong support for the belief that in America, smaller communities provide the most ideal environment for athletes to thrive. American communities with less than 50,000 inhabitants were the most overrepresented in this study, substantiating the birthplace effect's prevalence among American Athletes. In particular, this study had similar results to that of Bruner et al. (2011), as well as Côté et al. (2006), who also found great over-representations of athletes from communities of under 50,000 inhabitants. This study marks the sixth sport in which the birthplace effect has been studied in the United States, and further substantiates its prevalence in athletic development. The results of this study infer that athletes born into communities of over 249,999 are disadvantaged in the pursuit of athletic careers, given the existing underrepresentation of people from this community size amongst professional sprinters. This could be due to a multitude of factors, including the willingness of parents to allow their children to engage in physical activity unsupervised, and therefore more often. Côté et al. (2006) and Kytta (2003)

Table II. Canadian population, professional sprinters and the relationship between the two.

City Size	a. Canadian Population (%)	b. Sprinter Distribution (%)	Difference (%)	
>1000	28.5	0	-28.5	a. Metropolitan population distribution expressed as percentages of the greater Canadian population. Taken from the 1980 Canadian Census Report. b. Distribution of American professional sprinters by hometown population.
1000-5000	6.7	2	-4.7	
5000-9999	3.4	0	-3.4	
10,000-29,999	7.3	0	-7.3	
30,000-99,999	7.6	8	+0.4	
100,000-499,999	13.3	40	+26.7	
>500,000	33.2	50	+16.8	

suggest that smaller communities provide generally safer environments, where parents allow their children to pursue athletics unsupervised. This increases young children's exposure to physical activity, thus improving their chances of becoming professional. Additionally, as mentioned again by Côté et al. (2006), who cited Kristjansdottir and Vilhjálmsson (2001), youth athletics in larger populated communities typically require more supervision and planning when compared to smaller communities. In communities with over 500,000 inhabitants, facilities are often expensive to book and communities are generally less safe, resulting in less athletic exposure for the youth of these communities. However, more research is needed to determine whether or not these factors are applicable in the development of sprinters. Another explanation for these results could be the heightened significance of sport in small towns in America. Research conducted by Foley (1990), through an ethnography, found an increased significance in communal sport in small communities when compared to larger ones. Since smaller communities are less likely to have professional sports franchises, youth athletics had fewer alternatives when compared to larger cities, giving them a similar appeal to professional, live sport. In addition to being of incredible importance to members of small communities, youth sport was found to be a holistic description of socialization, perceived as necessary in communal youth development. Further research is needed, however, to determine whether or not these effects are prevalent in more small communities.

In regards to Canadian data, this study differs from existing research on the birthplace effect in America, but was somewhat similar to Canadian research. The ideal community size for sprinting development was discovered to be between 100,000 and 499,999, which is slightly smaller than existing research conducted in Canada, such as that of Baker and Logan (2007), who found that the ideal community size for hockey players was between 500,000 to 999,999 people. Although these findings are not strictly consistent with existing research, they are vastly different from the American results. While athletes from small communities are overrepresented in American sport, they are underrepresented in Canada. This contrast infers a significant difference between Canadian and American athletics. This difference in results is further substan-

tiated by Côté et al (2006), who also found that the birthplace effect impacted the United States, but not Canada. Given that athletic development is heavily impacted by environmental factors, this differentiation could be due to various sociocultural factors, or even fundamental differences in athletic recruitment. For example, research conducted by Rossing, Stentoft, Flattum, Côté, and Karbing (2018), illustrates that an athletes' proximity to athletic centres is an important factor in athletic development. Additionally, according to the Canadian census report of 1996, communities with less than 1,000 people generally lack the infrastructure that are available in larger cities, which may include athletic centres and facilities (Statcan, 1996). This could be an important reason for why Canadian athletes from communities of under 1,000 people are so underrepresented in professional sport. However, further research is required to draw substantial conclusions.

This study's data was limited by a variety of factors. Firstly, this study does not take into account the possibility of athletes moving away from their hometowns after birth. This could potentially skew data, as subject birthplace could be misrepresented. However, research conducted by Katz and Lang (2004), lessens the impact of this limitation. In an analysis of the 2000 US Census, they found relative stability among movement between communities of different sizes in America. This means that athletes surveyed are less likely to have moved to different sized communities during their development. Another limitation was the use of the 1980 Canadian Census (StatCan, 1980). Ideally, population representation charts would have been taken from the 1996 Canadian Census, as it was published closer to subject's birth years. However, many sections of the 1996 Canadian Census Report are not available to the public and remain difficult to retrieve. Consequently, this study used the 1980 Canadian Census report, as it was more widely accessible. This could potentially skew representational claims given that sprinters, who were primarily born in the mid-1990's, will be compared to data from approximately 15 years earlier. This did not detract from the significance of Canadian results however, as they served to widen the scope of this study, and still gave an accurate representation of the Canadian sprinting community as a whole. Additionally, given the small amount of Canadian subjects used and the undeni-

able differentiations in results between American and Canadian athletes, this limitation is not of paramount importance. These study results were further limited by an omitted-variable bias. Possible variables which could explain population's effect on athletic development were not measured. For instance, climate was not taken into account, a variable which could likely change both the length of training seasons and the athletic tastes of youth from rural communities. Additionally, community birthrates were not taken into account. If smaller Canadian communities were to have lower birthrates than larger cities, this could account for the representation differences presented in Table II.

Despite having some limitations, the results of this study are still important for understanding contextual factors in athletic development. I examined the birthplace effect's influence in Canadian and American sprinters; an aspect of sport which was unresearched before this study. Including this research in the greater discussion of contextual factors in athletic development is important, as it broadens the understanding of the birthplace effect: an important and influential factor in athletic development. This paper provides further research into a popular issue and provides data which is both similar and different to existing research. Additionally, given the worldwide popularity of sprinting, this research forms a base for future inquiry, as scholars are now able to compare the birthplace effect's influence in other countries to its presence in Canada and America. Furthermore, this study is useful to anyone who would like to further understand the role of the birthplace effect in athletic development.

The results of this study indicate that further research must be conducted on American athletic development. Findings suggest that communities with less than 50,000 inhabitants possess environmental characteristics which enhance athletic development. If these characteristics were to be identified, athletic directors and coaches could attempt to emulate them in larger communities, in order to increase the likelihood of athletic success. Further research should also be conducted on additional factors affecting athletic development. Studies such as that of Rossing et al. (2018), have explored the importance of new environmental contexts influencing development which remain largely under-researched. In particular, they

found proximity to athletic centres to be more impactful than birthplace population. Additional research into these contexts could broaden academia's understanding of athletics, and optimize athletic development. Finally, the birthplace effect should be examined in more locations in order to gain a greater understanding of the notion. The birthplace effect has been for the most part examined solely in North American and European countries, but has not been researched extensively in Asia, South America, Africa nor Australia. Investigating the birthplace effect in these continents could broaden academia's understanding of it and infer differences and similarities between global athletic programs.

Conclusion

The results of this study infer that in America, professional sprinters are more likely to originate from smaller populated communities, and therefore adhere to the birthplace effect. Similarly to existing research on the birthplace effect, the ideal community size for American Sprinters was determined to be of under 50,000 people. Comparatively, in Canada, the results signify that professional sprinters are less likely to come from smaller communities and are instead disproportionately overrepresented in communities of 100,000 to 499,999 inhabitants. Canadian findings were relatively consistent with existing literature on the birthplace effect in Canadian athletes. The results of this study substantiate the notion that American athletes are more likely to originate from smaller populated communities. They also signify that athletic development in America differs from the rest of the world.

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THE BIRTHPLACE EFFECT'S PREVALENCE IN SPRINTING

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The Impact of Carnosine on Myosin for a Possible Intervention or Prevention of Systolic Heart Failure

Nari Kim

Heart failure is a common but serious condition that affects approximately 5.7 million adults in the United States and costs the economy \$30.7 billion each year. More specifically, systolic heart failure, otherwise known as heart failure with reduced ejection fraction (HFrEF), is the most common form of heart failure that occurs when the muscle of the left ventricle loses its ability to contract, preventing enough oxygen and blood from circulating throughout the body. Although a myriad of treatment options have emerged in recent years for the treatment of heart failure and left ventricular systolic heart dysfunction, there is yet to be an established and definite treatment for this condition. Thus, it is paramount to develop a more effective therapeutic treatment by specifically targeting the carnosine protein. Through analysis of the ATP activity of myosin with and without carnosine, it was discovered that myosin activity increases in the presence of carnosine. This is a significant discovery as carnosine allows for contractions of the heart to increase. As heart contractions increase from an increase in myosin, increasing actin activity through a directly proportional relationship, it allows for an increased amount of blood to be pumped from the heart. Thus, the hypothesis was supported as the carnosine protein can be seen to enhance muscle contractions of the heart and allow for the treatment or possible prevention of systolic heart failure, which can be caused by any condition that impairs the heart muscle's ability to pump blood.

Keywords: carnosine, myosin, myosin ATPase activity, systolic heart failure, contractile function

Introduction

Heart failure is a serious condition that affects approximately 5.7 million adults in the United States and costs the economy \$30.7 billion each year (Division for Heart Disease and Stroke Prevention, 2016). It occurs when the heart is not pumping enough blood to meet all of the body's needs, leading to a loss in vital functions, and can affect both left and right sides of the heart (Nic, 2012). The reasons for this reduced pumping of blood lie in cardiac enlargement, or the enlargement of the heart, and when heart muscles become too stiff to properly contract (McMullen and Jennings, 2007). More specifically, systolic heart failure is the most common form of heart failure and occurs when the muscle of the left ventricle of the heart loses its ability to contract, preventing enough oxy-

gen and blood from circulating throughout the body ("Heart Failure Signs and Symptoms," n.d.). Systolic heart failure is otherwise known as heart failure with reduced ejection fraction (HFrEF) and ejection fraction is an important measurement of how well a heart is pumping, which helps to classify the certain type of heart failure. Those possessing heart failure with reduced ejection fraction have 40% and below of the blood in the left ventricle of the heart pumped out to the rest of the body, which is below the normal ejection fraction of more than 55% (Pai et. al, 2017).

Although a myriad of treatment options have emerged in recent years for the treatment of heart failure, such as the use of Beta blockers or Angiotensin-converting enzyme (ACE) inhibitors, there is yet to be an established and definite treatment for this condition (McConaghy & Smith, 2004). This is due to

the fact that even though current treatment options are effective to some extent in serving as a base-line treatment, it is rather recommended by Becher, Blankenberg, and Westermann from the World Journal of Cardiology that future treatments focus on “augmentation of heart rate in order to increase cardiac output,” or the amount of blood pumped by the left ventricle of the heart in one minute (Becher et. al, 2015). With this, a promising approach to the development of an effective intervention of heart failure lies in a dipeptide that has been reasoned to increase cardiac contractility (Black et. al, 1997). The dipeptide, carnosine, is made up of B-alanine and histidine and is found in high concentrations in the skeletal and heart muscle. B-alanine and histidine are two amino acids that constitute carnosine; b-alanine is naturally produced by the body while histidine is not naturally produced and needs to be obtained through food. The researchers hypothesized that if the amount of carnosine is increased, heart contractions can increase as well but they were unsure of how this could occur and what the connections were between carnosine and heart contractions.

Using this study by Black and other researchers as a basis, it was interesting to see if carnosine could increase heart contractions by affecting one of the proteins responsible for heart contractions: myosin. Myosin is an adenosine triphosphatases (ATPase) and slides past another protein actin to form the muscle contractions (Valberg, 2008) using chemical energy it converts into these movements (Rayment, 1996).

Review of Relevant Literature

Carnosine has been seen to improve exercise performance, including beneficial effects towards “cycling capacity, ventilatory threshold, and [longer] time [until] exhaustion” (Culbertson, 2010). This is because B-alanine supplementation has recently been shown to increase intramuscular carnosine levels, which leads to improved athletic performance by reducing the lactic acid accumulation in the muscles during exercise (Cronkleton, 2018). Additionally, carnosine possesses antioxidant properties, meaning it neutralizes dangerous and toxic substances called free radicals, and acts as a fundamental buffer in maintaining a normal acidity balance in muscles. Ensuring acid levels re-

main low is crucial as muscles reduce work capacity by reducing its ability to contract during periods of high-intensity exercise when acid levels get too high. By improving exercise performance, carnosine allows for the maintenance of a healthy oxygen supply that can help reduce the impacts of aging as it prevents the hardening of connective tissue and the shrinking of muscle fibers (Muscle Metabolism, n.d.).

Gaps in Current Literature

Carnosine was first discovered in 1900 and became the central focus of cardiovascular research in the late 20th century as researchers noticed its benefits to areas such as exercise and became interested in researching its effects in relation to the heart. Despite the fact that carnosine was discovered 119 years ago and has been found to be beneficial towards certain areas, the actual physiological function of carnosine still remains unknown (Hipkiss, 2013). Currently, no papers have been published on carnosine and its effect on myosin in respect to heart failure, although several studies, including studies from the *Chemistry Central Journal* and *Journal of Applied Physiology*, address that numerous questions on the properties of carnosine remain unanswered and its role in “contractile function of various types of muscle fibers in vivo is poorly understood” (Kaczmarek, et.al, 2016; Artioli, 2018; Black, 1997; Hipkiss, 2013; Taylor, 2009). Roberts and Zaloga, authors of several studies published in the *American Journal of Physiology* on carnosine, have even mentioned in their study that “the specific functions [of carnosine]” and “an exact physiologic function for carnosine in muscle [are] unknown” (Roberts & Zaloga, 2000).

In addition to the fact that there has been little to no research conducted on the relations between carnosine and heart failure with myosin in particular, there have been only a few attempts in trying to develop pharmaceutical drugs using carnosine as it poses difficulties with a lack of a standard method for doing so (Boldyrev, 2012). It is vital to study carnosine now although it was discovered back in 1900 because in recent years, there has been an increase in studies that have showed there were benefits to taking carnosine supplements, such as “[improved] oxygen delivery to tissues for use during exercise” (Greene, 2017). Al-

though this is the case and the study by Black and other researchers should have opened more discussion into the development of heart failure treatments with carnosine, “to date, clinical studies evaluating the utility of carnosine in cardiac disorders appear to be lacking” (McCarty & DiNicolantonio, 2014). Therefore, it is the purpose of this study to look at the effect of carnosine on myosin. This will aim to address the lack of information on carnosine and take a step towards forming a new understanding behind the molecular mechanisms of carnosine on the improvement of cardiac function during heart failure. This leads to the research question: How can carnosine have an impact on myosin for a possible intervention or prevention of systolic heart failure?

In order to form this new understanding, it is essential to discover the molecular mechanisms by which this is to occur using two assumptions: the first being that carnosine can improve heart contractions and the second being that myosin can still be an indicator of muscle contraction activity by increasing actin to form the muscle contractions even when actin is not analyzed in this study. With this new understanding, it can facilitate the development of therapeutic treatments by specifically targeting the carnosine protein. This is because if it is seen that carnosine has a directly proportional relationship with myosin, then it can serve to further corroborate recent findings that carnosine improves cardiac function during heart failure by increasing heart contractions and leading to increased blood flow. The development of therapeutic treatments targeting carnosine will be seen to contribute immensely to a condition that has no current cure and will show to help the scientific community take one step closer to finding a cure for the condition.

Thus, as myosin is one of the proteins responsible for heart contractions and carnosine has been shown to increase the pumping of the heart, it is hypothesized that if carnosine and myosin are analyzed, then there will be a directly proportional relationship between the two with carnosine increasing myosin when there are increasing amounts of carnosine present in the body.

Methods

As there is still a lack of information about carnosine, there was not a fair amount of studies employing experiments that could form the basis of this study. However, there was one key study by Tyska and other researchers from Harvard Medical School who looked to see if a certain mutation of myosin related to a type of heart failure increased or decreased heart contractions (Tyska et. al, 2000). To do this, they first used an extraction and purification experiment to extract the mutated myosin from mice with this heart failure. This experiment was used in this study as it was similar to the purpose of this study to first remove normal myosin from normal mice hearts.

Experiment 1: Myosin Extraction and Purification

The first step for this research was the protein purification of the myosin protein from the hearts of mice around a year old. In order to purify the myosin protein, it was first extracted from the mouse heart. The mouse had 0.12 mL of pentobarbital injected into them to induce sleep, in accordance with the anesthesia guidelines established by the Institutional Animal Care and Use Committee (Office of Animal Resources- Institutional Animal Care and Use Committee, 2017). Mice hearts are ideal for this study as mice hearts and human hearts are anatomically similar with respect to the partitioning of the cardiac chambers. In both mice and human hearts, the partitioning of the cardiac chambers both follow the same sequence of events and both the maturation of the cardiac valves and myocardium are similar (Wessels & Sedmera, 2003). In essence, the structure of mice and human hearts are almost identical.

