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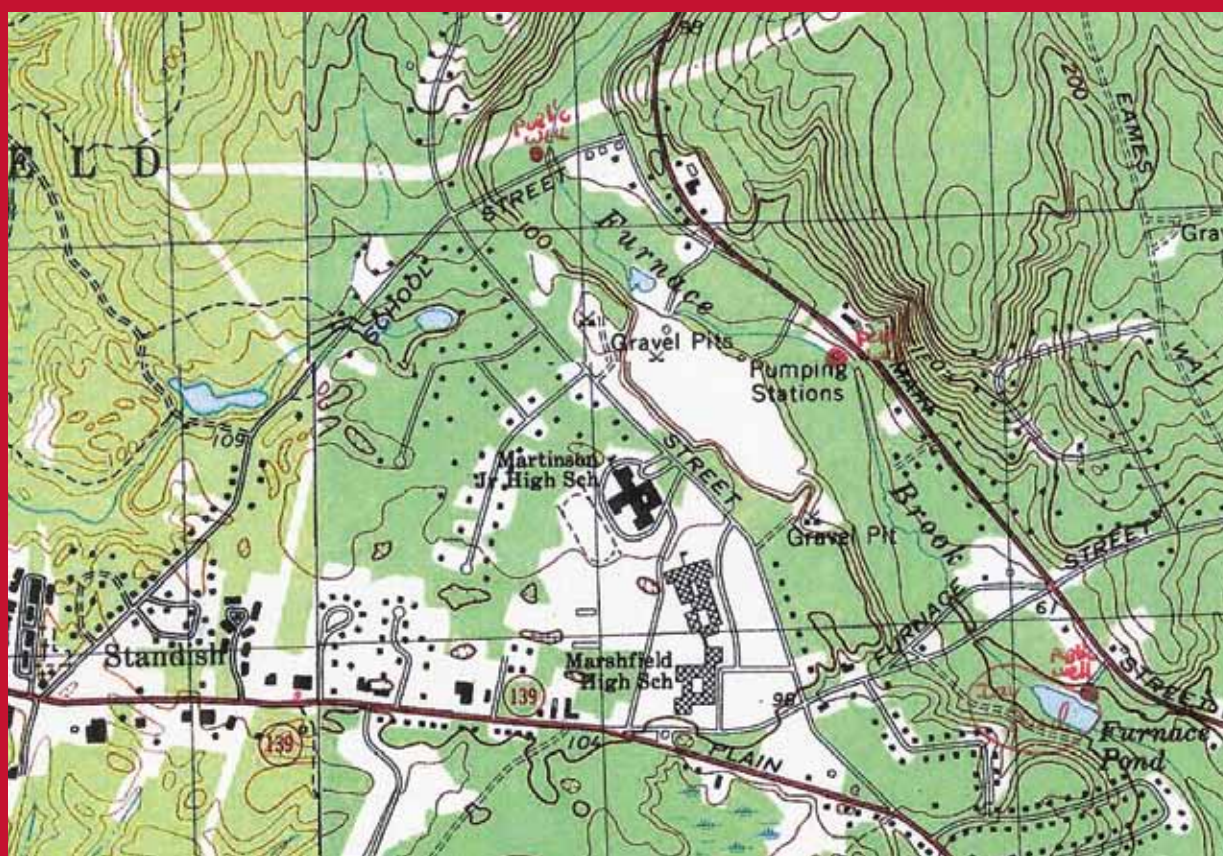
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The Undergraduate Review

A JOURNAL OF UNDERGRADUATE RESEARCH AND CREATIVE WORK



Furnace Brook Watershed, Marshfield, MA., as shared by BSU student Erik Croll (1969-2013)

Bryant, Croll, DeChristopher, Fruzzetti, Gagne, Houston, Howard, Howe, Hoyt, Jasper, Kearns, LaRose, Lloyd, Long, McElwee, McIsaac, McLaughlin, Medina, Melendy, Pina, Pistorino, Roberts, Roche, A. Rose, M. Rose, Scott, Strobel, Sullivan, Sylvia

Letter from the editor

Without continual growth and progress, such words as improvement,
achievement, and success have no meaning.
-Benjamin Franklin

The 2013-2014 academic year will mark this journal's tenth year of publication. I was first acquainted with the journal as a student author. I wrote a piece of memoir for a creative-nonfiction writing course, was encouraged to submit it for publication, and was fortunate enough to be selected as one of the twelve authors published in the inaugural volume of *The Undergraduate Review* (2003-2004). The following year I was recruited as a student editor, one of three, and then one of one, when the other two students went on to other endeavors. The journal's "headquarters" was the Honors' Center in the Academic Achievement Center. I had use of a communal computer, the coffee table, and as much floor space as I could commandeer. It was a great space, but we never expected the near three-fold increase in submissions to Volume II. An official designer was sought and hired to lay out the beefy 25-article, 230-page issue. Special considerations were made for cover design, contributor photos, and featured artwork. That same year, the journal found a permanent home in the Office of Undergraduate Research in Maxwell Library.

The UR continued to grow, improve, and succeed, showcasing more of the finest scholarly and creative work offered by BSU students. The journal grew in girth as well as in scope, and more disciplines were represented with each iteration. Last year, a new two-reader, double-blind review process was piloted. Thanks to the dedication of over 65 faculty reviewers it was deemed a success, despite a whopping record of 52 submissions!

We're not done— still growing. We received a record-breaking number of submissions again this year. Over 65 BSU students submitted their work to the reviewers. Nearly every discipline on campus was represented. The research featured in this journal is some of the finest yet, testaments to the wealth of knowledge, experience, and talent of BSU students and faculty.

I am amazed by the tremendous growth, reach, and success this journal has achieved in such a short period of time.

STACY MOSKOS NISTENDIRK, MA
Managing Editor

The Undergraduate Review

VOLUME 9 2012-2013

Managing Editor

Stacy Moskos Nistendirk

Director of Undergraduate Research

Jenny Olin Shanahan, Ph.D.

Contact information:

The Office of Undergraduate Research
200 Maxwell Library
10 Shaw Rd
Bridgewater State University
Bridgewater, MA 02325
508-531-2303

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IN MEMORIAM

Erik D. Croll (1969-2013)

All of us who knew Erik Croll—as a friend, classmate, student, researcher, or fellow traveler—were shocked and saddened to hear of his death on April 9, at just 43 years old. Erik is survived by his wife Lori, his mother Lucille, his father and stepmother David and Lynne, his brother