For the extraction of the myosin protein from the mice heart, which was conducted by an undergraduate student, the stomach of the mouse was sprayed with 70% ethanol and wiped with an alcohol prep wipe after the mouse had fallen asleep. Subsequently, the tail was tested to see if there was any movement to ensure the mouse had fallen into a deep sleep. The stomach was then opened and the still-beating heart was removed. After the heart was removed, it was wiped on a towel to remove excess blood. This was

in order to receive a more accurate measurement of its weight before homogenizing the heart in high salt buffer in a 1:5 ratio of wet tissue to volume. In order to compare the ratios in vitro to those existing in living muscle, weight per volume was more practical to use than weight per weight ratios. The heart was weighed and placed on ice after one single edge blade was used to cut the heart until it weighed approximately 30 mg. For future trials, the rest of the heart was cut into pieces weighing 30 mg, placed in 1.7 mL tubes, and stored in the freezer at -80 degrees Celsius. The materials for this procedure were thrown away in the biohazard box.

One 30 mg piece of the heart was used for the subsequent experiments. However, before this, the high salt buffer consisting of 0.3 mol/L KCl, 0.15 mol/L K₂HPO₄, 0.01 mol/L Na₄P₂O₇, 0.001 mol/L MgCl₂, and 0.002 mol/L DTT was made with a final pH at 6.8. After the high salt buffer was made, it was used to homogenize the 30 mg heart in a 1:5 wt:vol for 20 mins. 150 mL of high salt buffer was drawn up with a pipette and into a homogenizer tube with the heart which was pushed to the bottom of the tube. To homogenize the heart, a homogenizer rod was continuously twisted for 20 minutes to mix the buffer and heart together.

Following the homogenization, the homogenized heart was placed in a polycarbonate centrifuge tube and taken to the ultracentrifuge to be centrifuged at 65,000 RPM and 4 degrees Celsius for an hour to separate out proteins and particles from one another from the muscle tissue. During this time, the purification buffer was prepared. The purification buffer consisted of 2 mmol/L DTT and was used to precipitate the myosin, or cause the myosin protein particles to consolidate together in solid form. When the proteins consolidate together, this includes myosin as it is found in the heart muscle tissue which makes up the heart. Subsequently, further ultracentrifugation was performed with the pellet at 38,000 RPM and 4 degrees Celsius for 20 minutes.

While the pellet was being centrifuged, the myosin buffer was prepared. The myosin buffer consisted of 0.025 mol/L imidazole, 0.004 mol/L MgCl₂, 0.01 mol/L DTT, 0.001 mol/L EGTA, and 0.3 mol/L KCl at an overall pH of 7.4. Once the ultracentrifugation was completed after 20 minutes, the pellet was suspended in the myosin buffer to stabilize the myosin proteins.

Experiment 2: Bradford Protein Assay

Subsequently, a Bradford protein assay was conducted using BioRad DCTM Protein Assay Reagents A, B, and S to measure the myosin concentration. This is because the Bradford protein assay allows for the exact protein concentration of a sample to be determined with a series of dilutions of known protein concentrations, such as BSA. BSA (bovine serum albumin) is often used as a standard for protein assays and other quantitative assays for “its stability to increase signal in assays, its lack of effect in many biochemical reactions, and its low cost” (Ascoli, C. et. al, n.d.) The known protein concentrations are then compared alongside unknowns, such as the purified myosin from the heart as the amount of myosin present in the heart was not known. From 1 µg/ µL BSA standard, 0, 5, 10, 15, 20, and 25 µL were drawn up and added to six different tubes. 25, 20, 15, 10, 5, and 0 µL of distilled water were added to each tube respectively for a total volume of 25 µL per tube. Using the purified myosin from the protein purification experiment, 5 µL and 15 µL were mixed with 20 µL of distilled water and 10 µL of distilled water respectively to find the current total protein concentration of the myosin. Following this, 1000 µL of Reagent A and 20 µL of Reagent S were mixed together. 125 µL of the mixed reagent was added to six of the tubes with the standard and two of the tubes with myosin samples. After adding 1000 µL of Reagent B to the eight tubes, the tubes were mixed, poured into cuvettes, and taken to a UV-Visible Spectrophotometer to be read.

Experiment 3: SDS-PAGE

SDS-Page was then conducted to separate and isolate the myosin protein based on its molecular weight. This was the third step that was used to ensure the protein was fully purified as the SDS- Page is commonly used to “determine the success of a protein purification scheme,” and allows for the total protein, total enzyme activity, specific activity, yield, as well as purification level to be determined (Berg et. al, 2002). It is essential to have a good protein purification scheme to ensure there is a high degree of purification and a high yield since a low yield will “leave protein with which to experiment” at a low degree of purification. This allows for many contaminants to be left

which will “complicate the interpretation of experiments” (Berg et. al, 2002).

Using the readings from the UV-Visible Spectrophotometer, the myosin concentration from the Bradford protein assay was determined and used to prepare 4X loading buffer with DTT. The loading buffer was prepared by adding 4 μg of DTT to 100 μL of a 4X Bio Rad Laemmli Sample Buffer. 50 μL of the myosin sample used for protein estimation was added to 12.5 μL of the loading buffer and the mixture was heated for 5 minutes at 95 degrees Celcius. While the mixture was heated, 1X running buffer was prepared. The running buffer consisted of 6g Tris, 28.8g glycine, 2g of SDS (sodium dodecyl sulfate), and distilled water. Once the running buffer was stirred with a stir rod and the mixture was finished heating, the buffer and mixture were placed on ice for 15 minutes. Following this, Criterion™ TGX™ Precast Gel was inserted into an electrophoresis tank, which was connected to a Power Pac 300 machine, before the running buffer was poured over the gel. 20 μL of Precision Plus Standard Protein was loaded in the ladder beside the lanes of the gel to serve as the control, 25 μL of the mixture of myosin and the loading buffer was loaded into the first lane, and 35 μL of the mixture was loaded into the second lane. The gel was then left running for an hour and a half at a voltage of 120 watts. Afterwards, the gel was taken out and left to incubate in a container on a rocking platform with Coomassie Blue to be stained overnight. Coomassie Blue is a commonly used dye in SDS-PAGE as it detects as little as 0.1 μg of protein (Protein Science, 2012). Subsequently, the Coomassie Blue was poured out and the destaining buffer was poured on the gel to destain the gel overnight. The next day, the gel was read by a Thermo Scientific MyECL imager.

Experiment 4: ATPase Assays

Once the protein purification, Bradford protein assay, and SDS-Page were completed, two ATPase assays were conducted: one without carnosine and one with carnosine. This was another method used by Tyska & the other Harvard researchers. This assay is significant as it tests the amount of Pi released from the myosin. This is important because during a power stroke, or when myosin and actin slide past one another to create the muscle contractions, both adenosine di-

phosphate (ADP) and inorganic phosphate (Pi) are released from the myosin (Freundenrich, 2001). The third assumption is that the amount of Pi is an indicator of myosin activity, which corresponds to muscle contractions, as it is released from the interactions of myosin and actin which are proteins responsible for heart contractions.

The assay was conducted with an incubation time period of 5 minutes and in fourteen wells of a 96-well plate. Six of the wells include the phosphate standards needed for the assay and eight of the wells include duplicates of myosin with carnosine, without carnosine, and each of their respective background blanks. Background blanks are needed for the assay in order to correct for high levels of phosphate which have the potential to result in a sample background. Sample backgrounds are not ideal as this is where phosphates are freely floating around in the sample and will hinder the result as this assay is testing for the ATP reaction by testing only the phosphates released by the myosin, not the free phosphate.

To start, six phosphate standards were prepared. After diluting a 1 mM Phosphate Standard with distilled water, a 50 μM Phosphate Standard Solution was formed. Six increasing concentrations of this were plated in six wells of a 96-well plate. Once these were diluted again by distilled water, six standards with concentrations of 0, 12.5, 25, 31.25, 37.5, and 50 μM were formed.

A reaction mix was first made with 20 μL of assay buffer added to 10 μL of 4 mM ATP. 4 mM was chosen as the concentration for ATP as researchers Avena and Bowen found “the influence of carnosine on the splitting of ATP by myosin...most effective” at 4 mM out of 0.5 mM, 2.0 mM, and 4.0 mM ATP (Avena & Bowen, 1969). The assay buffer consisted of 40 mM Tris, 80 mM NaCl, 8 mM MgAc₂, and 1 mM EDTA at a pH of 7.5. In two of the wells containing duplicates of myosin without carnosine, 5 μL of purified myosin, 5 μL of the assay buffer, and 30 μL of the reaction mix were added. However, in two of the wells containing duplicates of myosin with carnosine, 5 μL of purified myosin, 5 μL of 1 mM carnosine, and 30 μL of the reaction mix were added. A concentration of 1 mM carnosine was chosen as it falls near the range of 2 mM to 10 mM carnosine tested by Yun and Parker, who found “near maximum [ATPase] activation achieved at 0.002 M” (Yun & Parker, 1965). As Yun and Parker

(Yun & Parker, 1965) determined maximum carnosine activation at a concentration of 0.002 M that was lower than the 0.10 M carnosine concentration found by Avena and Bowen (Avena & Bowen, 1969), it was reasoned that a lower concentration of 0.001 M should be used.

Once the reaction mix was added to the four wells, the timer began for 5 minutes. During the 5 minutes, the last four wells were prepared as an incubation period of 5 minutes at room temperature was not needed for the background blanks. For two of the wells that served as background blanks for the duplicates of myosin without carnosine, 5 μ L of myosin buffer, 5 μ L of the assay buffer, and 30 μ L of the reaction mix were mixed together. For the last two wells that served as background blanks for myosin with carnosine, 5 μ L of myosin buffer, 5 μ L of distilled water, and 30 μ L of the reaction mix were mixed together. Once 5 minutes had passed, 200 μ L of a malachite green reagent was added to all 8 wells, as well as to the phosphate standards, and the wells were left to incubate for an additional 30 minutes at room temperature to terminate the enzyme reaction. The incubation period of 30 minutes was also needed for the generation of a calorimetric product that results when the malachite green reagent forms a dark green color with the free phosphate released from the enzymes. After 30 minutes, the plate was taken to be read by the Gen5 spectrophotometric multiwell plate reader at an absorbance

of 620 nm. Using the generated data from the plate reader, Microsoft Excel was used to plot a standard curve with values from the 6 phosphate standards and to calculate the concentration of phosphate generated in the sample wells, which was used to determine the enzyme activity in units/L. This was repeated two more times for a total of three trials. A paired t-test was then performed to determine if the differences in the myosin activity values in the absence and presence of carnosine were simply due to random chance.

Results

Experiment 1: Extraction and Purification of the Myosin Protein

The myosin protein was successfully extracted and purified from the hearts of mice around a year old. The purified myosin from this experiment was used for the second experiment: the Bradford Protein Assay.

Experiment 2: Bradford Protein Assay Using Purified Myosin from First Experiment

The data shown in Table 1 depict the five BSA standards used for protein estimation in the Bradford Protein Assay, excluding the sixth one which

Table 1. Concentration (mg/mL) and Readings for BSA Standards in Bradford Protein Assay

Standard	Concentration (mg/mL)	Readings
Std 1	0.2	0.0611
Std 2	0.4	0.123
Std 3	0.6	0.1672
Std 4	0.8	0.2695
Std 5	1	0.36
	Calibration Equation	Abs = 0.37221 * Conc -0.02716
	Correlation Coefficient	0.97789

served as a control. The concentration and readings obtained from the assay at an absorbance level of 750 nm were used to construct a standard curve, as seen in Figure 1, to which the unknown myosin concentrations could then be determined from through interpolation within the BSA standard calibration curve. These concentrations can be seen in Table 2. The correlation coefficient signifies a strong positive linear correlation between the concentration and readings,

meaning that the readings increase as the concentrations increase. This can be seen in Figure 1, where the R-squared value, or the coefficient of determination, shows that the graphed line is the best fit for the data and is close to the line of best fit represented as a dotted line, meaning the fitted values would almost always equal the observed values as most of the variance is accounted for.

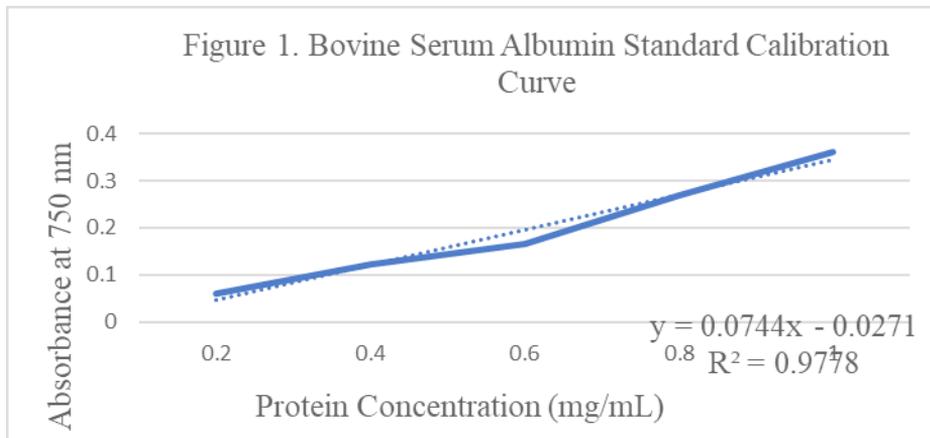


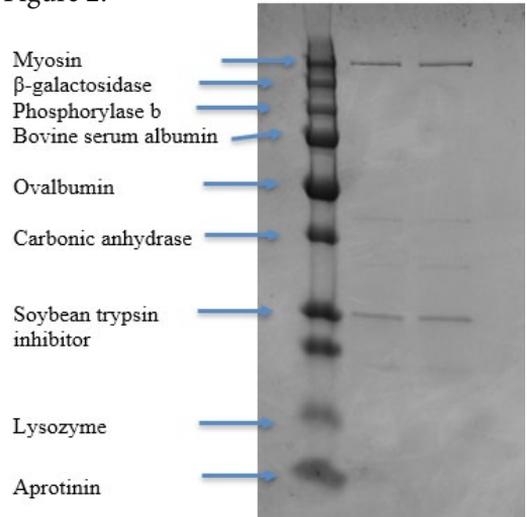
Table 2. Concentrations (mg/mL) of 5 μ L Myosin and 15 μ L Myosin

Sample	Concentration (mg/mL)	Readings
Sample 1 (5 μ L)	0.1361	0.0235
Sample 2 (15 μ L)	0.2846	0.0788

Experiment 3: SDS-PAGE

The image of the gel in Figure 2 displays the results from the SDS-PAGE. From this, a dark band can be seen at myosin, corroborating the fact that myosin was purified from the mouse heart. This also correlated with a common pattern found in SDS-PAGE where dark spectrin bands representing proteins with a molecular weight of more than 200 kDa are found at the top of the image of the gel. In this, dark bands can be seen at the top of the image next to myosin, which possesses a molecular weight of 210 kDa. This image demonstrated that only the myosin protein was extracted from the mouse heart and properly purified, which allows confirmation for the myosin concentration determined in the second experiment to be used for the fourth experiment.

Figure 2.



Experiment 4: ATPase Activity Assays With and Without Carnosine

Figures 3, 4, and 5 depict the standard phosphate curves for each of the three trials of the ATPase activity assay, which were used to calculate the myosin ATPase activity values seen in Table 3. Each of the standard phosphate curves were produced from the concentration and readings of the six phosphate standards from the ATPase activity assay. Interpolation within each of the standard phosphate curves produced the concentration of the generated phosphate in the assay that served as the phosphate control. This was then compared with the averages of the duplicates and background blanks for myosin with and without carnosine that measured the released phosphate. These values produced the myosin ATPase activity values seen in Table 3, which depicts the data for three trials conducted for myosin with and without carnosine. This table shows an increase in myosin activity when carnosine is present. When carnosine was pres-

ent, approximately double the amount of ATP were released from myosin per minute compared to when carnosine was not present. This means myosin activity was enhanced, indicating heart contractions increased in the presence of carnosine. When a paired t-test was conducted, it revealed the myosin ATPase activity values in the absence and presence of carnosine was statistically significant with a p-value of 0.033. This depicted a significance in that the differences between the values of myosin ATPase activity in the presence and absence of carnosine were not simply due to random chance which allows for the conclusion that the findings can support the hypothesis. This was that myosin values were increased in the presence of carnosine and there is a directly proportional relationship between the two.

Figure 3. Standard Phosphate Curve for First Trial

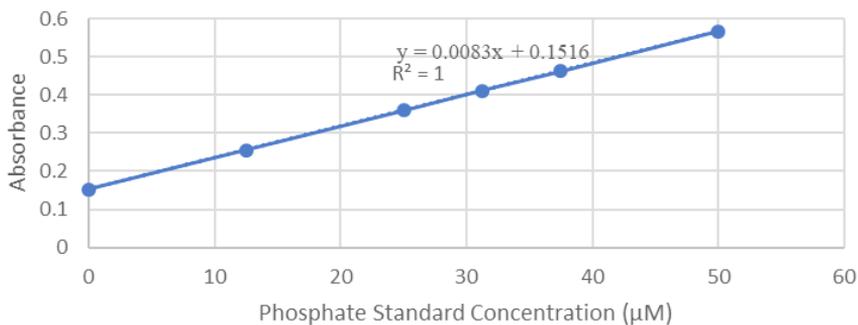


Figure 4. Standard Phosphate Curve for Second Trial

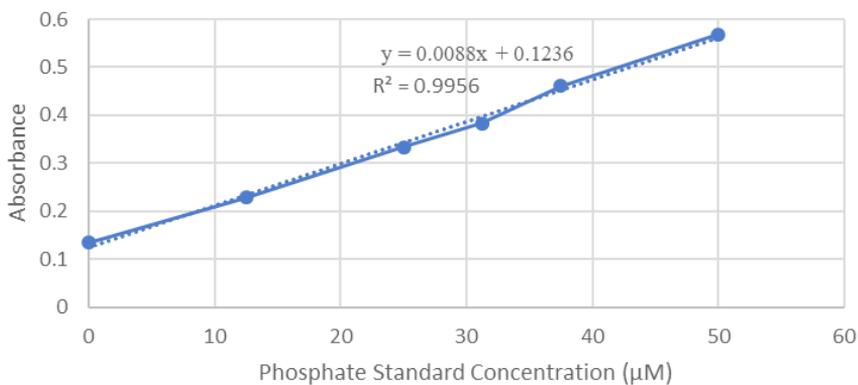


Figure 5. Standard Phosphate Curve for Third Trial

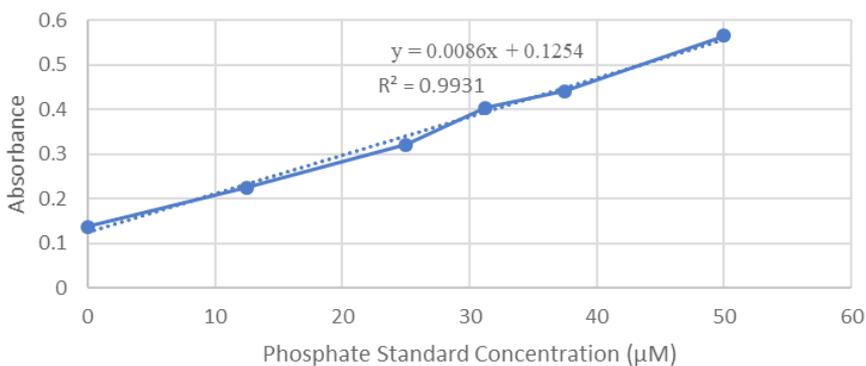


Table 3. Data for Three Trials on The Amount of ATP that Catalyzes the Production of 1 μM of Free Phosphate Per Minute

	- Carnosine	+ Carnosine
Myosin ATPase Activity ($\mu\text{M}/\text{min}$)	16.75181	27.93253
Myosin ATPase Activity ($\mu\text{M}/\text{min}$)	18.345456	33.254544
Myosin ATPase Activity ($\mu\text{M}/\text{min}$)	15.64651163	21.87906977
	T-Test Value:	0.033236954

Discussion/Conclusion

The results of this study suggest that myosin activity is enhanced in the presence of carnosine. Experiment 2 ensured the results for the myosin concentration in the protein estimation are precise with a correlation coefficient of 0.97789, meaning the BSA sample standards in the experiment were close to the standard concentrations. With Experiment 3, it further corroborated that myosin was properly purified from the mouse heart, which allowed for the myosin concentrations in Experiment 2 to be used for Experiment 4. Experiment 4 suggests that the myosin activity was increased in the presence of carnosine after a reaction time of 5 minutes as, on average, 27.689 μM of ATP was released from myosin per minute. Myosin ATPase activity was measured as myosin releases ADP and Pi to rebind to the actin filament and return to its initial position, causing the muscle contractions (Cooper, 2000). In other words, reaction of myosin ATPase is the immediate source of free energy that drives the muscle contractions. With an increase in myosin activity, it portrays an increase in the amount of free energy that can lead to increased muscle contractions. Current data indicates ATPase activity was enhanced in the presence of carnosine. This is in

agreement with several studies that have indicated that carnosine activates myofibrillar ATPase activity, which corresponds to the speed of muscle contraction (Briggs et. al, 1959; Yun & Parker, 1965; Avena & Bowen, 1968).

It was hypothesized that if carnosine and myosin are analyzed, then there will be a directly proportional relationship between the two with carnosine increasing myosin when there are increasing amounts of carnosine present in the body. This was supported by the results as myosin activity increased when carnosine was present compared to when carnosine was not present. As myosin activity corresponds to the activity of heart contractions and there was an increase in myosin activity, it can be understood that heart contractions are increased. With a directly proportional relationship between carnosine and myosin, as well as between myosin activity and heart contractions, there is a relationship between carnosine and heart contractions.

Significance

Currently, this is one of the only studies that assesses the impact of carnosine on myosin using mouse hearts as a way to determine if carnosine and myosin have a directly proportional relationship to increase blood flow in the heart. The results from the ATPase activity assay illustrates that in the presence of carnosine, myosin activity increases. For the first trial, myosin activity increased by approximately 11 $\mu\text{M}/\text{min}$. For the second trial, the myosin activity increased by approximately 15 $\mu\text{M}/\text{min}$, and the last trial illustrated that the myosin activity increased by approximately 6 $\mu\text{M}/\text{min}$. The findings are notable as it was found that in the presence of carnosine, myosin activity was increased, which would indicate increased muscle contractions and hypothetically lead to increased blood flow. With this, it can be assumed that myosin activity can increase with increasing amounts of carnosine. Thus, the carnosine protein enhances muscle contractions of the heart and allows for the treatment or possible prevention of systolic heart failure, which can be caused by any condition that impairs the heart muscle's ability to pump blood (Systolic Heart Failure, 2018). As previously established in the preceding section, there is a relationship between carnosine and heart contractions. The information from this study is significant as it provides a new understanding and lays the foundation for future treatments that have the potential to cure or prevent forms of heart failure by targeting the carnosine protein. Not only does this lay the foundation for future treatments for heart failure, it forms a new understanding in addressing the lack of information on the functions of carnosine since this study now shows that one of the functions of carnosine can be to increase heart contractions by affecting the myosin protein. This also corroborates the hypothesis of Black and others from the Bowman Gray School of Medicine who believed that carnosine increases cardiac contractility but had no definite proof. Furthermore, it provides support for the recommendation of Becher, Blankenburg, and Westermann for future treatments to augment cardiac output.

Limitations

Limitations include using three mice hearts for the three trials of the experiments conducted. This is a limitation as three mice hearts are not representative of all mice hearts; thus, the findings from this study could not yet be applied to human hearts. Another limitation is that this was an *in vitro* study because it would be more significant to see these results apply *in vivo* in mice themselves rather than in centrifuge tubes and well plates. Discrepancies in the data could have arisen due to issues with pipetting. This can be seen in Figure 1 with the line for readings. The line in Figure 1 seems to generally increase steadily with an exception to Standard 3 due to a slight dip in the readings. While the readings for Standards 1, 2, 4, and 5 seem to increase by approximately double the previous reading value, the reading value for Standard 3 only increased by a mere 0.03 from Standard 2.

Moreover, in Figure 2, it can be seen that a dull band is lightly highlighted to be soybean trypsin inhibitor. This can be attributed to an insufficient amount of β -Mercaptoethanol in the Laemmli Sample Buffer as a sufficient amount of β -Mercaptoethanol must be present to be able to reduce the disulfide proteins to allow for the protein to migrate properly to determine its molecular weight (2-Mercaptoethanol, n.d.). Disulfide proteins possess disulfide bonds that allow for the proteins to be stable with support for its protein structure. The lack of sufficient amount of the β -Mercaptoethanol most likely allowed for the presence of the line delineating the soybean trypsin inhibitor. If there was a sufficient amount, it would have reduced the disulfide bond, preventing the formation of a stable structure of the protein and a line delineating its presence in Figure 2.

Future Directions

Future directions will prioritize generalizing findings to be more representative of mice hearts, and subsequently, human hearts. These include experiments with more mice and looking at different proteins besides carnosine, such as anserine. This is because anserine and carnosine have been reported to prevent diseases related to oxidative stress (Arihara & Ohata, 2011) and oxidative stress has been seen to

be increased in heart failure (Sawyer, 2012). In the future, an in vivo study should also be conducted by testing carnosine in cardiac tissue in mice to see if it improves contractile function. If in vivo in mice is found to be significant, then carnosine could be tested in heart failure patients to see if it increases their heart rate or improves their blood flow.

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MOLECULAR MECHANISMS OF CARNOSINE IN HEART FAILURE

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Detection of Genetically Modified Organisms (GMOs) in North America in Tofu: A Quantitative Experimental Case Study on the Accuracy of Non-GMO labels

Ziyu Han

Genetic modification refers to the reprogramming of an organism's genetic material (DNA) to achieve favorable attributes. As many were skeptical about genetically modified organisms (GMO), North America enacted a voluntary labeling law on foods containing no GMOs. However, the lack of regulation by government authorities has allowed companies to utilize this legislation and deceitfully entice consumers with such labels to buy their products. To address this, a quantitative experimental case study on five different tofu products in North America, branded with or without a non-GMO label, using polymerase chain reaction was conducted. Results revealed that three tofu products with a non-GMO label were incorrect, while two had inapplicable results. Furthermore, findings suggested more governance on non-GMO labels placed on tofu products. Although this study offered a more extensive insight on the accuracy of non-GMO labels on tofu products, further research is necessary to generalize results on a larger scale.

Keywords: Genetic modification, genetically modified organisms, non-GMO labeling, polymerase chain reaction, tofu

Introduction

Established in 2009, the Non-GMO Project Verified Label is recognized as North America's "most trusted seal for GMO avoidance" (The Non-GMO Project, 2016). However, in April 2018, the Canadian Food Inspection Agency (CFIA) announced that the Non-GMO Project Verified Label no longer necessarily means the product is GMO-free (Campbell, 2018). In fact, a report done by researchers Bain and Selfa in 2017 discovered that the differences between the terms "non-GMO" and "Organic" were not obvious to the average consumer, permitting companies to take advantage of the seal and falsely allure consumers to purchase their products. This not only breaches the

trust between the Non-GMO Project and consumers, but also disrupts consumer purchasing behaviour and their understanding of a products' composition, directly impeding the objective of the Foods and Drugs Act and the CFIA, which states to "prohibit the labeling, packaging, selling or advertising of any food in a manner that is false, misleading or deceptive to consumers" (Canadian Food Inspection Agency, 2019).

The *Food and Drug Act* was authorized in 1997, three years after the inception of the first genetically modified organism, the Flavr Savr Tomato. Since then, humans have taken advantage of this revolutionary biotechnology to develop foods with enhanced and desired characteristics. This includes safer nutritional value, using fewer chemical fertilizers and pesticides

as stated by Monsanto, a multinational agricultural biotechnology cooperation (2019). This technique has played a key role in eradicating malnutrition and stimulating national food security (Olusegun & Olubiyi, 2017). However, adversaries of genetic modification argue that this technology poses a potential threat to the consumer as the product may include obscure allergens and toxins (Brady & Brady, 2003). Opponents further contend that genetic modification harms surrounding environments through cross-pollination (Brady & Brady, 2003). Others worry

about the ethics and the economic consequences regarding the control of agriculture through biotechnology companies (Radas et al., 2008).

Because of these concerns, legislation on the presence of GMOs in foods has been enacted worldwide, with the largest and most controversial one being mandatory labeling of GM products. In North America, there is significant evidence that a larger proportion of the population supports some form of GMO labeling on what they buy. Data for this information comes from a study conducted by Andree (2002), which indicates that more than 90% of Canadians supported the mandatory labeling of genetically modified foods. A study carried out by Radas et al. in 2005 respondents residing in America identified that about 83% wanted to see GM labels on their foods (Radas et al., 2008). However, despite consumers' preference and opinions, the labeling of GM foods is not mandatory in North America to date (Macdonald & Whellams, 2007). This created a perfect opportunity for food cooperations to legally be dishonest and mislead consumers with their labels (Macdonald & Whellams, 2007).

Given the status of the global food chain and given that both USA and Canada are two major producers and among the top five countries with the largest hectares of GM crops (International Service for the Acquisition of Agri-biotech Applications, 2016), it is likely that a significant portion of foods distributed in North America comprise of GMOs. Therefore, it is essential that the GM labels (and non-GM labels) on these products are accurate. The food product that will be used in this study to test the accuracy of labels is tofu. Tofu was chosen for the three following reasons. Firstly, the bulk of tofu products consists of a form of soybeans, which represents the number one genetically modified crop globally in quantity (James,

2014), accounting for nearly 50% of the world's GM planted areas (James, 2011). Secondly, the production process for tofu has insignificantly changed over the last 20 centuries, allowing for

consistent past research on tofu (Nikolić et al., 2017). Thirdly, as soybeans rank fourth in Canada's largest crop acreage, Canada is a main international exporter of soybeans, including tofu, exporting about two-thirds their soybeans to international food markets (SOY Canada, 2019).

Consumers have the right to know what is in their food and the right to select what they eat. Labels serve a critical role in assisting consumers to make conscientious choices as confirmed by research done by Bain and Selfa in 2017. As a result, this study plans to answer the question regarding how accurate non-GMO labels are on tofu labels sold in North American supermarkets. With the existing lack of concern and proper administration on GM food labeling in North American regulatory agencies, it is highly likely that mislabelling is present (Macdonald & Whellams, 2007). Using polymerase chain reaction, this study will attempt to verify a product's authenticity and potentially shed light on information for other researchers to build from.

Literature Review

In recent years, there has been an increase in debate and resistance against GMOs across the world since its introduction. This has resulted in a complete ban on GM food imports and cultivation in three countries and a requirement of mandatory labeling of GM foods in over 40 countries (Genetic Literacy Project, 2016). However, Canada's regulatory system, authorized by the CFIA, has approved 51 "plants with novel traits" and "novel foods" since 1995, most of which were genetically modified, with flexible laws on GM labeling and content thresholds (Andrée, 2002). As acknowledged from Macahilo's report on the GMO labeling laws in each country, the Canadian government offers minimal information about GM foods despite a large population of Canadians who want GM labeling on their food products (Macahilo, 2017). With this lack of knowledge, it is important to analyze the accuracy of non-GMF labels in North American supermarkets.

Non-GMO versus Organic

Since 2010, the longstanding market for non-GMO food products has expanded dramatically with two labels dominating the food market: The National Organic Program's USDA Organic Label and the Non-GMO Project Verified logo. The Project employs a product standard that aims to ensure that a product does not surpass its required level of GMO contamination (Greene, 2016), while USDA Organic is based on a process standard that requires the entire production process meets certain criteria to distinguish between GMO and Non-GMO foods. However, to the average consumer, the difference between the non-GMO butterfly logo and the organic label is not transparent and has generated significant confusion (Bain & Selfa, 2017). Megan Westgate, the executive director of the Non-GMO Project, stated that the

“relationship between non-GMO and Organic is probably the most politically sensitive thing we deal with” as hardly anyone can differentiate between the two terms (Bunge & Gasparro, 2015). The distinction between non-GMO and organic are essential to companies, specifically small businesses, as receiving the Non-GMO Project's or the USDA's organic approval take a long time and can come with an annual cost of thousands of dollars (Bain & Selfa, 2017). For other food companies, labels are viewed as a valuable way to improve their reputation and credibility as socially responsible and can help evade activist pressure (Bartley et al., 2015).

However, as reported by researchers Timmermans and Epstein, labeling acts as a powerful technique to mobilize conscientious consumers and encourage individuals to control their lives (2010). Other researchers, Bunge and Gasparro, found that consumers, despite having a lack of insight and education on GMOs, were more influenced and placed a higher value on specifically the non-GMO label than the secured organic label even though the non-GMO label offered more room for manipulation (2015). However, according to Professor McFadden, some companies are utilizing this consumer desire for a label as a marketing strategy, with large food cooperations taking advantage of consumers and including futile claims to their products that never contained GMOs in the first place (2018). McFadden believes that the purpose of labeling for these cooperations is more about mar-

keting and stigmatization rather than providing consumers with helpful material to aid in their decision-making (2018). To minimize consumer confusion and deception, researchers Bain and Selfa stress the USDA Organic label should be the sole non-GMO label on food products to minimize consumer confusion, believing that the Organic label is based on a comprehensive, holistic set of environmental approaches while the Non-GMO Project label is dependent on a test (2017). Therefore, it is imperative that consumers are informed about

the differences between the Non-GMO Project Label and USDA Organic Label, if both leading trademarks remain, to ensure clarification for consumers in their purchases.

Labeling Discrepancy

With insufficient information provided on the term “non-GMO,” companies often take advantage of the label and misinform consumers into thinking their product is healthy (Kilman, 2001). A recent sample of soybeans labeled as “non-GMO” from the Yves Canadian Veggie Bacon, a Canadian cooperation selling natural foods, was found to have been about 40% genetically modified, according to the Wall Street Journal. In their analysis of non-GMO labels in companies across North America, researcher Callahan and Kilman suggested these labels are often inaccurate due to the lack of government agencies that verify the accuracy of such labels, concluding that “enforcement is left to individual countries, most of which make little or no effort to test consumer products” (2001). Limiting to only government departments in North America, researcher Heslop confirmed that Federal organizations in North America have loosely regulated such products, assessing GM foods as “substantially equivalent” to non-GM foods and not enacting any special vetting on them prior to market introduction (2006). Several researchers gave suggestions to these cooperations. For instance, Bain et al., in their analysis on GMO contaminated landscapes, proposed that developing thresholds and product testing for GMOs provides more transparency for consumer trust and drawing on expert discourses and farming practices, where the credibility for standards is based on appeals to scientific norms and values, establishes legitimacy for such measures (2017). In addition, researcher

Holly from the Canadian Medical Association asserts that “smarter inspection, not more inspection” will be necessary to achieve greater truthfulness, specifically proactive detection of deficiencies and insightful analysis of system operations (2010). However, these extra implementations will be costly, for both consumers and state governments, and dissuade companies from enacting such policies (Grobe, 2004). According to Huffman, many companies refuse to label their food products, because of the cost, specifically the expense of testing, segregating crops, and the monitoring of the authenticity of such labels (2004). Critics argue that the Project offers already enough transparency as it specifically indicates “Non-GMO” and displays the threshold for GMO contamination (Bain & Selfa, 2017). However, the reliance on testing and thresholds implies there is some level of GMO contamination, and therefore products may not actually be non-GMO. In his article, Mol emphasizes that “value chain transparency will only execute its transformative powers towards sustainability ... when those meant to use the disclosed information have access to and literacy regarding this information” (2015). More consistent reporting and research is necessary for consumers, including farms, buyers, food producers, scientists, and lawmakers, to make decisions (Steiner & Bird, 2008). This confirms the necessity of more testing and reliable labeling to give consumers an informed judgment.

Labeling Regulation

In 1999, government departments asked The Royal Society of Canada to create the Expert Panel on the Future of Food Biotechnology to evaluate and monitor Canada’s ability to regulate GMOs. In 2001, the Expert Panel criticized the existing system and formed 53 recommendations to reform the regulatory system (Canadian Biotechnology Action Network, 2015). Up until today, only two recommendations have been fully implemented. To confront and prevent companies from freely pasting a “Non-GMO” label on their food products, the Canadian General Standards Board ratified a national standard for the voluntary labeling and advertising of foods that are and are not products of genetic modification in 2004 (Public Services and Procurement Canada, 2004). However, the Non-GMO Project established a standard on an inaccurate

definition of a GMO, allowing any company to use their logo as a seal for GMO avoidance, circumventing Canadian laws (Campbell, 2018). Additionally, the CFIA plays a role in monitoring Canadian food labels under the standards of the *Food and Drug Act* and *Consumer Packaging and Labeling Act* to ensure truthfulness (Louden & Macrae, 2010). Once the CFIA certifies a specific GM crop, it is classified as a plant with the novel trait (PNT) and undergoes an environmental inspection. The assessment contains approximately ten scientists that check information and raw field test statistics on the PNT from data provided by the applicant, published documents, technical papers, or international reports. However, problems do exist in the process. For example, the CFIA does not evaluate the accuracy of the assessment, as Researcher Andree says, nor does it assess the long-term, cumulative effect of the GMO (2002). Other professionals state that the information is also concealed from the public, illustrating the lack of transparency in the regulation of labeling in Canada (Canadian Biotechnology Action Network, 2015). This shows that critical improvement in Canada’s labeling regulation system to ensure better accuracy of labels.

Method

To answer the question, a quantitative experimental case study and then a thematic analysis was done. The concerns emphasized in the previous section will be analyzed using data from samples of tofu produced in North America and stamped with the non-GMO labels. Five different samples of tofu were chosen for this experiment, two of which had the non-GMO Project Verified label, another two which had their own non-GMO labels, and one that had no label.

All trials will be done by polymerase chain reaction (PCR). A PCR instrument was selected in this study for the following purposes: firstly, the PCR technique repeatedly copies DNA samples of products to ensure detection, quantitation, and accuracy (Foodchain ID, 2018). This amplification confirms the sensitivity and specificity in the PCR detection method. Secondly, a PCR approach is practical, reproducible and sensitive enough to detect up to 0.1% of GMOs in food products (Alasaad et al., 2016). Thirdly, the PCR test detects for a promoter from the Cauliflower Mosaic

Virus (CMV 35s), an icosahedral virus, and an insecticide gene extracted from *Bacillus thuringiensis* (Cry1F), in which a substantial number of transgenic crops, including tofu, have (Cankar et al., 2005).

Data Collection

Following Al-Salameen et al.'s model (2012) on the detection of GMOs in Kuwait's food market, five different brands of tofu were purchased to be examined with PCR. A positive test control sample was present that provided an example of a successful genomic DNA purification for soybean extractions. Two kits were bought, with each kit allowing for a maximum of 25 reaction trials. Five trials were used as a test-run and thirty trials were used to analyze all tofu product. The selected tofu were Sakura Fresh Silken Tofu, House Foods Premium Firm Tofu, Pulmuone Organic Tofu, T&T Soft Tofu, and Sunrise Premium Soft Tofu.

DNA Extraction

Before beginning the procedure, 14 tubes of 800 μ L NaCl solution, 13 tubes of 110 μ L of Universal DNA Buffer, isopropanol, and 70% ethanol were prepared. Additionally, 200 μ L of DNA Extraction Buffer was mixed with each tube of Proteinase K and placed back into the DNA Extraction Buffer container as the Proteinase K dissolved. In each trial, a small piece of tofu was extracted from the entity, smashed and transferred to a microcentrifuge tube using a micropipette until it reached the 0.1 mL mark. 400 μ L of DNA extract buffer was added to the tube and ground with a micropestle until no sizable pieces remained. Once finished, the food sample flicked to mix components together and incubated at 56 °C for 15 minutes. 300 μ L of NaCl solution was added to the tube and flicked for 30 seconds to mix solutions. The food sample was then centrifuged at full speed for 5 minutes. Once completed, the supernatant was transferred into a new microcentrifuge tube using a micropipette. Equal volume of room-temperature isopropanol was inserted into the supernatant to precipitate the DNA. The tube was incubated at room temperature for five minutes and then centrifuged at full speed for another five minutes. Once finished, the supernatant was removed, leaving a small DNA pellet at the bottom of the tube. The pellet was then

washed by adding 500 μ L of 70% ethanol to the tube and centrifuged at full speed for 2 minutes. The supernatant was removed and the tube, left with the pelleted DNA, was dried for 5 minutes. Afterwards, the pellet was resuspended in 50 μ L of Universal DNA Buffer by pipetting up and down several times and placed in ice.

PCR Amplification

Next, 20 μ L GMO primer mix (yellow), 5 μ L of extracted DNA and a PCR EdvoBead Plus was added to a 0.2 mL PCR tube and then mixed until everything completely dissolved into a light orange hue. The tube was centrifuged for a few seconds to obtain the sample at the tube's bottom and then the DNA was amplified using PCR by (1) denaturation 94 °C for 5 minutes; (2) 94 °C for 60 seconds, 58 °C for 60 seconds, and 72 °C for 60 seconds for a total of 35 cycles; (3) final extension 72 °C for 10 minutes. Once completed, the tube was placed in ice.

Electrophoresis Separation

Afterwards, agarose powder was mixed with 1X TAE buffer in a 250 mL flask and boiled in a microwave until the solution completely dissolved. After the solution cooled down to 60 °C, SYBR Safe was added and swirled. The agarose solution was poured into the gel-casting tray and watched until the gel solidified. The gel was then transferred to the electrophoresis chamber and submerged with 1X TAE Buffer. After 40 minutes, the gel was transferred into a transilluminator and the results were photographed.

Results

Each of the following six pictures show the results of the agarose gel electrophoresis of genomic DNA from five samples of extracted tofu. As shown, there were seven lanes in each photo. The first lane of every photo had the 100-base pair ladder. The 100-base pair ladder begins at the bottom, with each band 100 base pairs larger than the previous band. The second lane of each photo had the GMO positive control, except for Figure 2, that acts as a confirmation for the PCR reac-

DETECTION OF GMOS IN NORTH AMERICA IN TOFU

Figure 1: Agarose gel electrophoresis for SunRise Tofu. Lane 1 represents the 100-base ladder. Lane 2 represents the GMO positive control. Lane 3 to lane 7 represents the five tofu samples.

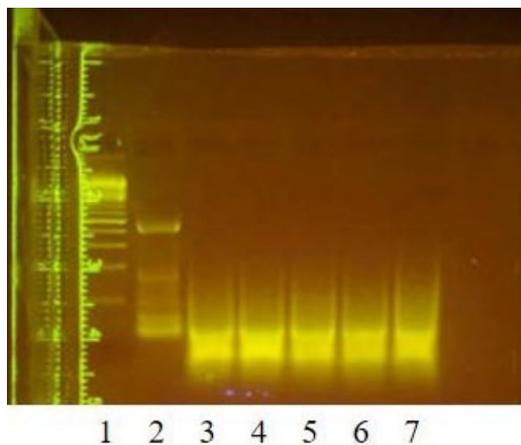


Figure 2: Agarose gel electrophoresis for House Foods Tofu. Lane 1 represents the 100-base ladder. Lane 2 to lane 6 represents the five tofu samples.

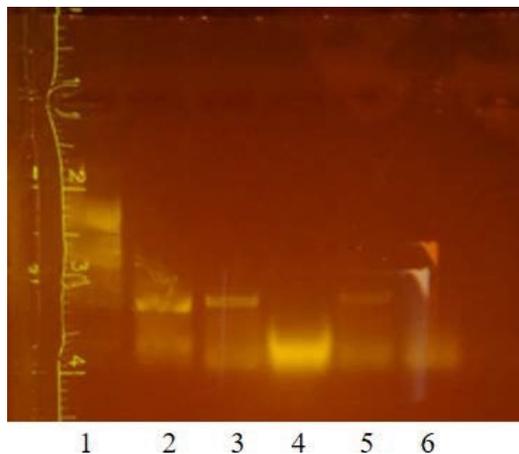


Figure 3: Agarose gel electrophoresis for T&T Supermarket Tofu. Lane 1 represents the 100-base ladder. Lane 2 represents the GMO positive control. Lane 3 to lane 7 represents the five tofu samples.

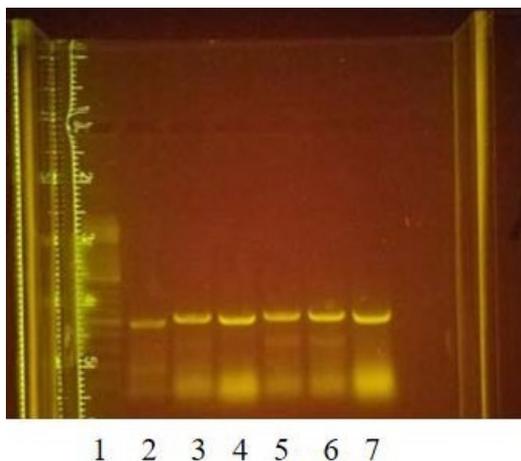
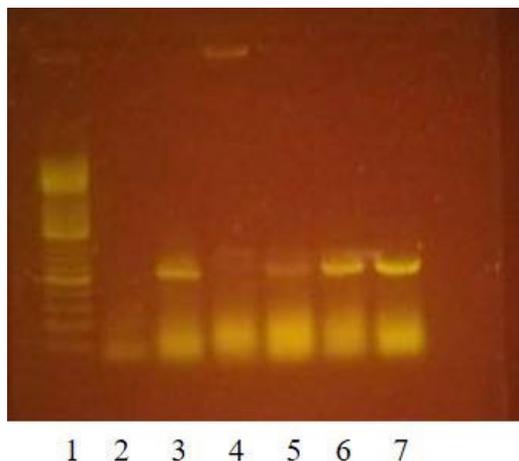


Figure 4: Agarose gel electrophoresis for Korean Food Trading LTD Tofu. Lane 1 represents the 100-base ladder. Lane 2 represents the GMO positive control. Lane 3 to lane 7 represents the five tofu samples.



tion and indicates where bands of DNA (Plant DNA, CMV 35s, and Cry1F) should have generally traveled. According to the Edvotek kit, plant DNA should be near 500 base pairs, CMV 35s should be near 200 base pairs, and Cry1F should be near 125 base pairs.

The remaining five lanes consisted of samples of the specified tofu product except for Figure 6, which included a sample of each of the five tofu products in every lane. This was done to summarize the results and get a comparison of the DNA in the tofu products.

DETECTION OF GMOS IN NORTH AMERICA IN TOFU

Figure 5: Agarose gel electrophoresis for Sakura Tofu. Lane 1 represents the 100-base ladder. Lane 2 represents the GMO positive control. Lane 3 to lane 7 represents the five tofu samples.

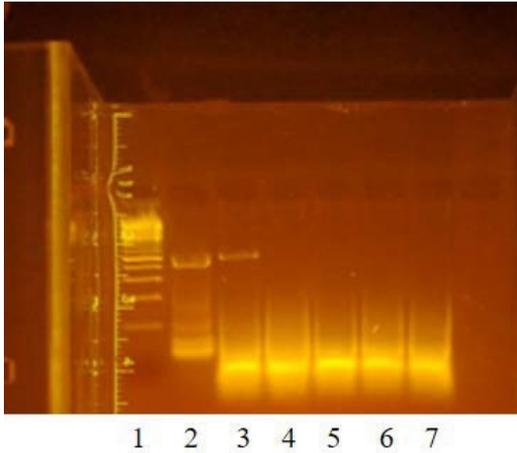


Figure 6: Agarose gel electrophoresis for blitz of all 5 different tofu samples. Lane 1 represents the 100-base ladder. Lane 2 is the GMO positive control. Lane 3 is Korean Premium Tofu. Lane 4 is SunRise Soft Tofu. Lane 5 is Sakura Fresh Silken Tofu. Lane 6 is House-Foods Firm Tofu. Lane 7 is T&T Soft Tofu.

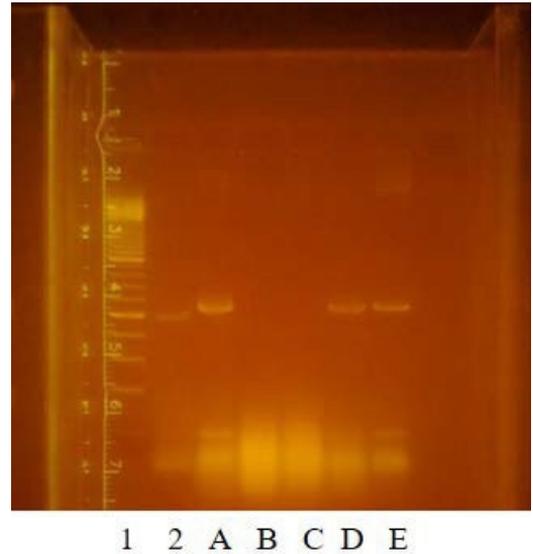


Table 1 (right): Table of all 25 samples used during the experiment. Illustrates the sample name, the manufacturing company, where it was processed, the label(s) on the product, and the length of DNA fragments after electrophoresis. N/A means no band was detected

DETECTION OF GMOS IN NORTH AMERICA IN TOFU

Sample No.	Sample	Company of Production	Place of Origin	Type of Non-GMO/Organic Label (as shown on product)	Length of Plant Chloroplast Gene (bp)	Length of Cauliflower Mosaic Virus Gene (bp)	Length of Bacillus Thuringiensis Gene (bp)
1	SunRise Soft Tofu	SunRise Soya Foods	Canada	No Label	N/A	N/A	N/A
2	SunRise Soft Tofu	SunRise Soya Foods	Canada	No Label	N/A	N/A	N/A
3	SunRise Soft Tofu	SunRise Soya Foods	Canada	No Label	N/A	N/A	N/A
4	SunRise Soft Tofu	SunRise Soya Foods	Canada	No Label	N/A	N/A	N/A
5	SunRise Soft Tofu	SunRise Soya Foods	Canada	No Label	N/A	N/A	N/A
6	HouseFoods Firm Tofu	House Foods American Production	United States of America	Non-GMO Project Verified Label	505	N/A	130
7	HouseFoods Firm Tofu	House Foods American Production	United States of America	Non-GMO Project Verified Label	510	N/A	120
8	HouseFoods Firm Tofu	House Foods American Production	United States of America	Non-GMO Project Verified Label	N/A	N/A	120
9	HouseFoods Firm Tofu	House Foods American Production	United States of America	Non-GMO Project Verified Label	510	N/A	120
10	HouseFoods Firm Tofu	House Foods American Production	United States of America	Non-GMO Project Verified Label	510	N/A	120
11	T&T Soft Tofu	T & T Supermarket	Canada	Non-GMO Project Verified Label	500	N/A	125
12	T&T Soft Tofu	T & T Supermarket	Canada	Non-GMO Project Verified Label	500	N/A	125
13	T&T Soft Tofu	T & T Supermarket	Canada	Non-GMO Project Verified Label	500	N/A	125
14	T&T Soft Tofu	T & T Supermarket	Canada	Non-GMO Project Verified Label	500	N/A	125

DETECTION OF GMOS IN NORTH AMERICA IN TOFU

15	T&T Soft Tofu	T & T Supermarket	Canada	Non-GMO Project Verified Label	498	N/A	125
16	Korean Premium Tofu	Korean Food Trading LTD	United States of America	Own Non-GMO Label	500	N/A	120
17	Korean Premium Tofu	Korean Food Trading LTD	United States of America	Own Non-GMO Label	500	N/A	125
18	Korean Premium Tofu	Korean Food Trading LTD	United States of America	Own Non-GMO Label	500	N/A	125
19	Korean Premium Tofu	Korean Food Trading LTD	United States of America	Own Non-GMO Label	500	N/A	125
20	Korean Premium Tofu	Korean Food Trading LTD	United States of America	Own Non-GMO Label	500	N/A	120
21	Sakura Fresh Silken Tofu	Sakura	Canada	Own Non-GMO Label	500	N/A	N/A
22	Sakura Fresh Silken Tofu	Sakura	Canada	Own Non-GMO Label	N/A	N/A	N/A
23	Sakura Fresh Silken Tofu	Sakura	Canada	Own Non-GMO Label	N/A	N/A	N/A
24	Sakura Fresh Silken Tofu	Sakura	Canada	Own Non-GMO Label	N/A	N/A	N/A
25	Sakura Fresh Silken Tofu	Sakura	Canada	Own Non-GMO Label	N/A	N/A	N/A

Analysis

In all six figures shown above, it is evident that the agarose gel is separated into three main sections: the first for the 100-base ladder (beginning from the bottom), the second for the GMO positive control, and the third for the tofu samples. The GMO positive control displays three distinct bands: a 500 bp band to represent the plant chloroplast gene, a 200 bp band to represent the CMV 35s promoter, and a 125 bp band to indicate the Cry1F gene. In this experiment, the results of five different types of tofu prod-

ucts were compared after undergoing electrophoresis to show the nature of the non-GMO Project Verified Label in the tofu industry. Five contrasting tofu were used: SunRise Soft Tofu (Figure 1), HouseFoods Firm Tofu (Figure 2), T&T Soft Tofu (Figure 3), Korean Premium Tofu (Figure 4), and Sakura Fresh Silken Tofu (Figure 5).

Figure 1 shows the gel electrophoresis for SunRise Soft Tofu. As shown, the only bands that were available were under the first bp band (100 bp). These bands were also very similar in traveling distance of about 42 mm and base pairs of about 0. This meant that it

DETECTION OF GMOS IN NORTH AMERICA IN TOFU

Table 2: Results of the final blitz of 5 tofu samples. Illustrates the sample name, the manufacturing company, where it was made, the label(s) on the product, the length of DNA fragments after electrophoresis, and the distance travelled by the DNA. N/A means no band was found.

Sample No.	Sample	Company of Production	Place of Origin	Type of Non-GMO/Organic Label (as shown on product)	Length of Plant Chloroplast Gene (bp)	Length of Cauliflower Mosaic Virus Gene (bp)	Length of Bacillus Thuringiensis Gene (bp)	Distance Travelled by bands (Plant DNA, CMV 35s, Cry1F) in mm
A	Korean Premium Tofu	Korean Food Trading LTD	United States of America	Own Non-GMO Label	505	N/A	125	42/0/62
B	SunRise Soft Tofu	SunRise Soya Foods	Canada	No Label	N/A	N/A	N/A	0/0/0
C	Sakura Fresh Silken Tofu	Sakura	Canada	Own Non-GMO Label	N/A	N/A	N/A	0/0/0
D	HouseFoods Firm Tofu	House Foods American Production	United States of America	Non-GMO Project Verified Label	505	N/A	110	42/0/64
E	T&T Soft Tofu	T & T Supermarket	Canada	Non-GMO Project Verified Label	510	N/A	115	41/0/63

did not have the CMV 35s promoter, which occurs at around 200 bp, nor the Cry1F gene, which occurs at around 125 bp. However, it can also be observed that the PCR did not detect any plant chloroplast in SunRise Tofu as indicated in Table 1. This meant that the results for this tofu were invalid because it had no useable DNA.

Figure 2 displays the gel electrophoresis for HouseFoods Firm Tofu. As shown, the plant chloroplast was detected in four of the five tofu samples (Table 1). Furthermore, all five samples were shown to have DNA bands near the 125 bp Cry1F band location. The first lane consisted of a band around 130 bp, while the other four lanes had bands of about 120 bp as listed in Table 1.

Figure 3 illustrates the gel electrophoresis for T&T Soft Tofu. As shown, all tofu lanes had clear plant chloroplast band and a Cry1F band. Some of the lanes also had bands that were approximately 400 bp (Table 1). Furthermore, all bands have a similar mitigated distance of about 55 mm (Figure 3).

Figure 4 shows the gel electrophoresis for Korean Premium Tofu, which has a similar trend to that of T&T Soft Tofu. Apart from Lane 4, all other four lanes of Korean Premium Tofu displayed two distinct bands, one of which highlights the plant chloroplast

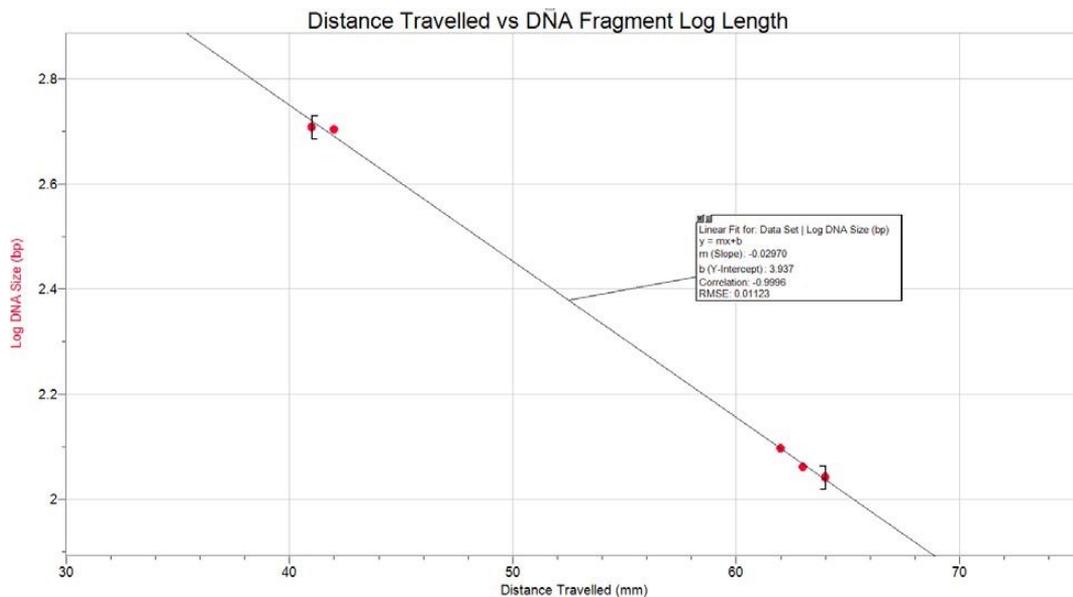
gene and the other which depicts the Cry1F gene present in the tofu. Lane 3 and Lane 7 appeared to have a Cry1F band of about 120 bp while Lane 4, 5, and 6 presented a Cry1F band of about 125 bp.

Figure 5 features the gel electrophoresis for Sakura Tofu, which is similar to that of SunRise Soft Tofu. Only Lane 3 indicates a plant chloroplast gene in Sakura Tofu while the other lanes consist of bands not in line with the plant chloroplast or Cry1F gene. Therefore, there is not enough physical evidence to justify that Sakura Tofu consists of no GMOs and can be considered “unknown.” It is evident that no tofu product tested for the CMV 35s gene.

After the 25 samples were tested and photographed, a blitz of the five tofu products went through a final gel electrophoresis alongside each other as shown in Figure 6. As seen in Table 3, Korean Premium Tofu (Lane 1), Housefoods Firm Tofu (Lane 4), and T&T Soft Tofu (Lane 5) all had GMOs ingredients in them, while the remaining two tofu products had no gene detected by the PCR, confirming and supporting the results obtained from the first 25 trials of tofu in Table 2.

DETECTION OF GMOS IN NORTH AMERICA IN TOFU

Figure 7: A semi-log graph that illustrates distance mitigated by DNA fragments of all 5 final blitz tofu samples in 2.0% agarose gel.



With these results, a semi-log graph with a relationship between the distance mitigated in millimeters (X-axis) and DNA fragments base pair lengths (Y-axis) was constructed as shown in Figure 7. The graph allows us to make an accurate estimate of how large an unknown band is just by knowing how far it has traveled. The points were a collection of the distance traveled by all the DNA fragments in Table 2. As shown, there is a negative correlation between the distance traveled and the Log DNA Length, illustrating that the greater the size of the DNA, the less distance it travels.

Discussion

Although the results produced in this experiment were in line with the starting hypothesis, it did offer some unexpected outcomes. It was predicted that there was a high chance of the non-GMO labeled tofu products to contain GMOs due to the poor supervision on these labels. From the results shown in Figure 1 to Figure 6, it is evident that the hypothesis regarding company mislabeling was experimentally proven

correct. Out of the five tofu products that were used for the experiment, three were shown to have contained GMOs despite having a non-GMO label. Surprisingly, out of all the 25 samples of tofu that were conducted in the experiment, none had shown to have contained the CMV 35s promoter gene. Furthermore, the remaining two products showed no results for any DNA genes when using the PCR, not even the plant chloroplast gene. One possible explanation for this is due to the fermentation process in the creation of tofu. Fermentation involves chemically breaking down substances through using microorganisms (Alford et al., 1999). In a study conducted by Walker et al. on DNA genes and wine fermentation, they mentioned that fermentation caused nutrient depletion, suggesting that the fermentation process may have disturbed the DNA in the tofu and broke it down, making it undetectable by the PCR (Walker et al., 2014). Furthermore, the results in the experiment were unexpected as both products labeled with the non-GMO Project Verified label, an acclaimed seal in both Canada and the United States, turned out to contain GMOs.

Limitations

After concluding the research process and gathering the findings, there are several limitations that need to be considered. The largest limitation lies in the Edvotek PCR kit used to analyze the tofu products. The PCR instrument that was purchased was limited to detecting up to only two primers that would illustrate the presence of GMOs, a promoter of CMV 35s or an insecticide gene extracted from Cry1F. Therefore, if the product consisted of any other GMO gene, the PCR kit would not have picked it up, potentially creating some discrepancies in my results. Furthermore, the supplies provided in the two purchased kits allowed for a maximum of 50 test trials. However, due to human error and time, only 30 trials were effective and applicable. This added a limitation on the number of tofu available to test while still maintaining enough results for each product. Given this limitation, the study may have missed opportunities for a more extended analysis. However, because the study exemplified evidence of some non-GMO labeled tofu products to contain GMOs, the results still offer crucial insight into the deception of food companies.

An additional limitation was the scope of the study. Because it was narrowed down to specifically tofu, the findings were unable to be generalized to all foods in North America, and therefore, limiting the implications of my conclusions.

Lastly, to make tofu, it must undergo a fermentation process. This would have broken down the DNA genes in tofu and made it undetectable. It is possible that this risk in using tofu led to inaccurate results.

Future Research

The results and conclusions for this experiment have the potential for future research to address these limitations. Since the results of the DNA found after electrophoresis were mostly blurry and unclear, reproducing this experiment using 1X TBE buffer instead of 1X TAE buffer can possibly lead to a more profound and clearer separation of DNA bands as TBE is a better conductive medium than TAE and used for fragments that are less than 2kb (Oswald, 2017).

TBE buffer would also produce a higher resolution for small DNA fragments than TAE (Miura et

al., 1999). Furthermore, since the tofu products tested were strictly made in Canada or the United States, replicating the experiment with tofu made in a diversity of different countries can lead to a greater range of results and the opportunity for further analysis. Or, since tofu has the potential risk of undergoing fermentation, repeating this experiment with a variety of food products (corn, papaya, etc.) with the non-GMO Project Verified Label can indicate a more generalized result that can be applicable and better test for the accuracy of non-GMO labels.

Conclusion

The results of this experiment clearly summarized that consumers are buying “non-GMO” products still containing GMOs that were initially said to not have. Therefore, the implications of this study are clear. Authorities across North America must be monitored and make a greater effort at regulating what gets placed on the foods distributed throughout the continent. Furthermore, with Canada and the USA being two leading producers in biotech groups (James, 2011), it can also be concluded that this sort of false advertising or mislabelling must also occur on products other than tofu. The use of GMOs across the world is rising exponentially, either because of the opportunity to create a near-perfect food product at a cheap cost or save millions of lives from hunger, malnutrition, and starvation (Toft, 2012). Through enforcing these applications in the future, consumers will be given the insightful understanding and truthful information they deserve for what they eat, just like what the Canadian Federal Inspection Agency has promised to do.

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DETECTION OF GMOS IN NORTH AMERICA IN TOFU

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Comparing the Anti-Drug Abuse Act of 1986 to the Boggs Act of 1951 and the Narcotic Control Act of 1956 in Levels of Severity

Norah Khadraoui

The first mandatory minimums for narcotics were the Boggs Act of 1951 and the Narcotic Control Act of 1956 created due to increasing drug abuse rates. In 1970 Congress repealed the laws stating that they were too harsh and ineffective. Sixteen years later the Anti-Drug Abuse Act of 1986, a new mandatory minimum, was passed. I conducted a content analysis comparing the severity of sentencing from the aforementioned laws to establish if Congress repeated the same policy. I ran a chi-square test for homogeneity and found that the laws were dissimilar in severity. My results showed that the laws of the 1980s were more severe compared to the 1950s, which supports that Congress overlooked its prior findings concerning mandatory minimums and repeated the ineffectiveness of previous laws on a larger scale. This research supplements the larger body of work that indicates that the Anti-Drug Abuse Act is inadequate.

Keywords: The Boggs Act of 1951, The Narcotic Control Act of 1956, The Anti-Drug Abuse Act of 1986, mandatory minimums

INTRODUCTION

Congress has the power to pass sentencing laws that can, directly and indirectly, impact the American people. This makes it incredibly important that Congress put careful consideration into its sentencing policy as it affects millions of people. The following is an in-depth analysis to if Congress repeated the same sentencing policy with three narcotics-related mandatory minimum laws and if Congress repeated the same mistakes of the past.

LITERATURE REVIEW

I. The Emergence of Drug Mandatory Minimums

Over the course of American history, federal drug enforcement and criminalization have increased in severity. Before the 20th century, there was no federal regulation of highly addictive opium and it was distributed freely, especially to soldiers. After drug abuse and addiction became more rampant, the effects triggered the federal government to become involved. In response to these escalating rates in drug abuse, the Narcotic Drugs Import and Export Act created the Federal Narcotics Control Board (FNCB) which

oversaw the import and export of drugs.¹ Rising drug abuse was also the cause of the emergence of drug-related mandatory minimums with the ideology that tougher penalties will deter drug trafficking.²

Mandatory minimums are statutory requirements made by Congress that a person convicted of a specific offense, involving a certain drug and quantity, will receive a minimum sentence requirement no matter the circumstances. In the mid 20th century, the Senate Special Committee to Investigate Organized Crime in Interstate Commerce revealed a growing trend in American society to Congress—drug addiction and trafficking among young people. Champion for drug-related mandatory minimums, Federal Bureau of Narcotics Commissioner—Harry J. Anslinger—argued that soft-hearted judges were to blame for the high addiction rates and that young addicts needed longer sentences rather than rehabilitation because he believed drug addiction was a contagious disease akin to smallpox.³ During the mid 20th century, little was understood about drug addiction as compared to today; it was not surprising that Anslinger's ideas were popular, especially among Congress members, to show their constituents that they were “tough on crime.”

The Boggs Act of 1951—an amendment to the Narcotic Drugs Import and Export Act and the first codified mandatory minimum sentences for the possession or sale of narcotics—passed easily in Congress. The intent of mandatory minimums such as the Boggs Act was to discourage drug use, lower judicial discretion, and discourage drug trafficking to promote a safer, drug-free environment. A first offense for the Boggs Act carried a minimum of 2-5 years in prison, a second offense carried prison terms of 5-10 years, a third offense carried a sentence of 10-15 years. The Boggs Act most notably made no distinction between

drug users and drug traffickers for purposes of sentencing. Four years after the enactment of the Boggs Act, a Senate subcommittee concluded in a published report that drug addiction is contagious and addicts should be confined to prevent it from spreading to others.⁴ The solution became a compulsory treatment where the addict would be put in isolation, usually in prisons. Throughout the 1950s, the Boggs Act was amended to allow a life sentence or death penalty for those who committed a third offense.⁵ This led to a nationwide movement where states started to impose their own mandatory minimums nicknamed “Little Boggs Acts.”⁶ The Narcotic Control Act of 1956, another amendment to the Narcotic Drugs Import and Export Act, increased penalties for drug offenses and established the death penalty as punishment for selling heroin to youths while lowering chances of parole. Despite this, reports in the 1950s found that the U.S. drug addiction rates were higher than any other Western nation.⁷

II. The Repeal of Drug Mandatory Minimums

In the 1960s, support for severe punishment of drug offenses waned. A more medical—rather than punitive—approach was favored with organizations such as the American Bar Association (ABA) speaking out against strict punishment. In 1963, the Presidential Commission on Narcotic and Drug Abuse issued a report, under President Kennedy's request, recommended more funds for narcotic research, less strict punishment for drug offenses, and the dismantling of the Federal Bureau of Narcotics which was created in the 1930s.⁸

The government heeded the recommendations as well as created the Bureau of Drug Abuse Control

1 Thomas M. Quinn, “The Evolution of Federal Drug Control Legislation,” *Catholic University Law Review* 22, no.3 (1973): 588.

2 *Ibid.*, 602.

3 Molly M. Gill, “Correcting Course: Lessons from the 1970 Repeal of Mandatory Minimums,” *Federal Sentencing Reporter* 21, no.1 (2008): 57.

4 Gill, “Correcting Course,” 57.

5 Henry S. Wallace, “Mandatory Minimums and the Betrayal of Sentencing Reform: A Legislative Dr. Jekyll and Mr. Hyde,” *Journal of Correctional Philosophy and Practice* 57, no.3 (1993): 9.

6 *Ibid.*

7 Gill, “Correcting Course,” 57.

8 Lisa N. Sacco, “Drug Enforcement in the United States: History, Policy, and Trends,” *Congressional Research Service*, (2014): 57.

within the Department of Health, Education, and Welfare.⁹ President Kennedy then began to use his pardoning power to provide commutations to drug offenders who he believed to have had an excessive sentence and were not eligible for parole under the Narcotic Control Act.¹⁰ Then in 1969, President Nixon stepped into office and called for changes in federal drug control laws. Nixon's appointees, as well as Congress, began criticizing the effectiveness of mandatory minimums. Mandatory minimums were criticized for treating casual violators as severely as kingpins, increasing prosecutorial power, and interfering with judicial discretion and the judges' role of making individualized sentences. This led to the Controlled Substances Act of 1970, which repealed mandatory minimums and created a comprehensive system of scheduling drugs for federal drug control which had bipartisan support including then-Congressman George H.W. Bush.¹¹ Congressman Bush argued that mandatory minimums were not a useful tool and reducing the sentences could lower the drug crime rate because the courts would be able to make more equitable actions. The Controlled Substances Act of 1984 had three goals: to rehabilitate drug addicts rather than punish, provide better tools to law enforcement when investigating drug trafficking, and to make the sentences fit the crime. This act also established the Federal Sentencing Guidelines, a nonmandatory guide for judges towards a sentence based on two factors: the offense level and criminal history.¹²

III. The Resurgence of Drug Mandatory Minimums

In the 1970s, marijuana, heroin, and cocaine use rose to the point where the Nixon administration determined that 1.3% of the population was addicted to drugs. This led to Nixon's famous declaration

9 *Ibid.*, 5.

10 Gill, "Correcting Course," 57.

11 Quinn, "The Evolution," 165.

12 Refer to Appendix I for more information about the Federal Sentencing Guidelines

13 Deborah Small, "The War on Drugs Is a War on Racial Justice", *Social Research* 68, no. 3 (2001): 898.

14 Matthew C. Lamb, "A Return To Rehabilitation: Mandatory Minimum Sentencing in an Era Of Mass Incarceration", *Journal of Legislation* 41, no. 1 (2015): 126.

15 Sacco, "Drug Enforcement", 9.

16 See Appendix II for Exceptions to Mandatory Minimums

of the War on Drugs in 1971—a federal campaign whose stated aim was to reduce the drug abuse rates. However, there is debate if curbing drug abuse was the intention or if the War on Drugs was for political gain.¹³ This War on Drugs later proved to have disastrous effects on minority communities, especially in black communities, in particular with the rise of the crack epidemic in the 1980s. Crack cocaine was revolutionary as it was cheaper than powder cocaine and more easily transported. As a result, it grew rampant in major cities. The catalyst was the death of Len Bias, a basketball star from the University of Maryland who died of a crack overdose that shook the country. Congress wasted no time responding to headlines regarding this healthy young man's death. The House Judiciary Committee drafted and passed the Anti-Drug Abuse Act of 1986, a new mandatory minimum in less than one week. This resurgence of mandatory minimums also stemmed from concerns about the amount of judicial discretion in sentencing.¹⁴ The Anti-Drug Abuse Act established two factors for mandatory minimum terms: drug quantity and type.¹⁵ It also made harsher penalties for crack cocaine and triggered even more mandatory minimums to be passed shortly afterward. These minimums are still in place today with little exceptions.¹⁶

IV. A Gap In The Way We Understand Mandatory Minimums

There has been a lack of acknowledgment by Congress that the use of mandatory minimums to lower drug abuse rates has been tried—with the Boggs Act of 1951 and Narcotic Control Act of 1956—and failed to be effective in curbing drug use. This lack of acknowledgment as evidenced by Vice President Henry Wallace in his article, "Mandatory Minimums and the Betrayal of Sentencing Reform: A Legislative Dr.

Jekyll and Mr. Hyde” when stating, “there was not a word of acknowledgment of the momentousness of the undertaking—not a word explaining why the lessons of the failure of the Boggs Acts were now being ignored.”¹⁷ Researchers, such as Molly M. Gill—a lawyer, advocate, expert on sentencing law and policy, and Vice President of Policy for Families Against Mandatory Minimums (FAMM)—have pointed out the similarities between the Boggs Act, Narcotic Control Act, and the Anti-Drug Abuse Act. However, research has yet to be conducted to determine if these laws are as similar as they may seem. By identifying the similarities between the mandatory minimum laws of the 1950s and the laws of the present with the Anti-Drug Abuse Act of 1986, it can be determined whether or not Congress is repeating the same mistake they committed in the past and if the Anti-Drug Abuse Act is effective.

METHOD

For the purposes of focusing on narcotic mandatory minimums, I analyzed Subtitles A, B, and G of the Anti-Drug Abuse Act, which all revolve around narcotics-related mandatory sentencing. To compare the Anti-Drug Abuse Act with the laws of the 1950s, I used the following amendments to the Narcotic Drugs Import and Export Act: the Boggs Act and specifically Title I and II of the Narcotic Control Act of 1956 as they pertain to narcotics-related mandatory sentencing. I conducted a conventional mixed method content analysis with three categories of low, medium, and high severity sentences. The maximum sentence present in the laws is “life.” Since a life sentence is not a set number, the second longest sentence, which was 40 years, will be used for the purpose of calculating the range of years for each category. I calculated the median, first quartile, and third quartile range of the span of years that the laws had had which was from 0 years to 40 years. The median was at 20 years, the first quartile was at 10 years, and the third quartile was at 30 years. Thus, the year range for low severity is 0 years to 10 years, medium severity is 10 to 30 years, and high severity is 30 years to life. If a sentence overlaps with multiple categories, then the sentence was

counted for every category it fell into. A single sentence range could count up to three times.

I chose a content analysis because content analyses commonly compare different bodies of texts and the coding categories are derived directly from the text data. I started coding by reading the specified sections of the laws three times to achieve a sense of the whole law and then highlighting the sentences that capture one of the three levels of severity. After compartmentalizing the contents of the laws into the three categories, I began to compare the similarities of the laws. Mixed method research would fit best for this because I needed the explorative categories and interpretive aspects of a qualitative method; I also needed the quantitative methods in order to evaluate the relationship between the laws. I needed to quantify how much of each category is present in the laws in order to compare their similarities using the chi-square test for homogeneity. Using a chi-square test, I was able to test the three categorical variables from the different laws and determine whether frequency counts were distributed identically across the laws. I conducted the chi-square test using a chi-square test calculator from the website Socscistatistics, a statistical resource for social scientists.

RESULTS

The Boggs Act had six sentences total for the transportation, concealment, or sale of any narcotic drugs. To determine the number of offenses the offender has committed, the prosecution not only takes into account the previous violations from this Act but also section 2557 (b) (1) of the Internal Revenue Code which outlines the same offense for the Boggs Act. Offenders found guilty of section 2557 (b) (1) of the Internal Revenue Code before being charged with the Boggs Act could be charged by the prosecution for violating the Boggs Act as a second offense and vice versa for the Internal Revenue Code. The relationship between the Boggs Act and the Internal Revenue Code explains why the sentences were repeated to show the penalties for violating the Boggs Act and then the Internal Revenue Code. The first offense and second offense penalties are considered low severity, and the third or subsequent offense is medium severity.

¹⁷ Wallace, “Mandatory Minimums,” 10.

COMPARING THE ANTI-DRUG ABUSE ACT, THE BOGGS ACT AND THE NARCOTIC CONTROL ACT

Table 1: Boggs Act

Low Severity	Medium Severity	High Severity
2-5	10-20	N/A
5-10	10-20	
2-5		
5-10		

Table 1 displays the mandatory minimum ranges. For example, “2-5” stands for not less than 2 years or more than 5 years. The Boggs Act has 6 total sentences with 4 low severity and 2 medium severity.

The Narcotic Control Act has 15 sentences total with 9 low severity, 11 medium severity, and 6 high severity. Table 2 below is the Narcotic Control Act sentences broken down by severity and section.

As for the Anti-Drug Abuse Act, it had a total of 27 sentences with 10 low severity, 18 medium severity, and 20 high severity. Table 3 is the Anti-Drug Abuse Act broken down by severity and section.

I combined the Boggs Act and Narcotic Control Act because they are both amendments to the Narcotic

Table 2: Narcotic Control Act

Low Severity	Medium Severity	High Severity
Title I violations of laws relating to narcotic drugs and marihuana*	Title I violations of laws relating to narcotic drugs and marihuana	Title I violations of laws relating to narcotic drugs and marihuana
2-10	5-20	10-40
5-20	10-40	10-40
5-20	5-20	10-40
Not more than 5	10-40	
	10-40	
Importation etc. of narcotic drugs	Importation etc. of narcotic drugs	Importation etc. of narcotic drugs
5-20	5-20	10-40
5-20	10-40	10-40
	5-20	
	10-40	
Unlawful possessions of narcotic drugs and marihuana on vessels	Unlawful possessions of narcotic drugs and marihuana on vessels	Unlawful possessions of narcotic drugs and marihuana on vessels
Not more than 5		
5-20	5-20	10-40
	10-40	
Title II amendments to title 18 of USC addition of new chapter-narcotics	Title II amendments to title 18 of USC addition of new chapter-narcotics	Title II amendments to title 18 of USC addition of new chapter-narcotics
2-5	N/A	N/A

*In the Narcotic Control Act marijuana is spelled marihuana

COMPARING THE ANTI-DRUG ABUSE ACT, THE BOGGS ACT AND THE NARCOTIC CONTROL ACT

Table 3: Anti-Drug Abuse Act

Low Severity	Medium Severity	High Severity
Subtitle A Narcotics Penalties and Enforcement short title	Subtitle A Narcotics Penalties and Enforcement short title	Subtitle A Narcotics Penalties and Enforcement short title
5-40	10-life	10-life
Not more 20	20-life	20-life
Not more than 20	20-life	20-life
Not more than 30	5-40	Life
	20-life	5-40
	10-life	20-life
	Not more 20	10-life
	20-life	Life
	Not more than 30	20-life
		Life
Simple possession	Simple possession	Simple possession
Not more than 1 year	N/A	N/A
15 days to 2 years		
90 days to 3 years		
Subtitle G controlled substances import and export short title	Subtitle G controlled substances import and export short title	Subtitle G controlled substances import and export short title
5-40	10-life	10-life
Not more 20	20-life	20-life
Not more than 20	20-life	20-life
Not more than 30	5-40	20-life
	20-life	Life
	10-life	5-40
	Not more 20	20-life
	20-life	10-life
	Not more than 30	Life
		20-life
		Life

COMPARING THE ANTI-DRUG ABUSE ACT, THE BOGGS ACT AND THE NARCOTIC CONTROL ACT

Drugs Import and Export Act to become one population of data and the other population for the statistical test was the Anti-Drug Abuse Act. The amendments of the Narcotic Drugs Import and Export Act has 13 low severity, 13 medium severity, and 6 high severity sentences. After being put into the chi-square test calculator from socsistatistics, the results came out to be statistically significant regarding the severity of the sentences. This means that the frequency counts of the severity of the sentences are not distributed identically across the laws. The p-value came to .03962 with the standard of statistical significance being at a p-value less than .05. With the current p-value, the null hypothesis that the laws are similar is rejected. Instead, the alternate hypothesis that the laws are dissimilar is accepted. This p-value also indicates that the chi-square statistic (the difference between the observed counts and the counts if there were no relationship in the population) overall of 6.4569, concerning the deviation of severities in sentences between the Boggs and Narcotics Control Act and the Anti-Drug Abuse Act, is statistically different.

Within the chi square test it can be observed that the differences between the chi square statistic for low and high severity between the Boggs and Narcotic Control Act and the Anti-Drug Abuse Act is very large, whereas the chi square statistic for medium severity is closer

together. These conclusions suggest that Congress has changed its sentencing policy at the extremes of the spectrum making their sentences more severe. As shown, there has been a general shift for the sentences to become more severe: with a jump from 6 high severity sentences in the 1950s to 20 in the 1980s, and the number of low severity sentences significantly decreasing from the 13 in the 1950s to 9 in the 1980s. Given this shift of more high severity sentences and less low severity, the results are evidence that the laws have become more severe. Federal sentencing laws should be carefully considered before implementation because it directly affects the lives of hundreds of thousands of people in the federal court system, but in order to appear “tough on crime,” Congress implemented harsher mandatory minimum penalties. The Narcotic Drugs Import and Export Act amendments were repealed by Congress because they deemed them as unsuccessful because of the harsh penalties, but the Anti-Drug Abuse Act is even more severe. Congress repealing the acts provides evidence that the Anti-Drug Abuse Act is ineffective. However, this conclusion comes with limitations because a firm conclusion that the Anti-Drug Abuse Act is ineffective cannot be reached with this evidence alone. Yet, it can be used as a supplement to the large body of work that argues the Anti-Drug Abuse Act is ineffective to lower drug abuse rates.

Table 4: Chi-Square Test Results

	Low Severity	Medium Severity	High Severity	Raw Totals
Boggs Act and Narcotic Control Act	13 (1.88)	13 (0.02)	6 (1.95)	32
Anti-Drug Abuse Act	9 (1.28)	18 (0.01)	20 (1.33)	47
Column Totals	22	31	26	79 (Grand Total)
		Chi square statistic: 6.4569		p-value .03962

*The numbers in the parentheses is the chi square statistic for each cell

DISCUSSION

This research reveals that the Anti-Drug Abuse Act, like its predecessors, is unsuccessful in lowering the drug abuse rates. However, this conclusion comes with limitations because a firm conclusion that the Anti-Drug Abuse Act is inadequate cannot be reached with the results of this research alone. Nevertheless, it can be used as a supplement to the large body of work that also argues that the Anti-Drug Abuse is ineffectual to lower drug abuse rates. Congress itself admitted in the 1970s that the method of mandatory minimums was not working to accomplish all its goals; yet, in the 1980s, it returned to the same methods with more severity.¹⁸ My results showed that the laws became more severe; thus, Congress essentially disregarded its prior findings concerning mandatory minimums and repeated their mistake with even higher stakes. The Anti-Drug Abuse Act created a lot of negative effects that still impact American society today. The following is an analysis of the effects of the Anti-Drug Abuse Act.

I. Effects of the Anti Drug Abuse Act

The Anti-Drug Abuse Act of 1986, still in effect today, created racial sentencing disparities with unfairly disparate sentences. One of the ways it exacerbates racial disparities is through its harsher penalties for crack cocaine than powder cocaine. Although powder cocaine and crack cocaine have little differences chemically, penalties for crack are 100 times more severe than for powder creating a 100:1 ratio between the severity of the sentence for crack cocaine to powder.¹⁹ This created large racial disparities within federal sentencing because Black offenders were more likely to use or buy crack cocaine than Whites and Whites were more

likely to use or buy powder cocaine.²⁰ Although the Fair Sentencing Act lowered the 100:1 ratio, the difference is still quite large to around 18:1.²¹ The difference between the average sentence imposed on Black offenders versus White offenders increased from 28% in 1984 to 49% in 1990.²² Deborah Small, who published an article for The Johns Hopkins University Press, drew parallels to the crack disparity to the Jim Crow Era due to the racial injustices it stimulated. Even with determining the drug quantity, there were issues within the Anti Drug Abuse Act. Police officers would measure the drug quantity based on the entire weight of the substance, not the amount of drugs itself. For example, if there were 10 grams of sugar and 5 grams of powder cocaine, the defendant would be prosecuted as if there were 15 grams of powder cocaine, further emphasizing the ineffectiveness of the Anti-Drug Abuse Act by giving unjustified longer sentences.²³

There has been debate whether mandatory minimums deter crime. The National Association of Assistant Attorneys (NAAUSA) believes that they do. As seen in their letter to the Senate Judiciary Committee in 2014, Robert Mueller, former FBI Director and current head of the Special Counsel investigation of Russian interference in the 2016 United States elections, would agree with the NAAUSA in his “Mandatory Minimum Sentencing” article. According to the Pew Charitable Trusts, serious crime has been declining for the past two decades but many criminologists concluded that incarceration has reached a tipping point where additional incarceration will not have an effect on the crime rates.²⁴

There has been an unsustainable rising population of prison inmates in the United States partly due to mandatory minimums (including for non-drug related offenses) with the 90,000 increase of federal prisoners from 1980 to 2015²⁵ and half of all federal in-

18 Quinn, “The Evolution,” 165.

19 William W. Schwarzer, “Sentencing Guidelines and Mandatory Minimums: Mixing Apples and Oranges,” *Southern California Law Review*, (1992): 409.

20 Marvin D. Free, “The Impact of Federal Sentencing Reforms on African Americans,” *Journal of Black Studies* 28, no. 2 (1997): 270.

21 Charles Doyle, “Mandatory Minimum Sentencing of Federal Drug Offenses,” *Congressional Research Service*, (2018): 4.

22 Schwarzer, “Sentencing Guidelines,” 407.

23 Barbara Meierhoefer and Paul J. Hofer, “The Consequences of Mandatory Minimum Prison Terms: A Summary of Recent Findings,” *Federal Judicial Center* 7, no. 1 (1994): 1.

24 Susan K. Urahn, “Time Served The High Cost, Low Return of Longer Prison Terms,” *Pew Center On The States*, (2012): 1.

25 “Federal Drug Sentencing Laws Bring High Cost, Low Return,” *The Pew Charitable Trusts*, (2015): 1.

mates are drug offenders (49.8%) in 2017 according to the United States Sentencing Commission (USSC).²⁶ Around 44.7% of those federal inmates were charged with a mandatory minimum. When charged with mandatory minimum laws the number of years was more than double than drug offenses without the mandatory minimum (7.8 years versus 3.5 years), and 52.8% of people who were sentenced with a mandatory minimum drug offense were sentenced to 10 years or more.²⁷ Today, probation has all but disappeared as a sanction for drug offenders and drug offenders are one of the single greatest contributors to the growth of the federal prison population.²⁸ What also worsened the growing mass incarceration rate is that federal drug sentencing laws failed to reduce recidivism with nearly one-third of the drug offenders commit new crimes or violate their probation post-release returning back to prison. It has also proven to be very expensive, 1 in 4 dollars spent by the US Justice Department is for the federal prison system around 6.7 billion per year.²⁹ It does not help that illegal drug prices have declined while illegal drug use has increased in response.³⁰ Mandatory minimums are claimed to target high-level drug dealers, but those sentenced for relatively minor roles represented the biggest share of federal drug offenders, and nearly a fifth of federal drug offenders were street dealers in 2015.³¹

There is also the concern that mandatory minimums violate separation of powers because Congress removes some judicial power when forcing judges to enforce these sentences.³² The courts and Congress differ in opinion about mandatory minimums, the courts tend to be against mandatory minimums and Congress tends to be in favor of mandatory minimums. The reason that may be true is that the courts have first-hand interactions with the defendants, less politically motivated, and goes through the mitigat-

ing/ aggravating factors whereas Congress does not and often go by stereotypes about drug dealers mainly focusing on deterrence and incapacitation.³³

The Anti-Drug Abuse Act appears to be more harm than good. It has increased racial disparities during sentencing and created a costly trend of inmates going into prisons that leaves a gaping hole in their communities and families, encouraging the cycle of poverty, crime, and drug use. This is further evidence on the ineffectiveness of the Anti-Drug Abuse Act that my research supports. The Anti-Drug Abuse Act has repeated the same mistakes of its predecessors, the Boggs Act and Narcotic Control Act, and has arguably worsened their negative effects on a larger scale.

II. Possible Alternatives to Mandatory Minimums/ Reform

One of the most prevalent answers to mandatory minimum reform is to expand the federal safety valve which allows defendants to be given a shorter sentence than the mandatory minimum based on a set of criteria. The authors of “Sense and Sensibility in Mandatory Minimum Sentencing,” both of whom are law professors, argue that mandatory minimum reform should be approached not with the intention of repealing them but to make more plausible minimal changes by expanding the federal safety valve that today is limited. This can be done by adjusting the wording of 18 U.S.C. §3553 Imposition of Sentence or 28 U.S.C. § 994 Duties of Commission.³⁴ These adjustments would retain that no one is harmed by the defendant’s actions but also it could apply to first-time low-level drug offenders and previous disqualifiers like the use of a firearm. It would also still provide sufficient incentive for defendants to work with law enforcement. Gill in “Turning off the Spigot: How Sentencing Safety

26 *Report At A Glance: Overview of Mandatory Minimum Penalties in the Federal Criminal Justice System, United States Sentencing Commission*, (2017): 1.

27 *Ibid.*

28 “Federal Drug Sentencing Laws Bring High Cost, Low Return,” 1.

29 *Ibid.*

30 *Ibid.*

31 *Ibid.*

32 Refer to Appendix III for more information on the Constitutional Debate On Mandatory Minimums

33 Marc Mill and Daniel J. Freed, “Editors’ Observations: The Chasm between the Judiciary and Congress over Mandatory Minimum Sentences,” *Federal Sentencing Reporter* 6, no.2 (1993): 61.

34 Paul G. Cassell and Erik Luna, “Sense and Sensibility in Mandatory Minimum Sentencing,” (*Federal Sentencing Reporter*, (2011): 222.

Valves Can Help States Protect Public Safety and Save Money” proposes that the safety valve should also be expanded where the court could depart of the mandatory minimum if they find that substantial injustice would occur if the mandatory minimum is applied.³⁵ Also, that a safety valve can be tailored in two ways: policymakers can choose the offense and/or offenders that will be eligible for safety valve relief, and standard for invocation where the judge can lift the minimum if the minimum is not “necessary to ensure public safety” or will cause a “substantial injustice.”³⁶

Another alternative to mandatory minimums would be the Federal Sentencing Guidelines. The USSC themselves in their 2017 mandatory minimums report stated: “a strong and effective Federal Sentencing Guidelines system best serves the purposes of the Sentencing Reform Act.”³⁷ Building upon this a report by the Federal Judicial Center which stated that the Federal Sentencing Guidelines could bring the benefits of mandatory minimums at a lower cost with fewer negative effects.³⁸ One of the main differences between the Federal Sentencing Guidelines and mandatory minimums is that due to the Supreme Court case *United States v. Booker* the sentences that the guidelines provide are not mandatory for the judges to sentence it allows for more judicial discretion to take place. Again in “Sense and Sensibility in Mandatory Minimum Sentencing” the authors stated that “almost everyone (including guidelines skeptics) would agree that using the guidelines to ameliorate the worst cases of excessive mandatory sentencing would be an improvement over the current status quo.”³⁹ Additionally, the report by the Federal Judicial Center also stated that the guidelines are more proportional than mandatory minimums because it accounts for a prior record, this could be due to the “sentencing cliff” phenomena that have been occurring with mandatory minimums where there are great differences between sentence length for relatively small differences in be-

havior.⁴⁰ The guidelines also take into account many more factors than mandatory minimums maintaining some flexibility to permit individualized sentences warranted by mitigating or aggravating factors, essentially allowing for more judicial discretion. Judges are also permitted in extraordinary circumstances to depart either upward or downward from the guideline range. The purposes of both laws are similar which was to create an egalitarian form of drug sentencing so that there would not be extreme differences between judges as to how long they sentence a drug offender for the same crime regardless of race or class, but there has been a debate if restricting this judicial discretion is beneficial. With the research paper “Mandatory Sentencing and Racial Disparity: Assessing the Role of Prosecutors and the Effects of Booker,” published by the Yale Law Journal, the authors found that the expansion of judicial discretion post *U.S. v. Booker* did not increase racial disparity and that forcing sentencing laws to be more rigid exacerbates the problem of racial disparity and leads to less equitable administration.⁴¹

III. Further Research and Limitations

The limitation to the current study’s finding is that the research only examined the two amendments of the Narcotic Drugs Import and Export Act and the Anti-Drug Abuse Act. Further research could expand beyond these laws to more thoroughly capture the severities between the narcotics-related mandatory minimums of the 50s to the 80s. If the scope was expanded, research could better assess if there are harsher penalties between the mandatory minimums of the 50s and the 80s, which were both largely passed due to public hysteria. Also, the research did not account for the change throughout time and public opinion surrounding drug abuse. Future research could expand the number of laws examined as well as examine the

35 Molly M. Gill, “Turning off the Spigot: How Sentencing Safety Valves Can Help States Protect Public Safety and Save Money,” *Federal Sentencing Reporter* 23, no. 3 (2013): 353.

36 *Ibid*, 354.

37 *Report At A Glance*, 2.

38 Barbara S. Vincent and Paul J. Hofer, “The Consequences of Mandatory Minimum Prison Terms: A Summary of Recent Findings,” *Federal Sentencing Reporter* 7, no. 1 (1994): 1.

39 Cassell, “Sense and Sensibility,” 221.

40 Vincent and Hofer, “The Consequences,” 29.

41 Sonja B. Starr and Marit M. Rehavi, “Mandatory Sentencing and Racial Disparity: Assessing the Role of Prosecutors and the Effects of

motivations behind the passage each law and if the intentions were similar as well.

Another suggestion for further research is to change the scope from the federal level to the state level. The majority of the US inmate populations are at State Prisons having a total of about 1.3 million people in 2019 compared to the 221,000 in Federal Prisons.⁴² The majority of drug offenders are charged at the state level. Out of the state inmate population, around 15% of them are drug offenders.⁴³ As mentioned previously after the passing of Boggs Act “Little Boggs Acts” were passed throughout the states and a similar trend occurred in response to the Anti-Drug Abuse Act as well so politicians can maintain a “tough on crime” image. Further research could look into these “Little Boggs Acts” and compare them to the mandatory minimums that sprung up around different states immediately following the Anti-Drug Abuse Act. By examining mandatory minimums on a state level research can account for even more people impacted by these laws, since state prisons hold the majority of drug offenders in the US.

APPENDIX

I. Federal Sentencing Guidelines

The Federal Sentencing Guidelines, although similar to mandatory minimums, are very different. The guidelines have a series of requirements from the Drug Quantity Table that if fulfilled a defendant would be placed into a certain base level number, the guideline has 43 offense levels, the higher the level, the longer the sentence forming the vertical axis of the Guidelines chart. The horizontal axis of the chart is the criminal history category from I-VI, a defendant can receive one criminal history point for prior sentences less than 60 days; 1-3 points for a sentence for a violent offense not relating to the current charged offense; 2 points for prior sentences exceeding 60 days or if the offender commits the charged offense while

on probation, parole, supervised release, imprisonment, work release, or escaped status; 3 points for prior sentences exceeding 1 year and 1 month.⁴⁴

II. Exceptions to Mandatory Minimums

There are some exceptions that a defendant can potentially fulfill that he/she would be able to be sentenced to fewer years: if the prosecutors decide not to prosecute, the President pardon the defendant or commute his/her sentence, or a statutory safety valve set by the prosecutor.⁴⁵ The safety valve provides an incentive for defendants to work with the government in exchange for a reduced sentence. There are five requirements for the safety valve:

- The defendant may not have no more than one criminal history point (The Sentencing Guidelines assign criminal history points based on a defendant’s past criminal record)
- The defendant has not used a dangerous weapon during the offense
- The defendant is not an organizer or leader in the drug enterprise
- The defendant provided the government with all the information and evidence they know including for other crimes (providing “substantial assistance”)
- The offense must not have ended in a serious injury or death.⁴⁶

One of the requirements of “substantial assistance” is problematic because there is not a uniform standard of what that is, rather it is under the discretion of the prosecutor. The issue with this safety valve is that most of the convicted drug offenders with the mandatory minimums are low-level drug dealers who likely wouldn’t be able to provide substantial assistance, disqualifying them from the safety valve. Even with the safety valve the majority of drug offenders with mandatory minimums are low-level offenders and had little or no prior criminal record according to the United States Sentencing Commission (USSC).

Booker,” *Yale Law Journal* 123, no.1 (2013): 78.

42 Wendy Sawyer and Peter Wagner, “Mass Incarceration: The Whole Pie 2019,” *Prison Policy Initiative*, (2019).

43 Sawyer and Wagner, “Mass Incarceration,” (2019).

44 “2018 GUIDELINES MANUAL,” *United States Sentencing Commission*, (2018).

45 Doyle, “Mandatory Minimum Sentencing,” 1.

46 Doyle, “Mandatory Minimum Sentencing,” 1.

I. Constitutional Debate on Mandatory Minimums

Mandatory minimums have been argued to violate the right of due process, cruel and unusual punishment clauses, federalism as well as the equal protection clause of the 14th amendment because of its racial disparities. On the other hand, mandatory minimums could fall under legislative authority with the necessary and proper clause, treaty power, territorial and maritime jurisdiction, and the commerce clause. This constitutionality debate thus far has been on the side that mandatory minimums are constitutional through a series of different court cases that Senior Specialist in American Public Law Charles Doyle did examine in his research and stated, “By and large, courts have also found no impediment to imposition of mandatory minimum sentences under the Due Process, Equal Protection, or Cruel and Unusual Punishment Clauses, or the separation-of-powers doctrine”.⁴⁷

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⁴⁷ Doyle, “Mandatory Minimum Sentencing,” 1.

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Emma Fridy is currently a junior in high school at Dupont Manual in Louisville, KY. She is a passionate academic who is always ready to challenge herself. Emma enjoys almost all subjects, but she has a special affinity for the humanities as well as language and linguistics. She chose to pursue her first extended research project in dialect perception, a field which she plans to study further in college. In her free time, Emma is captain of her debate team, helps her community, and is active in local politics. Altogether, she is an extremely well-rounded student with a bright future.

Katrina Gonzales is a junior in the Commercial Art & Graphic Design program at the Bergen County Technical High School in Teterboro, New Jersey. While her research focuses on a topic within the psychology field, she is interested in pursuing her passion for mathematics by having a career in finance. Gonzales is also a member of her school's Heroes & Cool Kids

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Ziyu Han is currently a Grade 12 student studying at St. Andrew's College in Aurora, Ontario. He was born in China but moved to Canada at the age of 2. Passionate about the sciences and mathematics, Ziyu plans to pursue an Industrial engineering degree in university, hoping to apply his knowledge to a global scale in helping communities around the world. To stay active, he plays a variety of sports during the year: soccer in fall, basketball in winter, and badminton in spring. During spare time, he enjoys playing Chess and is always eager to face new opponents.

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Katie Moltz is an English teacher at Valley Stream South High School in Valley Stream, NY. She teaches AP Research which is part of the College Board's Capstone program, as well as seventh grade English. Ms. Moltz is from Valley Stream and graduated with her Bachelors and Masters degree in English and Special Education from Molloy College. She has been teaching at Valley Stream South for the past three years, and is involved with various extracurricular activities. Ms. Moltz is excited to grow the Capstone program at her school, and continue to foster the love of learning in her students.

Michelle Satchwell is an English teacher at Carmel High School in Carmel, Indiana. She teaches AP Research in the AP Capstone program as well as dual-credit and honors classes. She has been an AP College Board Consultant for AP Capstone since 2014. Co-author of Reading Lists for College-Bound Students and STACS: Strategies to Acquire Composition Skills, Mrs. Satchwell was the Carmel Clay school corporation's Teacher of the Year in 2004 and is an Armstrong Teacher Educator at Indiana University. Mrs. Satchwell is a devoted educator who delights in helping her students reach their potential.

Samantha Scheepers is an Upper School English and AP Research teacher at St. Andrew's College. She is also the chair of the school's Standing Committee for Excellence in Teaching and Learning. She holds a Master's of Teaching, specializing in metacognition and reading comprehension, as well as a BA (Hons.) with high distinction in English and Renaissance Studies from the University of Toronto. She has recently completed a teaching fellowship focused on leadership in independent schools at Columbia University and has presented her research on cooperative learning through the International Boys' School Coalition.

Alesia Williams has a background in the humanities. She has a BA in art history from Berea College and has completed coursework for an MA from the University of Cincinnati. She has a MAT with a focus on English from Spalding University. She has been teaching in the public school system in Louisville, KY for sixteen years. Thirteen of those years have been at duPont Manual High School which has five magnets

and is typically ranked as the best high school in Kentucky. She has been teaching AP English Language and Composition for ten years and AP Research for one year. She is focused on helping her students achieve at the highest levels, especially in regards to academic writing. She encourages her students to think of themselves as writers and to pursue writing competitions and publication. Her students have been recognized with top honors from the NCTE and KCTE writing competitions, the Scholastic Art and Writing competition, and the MIT INSPIRE research competition.

Editors of the Journal

Suzanne Conklin
Akbari

BA, MA, MPhil,
PhD

Suzanne Conklin Akbari is professor of English and Medieval Studies at the University of Toronto, and was educated at Johns Hopkins and Columbia. Her research focuses on the intersection of English and Comparative Literature with intellectual history and philosophy, ranging from neo-platonism and science in the twelfth century to national identity and religious conflict in the fifteenth century. Akbari's books are on optics and allegory (*Seeing Through the Veil*), European views of Islam and the Orient (*Idols in the East*), and travel literature (*Marco Polo*); she is currently at work on *Small Change: Metaphor and Metamorphosis in Chaucer and Christine de Pizan*. She is volume editor for the *Norton Anthology of World Literature* (Volume B: 100-1500), co-editor of the *Norton Anthology of Western Literature*, and editor of *The Oxford Handbook to Chaucer*. She has begun a new research project called *The Shape of Time*, contrasting the temporal breaks found in medieval chronicle traditions with poetic narrations of the historical past. Akbari is cross-appointed to the following units at the University of Toronto: Centre for Medieval Studies; Centre for Comparative Literature; Centre for Jewish Studies; Department of Near and Middle Eastern Civilizations; Centre for Reformation and Renaissance Studies.

Barrie Bennett

BPE, MEd, PhD

Barrie Bennett is professor emeritus at the Ontario Institute for Studies in Education at the University of Toronto (OISE/UT). His research work focuses primarily on the design of powerful learning environments for students and teachers through the process of systemic change. He is currently working in districts in three countries on long-term projects related to instructional intelligence and systemic change (Australia, Ireland and Canada). Instructional intelligence involves intersecting the current research on curriculum, assessment, and instruction guided by what is known about how students and teachers learn. That intersection being driven by what is known about change and systemic change. He also assists teachers, schools, and districts with issues related to classroom management and school wide-discipline. Barrie has taught at the elementary and secondary levels, as well as, having worked in group homes, prisons, and security units for juvenile offenders. He has written six books: *Cooperative Learning: Where Heart Meet Mind*; *Classroom Management: A Thinking and Caring Approach*; *Beyond Monet: The Artful Science of Instructional Integration*; *Graphic Intelligence: Playing With Possibilities* and most recently *Power Plays*. Currently he is just finishing a text titled, *Effective Group Work: Beyond Cooperative Learning*.

Anthony Campbell

BA, MA, PhD

Anthony Campbell established Grow for Good Urban Teaching Farm in 2013 as a business model innovation laboratory and learning centre for young entrepreneurs. He spent time working throughout North America, Europe, Australia, Asia and now resides in his hometown of Toronto. Examples of Anthony's work are documented in *The Innovator's Field Guide* (2014), co-authored by David Crosswhite and Peter Skarzynski, as well as multiple Harvard Business School and Corporate Executive Board case studies chronicling the innovation and capability-building efforts of companies such as Samsung, Whirlpool, Best Buy and McDonald's. Previously, Anthony taught Film Studies, Writing and English Literature at The University of Western Ontario.

- Jeremy B. Caplan
ScB, PhD
- Jeremy Caplan is an Associate Professor in Psychology Department at the University of Alberta, where he is also the Principal Investigator at the University of Alberta Computational Memory Lab. The lab is focused on human verbal memory behaviour and its basis in cognitive and neural processes. The team takes several approaches towards research, including mathematical modeling, measures of behaviour in the cognitive psychology tradition, and measures of brain activity using electroencephalography (event-related potentials and oscillations) and functional magnetic resonance imaging. He has been a referee for 38 academic journals.
- Nathan Chow
BSc, Msc, BEd
- Nathan Chow teaches Physical Sciences at Royal St. George's College (RSGC) in Toronto and consults on educational material at Perimeter Institute for Theoretical Physics in Waterloo. He has worked with Ontario's Ministry of Education to develop research-based teaching resources for Physics teachers within the province and across the rest of Canada. His academic research explored whether or not we understand how gravity behaves at intergalactic distances and provided possible explanations for our observations of dark energy. He has presented this research and led teacher training workshops around the world. In addition to AP Physics 1 and C, he teaches the AP Capstone Research course at RSGC.
- Hance Clarke
BSc, MSc, MD,
PhD, FRCPC
- Dr. Clarke is the director of Pain Services and the medical director of the Pain Research Unit at the Toronto General Hospital. He is appointed to the Institute of Medical Sciences at the University of Toronto and is a graduate of the Royal College Clinician Scientist Program. His research interests include identifying novel acute pain treatments following major surgery, identifying the factors involved in the transition of acute postsurgical pain to chronic pain, studying the genetics of acute and chronic pain after surgery, and identifying risk factors associated with continued opioid use and poor health related quality of life after major surgery as well as the efficacy of hyperbaric medicine. Over the past five years he has authored 47 peer reviewed manuscripts.
- Will Fripp
BA, MA
- Will Fripp is a public affairs and political risk analyst for Canadian and international clients. A B.A. in History and Political Science from Victoria University at the University of Toronto and an M.A. in Intelligence and International Relations from the University of Salford in Manchester, England, he is a historian specializing in intelligence and espionage, and its modern influences. Will anchored www.spiesin-theshadows.com, a web based curriculum outlining Canadian foreign intelligence history and its impacts on Canada's national development. An occasional lecturer, Will's writings and review articles appear in peer-reviewed academic journals like *Intelligence and National Security*, and elsewhere.
- Michael Gemar
BSc, BA, PhD
- Michael Gemar received undergraduate degrees in Psychology and Philosophy from Rice University, and a PhD in experimental psychology from the University of Toronto. He has worked as a researcher at the Centre for Addiction and Mental Health, examining the cognitive and neural correlates of mood disorders, and was involved in a landmark study demonstrating the efficacy of mindfulness meditation to prevent depressive relapse. He has co-authored numerous journal articles, and taught for over a decade at U of T. More recently, he has worked in the area of health policy, and is currently at a Canadian non-profit.
- Jennifer Goldberg
BA, BEd, MA
- Jennifer Goldberg holds an M.A. in History from the University of Toronto. Her graduate studies focused on teacher misconduct in 19th century Ontario, and her research is published in *Historical Studies in Education*. She currently teaches at Havergal College, where she has also served as Chair of Teaching and Learning. In this capacity, she has explored the role of feedback in student learning, and has presented on this work at the National Coalition of Girls' Schools and Conference of Independent Teachers of English.

- Margaret S. Herridge
BSc, MSc, MPH,
MD, FRCPC
- Margaret Herridge is a Professor of Medicine and Senior Scientist at the University of Toronto. She is also a senior clinician in Critical Care and Respiratory medicine at University Health Network. Her research focus is on long-term outcomes after critical illness for patients and families and specifically on functional, neuropsychological, healthcare utilization and quality of life metrics. Her graduate studies were in Cell and Molecular Biology at Queen's University where she subsequently obtained her degree in Medicine. After completing her clinical training in Internal Medicine/Respirology and Critical Care at the University of Toronto, she obtained her Master of Public Health in Epidemiology and Statistics from the Harvard School of Public Health.
- Ted Higginbotham
BSc, MSc
(Candidate)
- Ted Higginbotham is a graduate student at The University of Toronto and Hospital for Sick Children. His research is focused on further delineating the role of genomic structural variation in autism spectrum disorder and human disease. Ted is a contributing member of the Clinical Genome Resource (ClinGen), an international consortium working to define the clinical relevance of genes for use in precision medicine and translational research.
- Tim Hutton
BA, MLIS
- Tim Hutton is a teacher-librarian at Royal St. George's College. He has a BA in History and American Studies from the University of Toronto and a Masters in Library and Information Science from San Jose State University. At the secondary level, he has taught courses in the social sciences, humanities and communications technology, including a locally designed interdisciplinary course in urban studies.
- Ira Jacobs
Dip Phys Ed,
MHK, DrMedSc
- Professor Ira Jacobs became dean of the Faculty of Kinesiology & Physical Education at the University of Toronto on July 1, 2010, and was re-appointed to his current second decanal term. Before assuming this role, Jacobs was chair of York University's School of Kinesiology and Health Science from 2007 until 2010, and a federal government scientist from 1982 until 2007.
- Jacobs earned his doctorate in clinical physiology from Sweden's Karolinska Institute, where he specialized in skeletal muscle metabolism. For the next 25 years, he did extensive exercise physiology research in Canada's human sciences laboratory, operated by the Department of National Defence. There, Jacobs rose to the position of chief scientist and led a unique international research group that helped to enhance the performance of military special operations units through their research into physiological, nutritional and pharmacological strategies.
- He is a past president of the Canadian Society for Exercise Physiology and the Canadian Council of University Physical Education and Kinesiology Administrators. He is a fellow of the American College of Sports Medicine, an international fellow of the US National Academy of Kinesiology, and in 2016, he was named a Fellow of the Canadian Academy of Health Sciences.
- Jacobs' research has led to the publication of more than 200 scientific articles, reports and book chapters about his research interests that include the physiological responses to physical exertion in environmental extremes, performance enhancement through pharmacological and nutritional manipulation of metabolism, and exercise pharmacology.
- During his term as dean, the Faculty of Kinesiology & Physical Education has been rated as among the top academic programs in the world for kinesiology, physical education, sport and exercise sciences.

- John Lambersky
BA, MA, BEd,
PhD
John Lambersky is a teacher and head of the Canadian and World Studies department at Royal St. George's College in Toronto, where he leads the AP Capstone program. He has presented his work on teaching practice at the conferences of the International Boys' School Coalition, the National Association of Independent Schools, and the Canadian Accredited Independent Schools. His academic research is focused on school culture as a mechanism for school improvement. His work has been featured in *Leadership and Policy in Schools*, *The Dalhousie Review*, and *The Nashawaak Review*.
- Lori Loeb
BA, MA, PhD
Lori Loeb is Associate Professor of Modern British history at the University of Toronto. She has a Masters in Museum Studies and a PhD in History. A specialist in the Victorian period, she is the author of *Consuming Angels: Advertising and Victorian Women*. Generally, she writes about things in nineteenth-century Britain. A past Deputy Chair and Associate Chair (Graduate) of the History Department, she is currently MA Coordinator. She teaches courses in nineteenth and twentieth-century British history, Victorian material culture and the English country house.
- Jaime Malic
BA (Hons), MA,
BEd, PhD
Jaime Malic recently completed her PhD in Educational Leadership and Policy at the Ontario Institute for Studies in Education at the University of Toronto. Her research focused on leadership values and practices in independent schools in Ontario. Jaime has more than ten years of experience as an educator in both independent and public schools. She currently teaches AP Capstone Seminar and senior English courses at St. Clement's School. Jaime has served as both a Reader for AP Capstone Seminar and a writer on the Item-Writing Committee for the Ontario Secondary School Literacy Test. She has written for Independent Teacher and presented on various topics at the Conference of Independent Teachers of English Annual Conference, the Ontario Advanced Placement Administration Conference, and the Advanced Placement Annual Conference.
- William J. McCausland
BAsc, MEng, MA,
PhD
William McCausland is an associate professor of economics at the Université de Montréal. His research applies Bayesian statistical methods in two main areas. The first is discrete choice, at the interface of economics and psychology, where researchers study how people make choices from a small menu of available options. The second is time series modelling in economics, which has many applications in macroeconomics and financial economics. His undergraduate studies were in Engineering and he received his Ph.D. degree in economics from the University of Minnesota.
- Kate Schumaker
MSW, PhD
Kate Schumaker is the Manager of Quality Assurance & Outcome Measurement at the Catholic Children's Aid Society of Toronto, and holds the position of Assistant Professor (status only) at the Factor Inwentash Faculty of Social Work, University of Toronto. She has worked for over 20 years in child welfare and children's mental health, including front-line clinical positions and 10 years producing and implementing child welfare policy for the provincial government. In 2011-12 she worked for the Commission to Promote Sustainable Child Welfare, supporting accountability framework development, including the establishment of a set of standardized performance indicators for the child welfare sector in Ontario. Her areas of practice and research interest include poverty, child neglect, trauma-informed practice, child welfare decision-making, and evidence-informed policy and practice.

Michael
Simmonds

BPE, M.A., Dip.
Ed., MEd, EdD

Michael Simmonds has worked in independent schools for over two decades. He taught science, biology, chemistry, physics, and math before becoming an administrator and Head of School. He earned graduate degrees from both McGill and Columbia universities respectively before receiving his doctorate from the University of British Columbia in Educational Policy & Leadership. His work on accountability synopticism is published in the peer-reviewed, *The International Education Journal: Comparative Perspectives*. He currently works at Haverhill College as the VP School Life, Operations & Student Wellness.

Alumni Editors

Nick Bethlenfalvy is a second-year student in Trinity College at the University of Toronto. He graduated from Royal St. George's College in 2018. His studies included the two year AP Capstone program, which involved AP Research where he analyzed the root causes of rising pedestrian fatalities in Toronto. After taking the Ethics, Society and Law stream in the Margaret MacMillan Trinity One Program, Nick hopes to pursue an undergraduate degree in Economics.

Ryan Hamilton is studying history at the University of Toronto, where he graduated from the Pearson Stream of the Vic One program. He is also a graduate of the AP Capstone program at Royal St. George's College in Toronto, where his research focused on a Canadian battalion in the First World War.

William Howard-Waddingham is a student at Yale University studying political science with a concentration in human rights. He works as a research assistant with Professor Ryan Thoreson at the Yale Law School's Schell Centre for International Human Rights. In this role, he has conducted research on the ineffectual nature of incarceration for punishing those who non-violently discriminate against LGBTQ people, and how such incarceration is a human rights abuse in and of itself. William is passionate about social justice, equality, and international politics. These passions extend to his extracurricular activities. He serves as a researcher for the Policy Accountability Project with the Yale Undergraduate Legal Aid Association. This project is intended to document cases of police brutality in Connecticut, and strives to support victims by holding officers accountable for their actions. He is also involved with the Yale International Relations Association and the Yale Review of International Studies, where he runs the Europe desk and is an editor for YRIS's academic journal.

Pearse O'Malley is a 2018 graduate of Royal St. George's College and current second-year student at the University of Toronto studying Neuroscience. In addition to his responsibilities as a student, he is a research assistant at The Hospital for Sick Children in Toronto, where he works on data collection and curation for studies conducted by The Canadian Children Inflammatory Bowel Disease Network (CIDCaNN). On campus, he is involved in Women in Science and Engineering and Hemoglobin, both organizations that seek to increase the representation of minority groups in the fields of STEM and within research study cohorts. Pearse aspires to a career in healthcare and is primarily interested in primary care, women's rights, and education.

Guidelines for Contributors

The Young Researcher is a peer-reviewed journal dedicated to publishing the best original research from secondary school students.

The journal's mission is to provide a larger audience for the original academic research of ambitious secondary students, provide a forum for peer-review, and create a community of young researchers. In addition, the journal strives to advance the quality of academic writing in secondary schools.

The Young Researcher is edited by secondary school students working closely with scholars and active researchers at universities and in the community. The journal operates a blind peer-reviewed review process, following those found in academic research journals.

The journal encourages submissions of original research (including relevant replication studies) from a wide range of academic disciplines within the social sciences, humanities, and sciences.

Submission Guidance:

- No more than 5,000 words, excluding references and appendices (in English)

- Articles should have the following sections or equivalent:

Introduction

Literature Review

Method, Process, or Approach

Findings or Results

Discussion, Analysis, and/or Evaluation

Conclusion and Future Directions

References

- Papers should be formatted using discipline-appropriate methods (MLA, APA, and Chicago are acceptable).

- Papers should have an abstract (no more than 150 words) and have 4-6 keywords

- All units of measurement should be in metric wherever possible

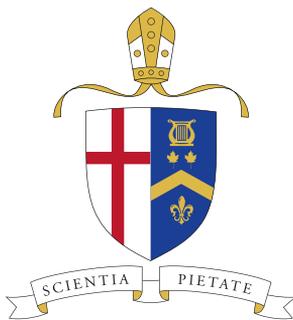
- All studies involving human participants must have been approved by a Research Ethics Board

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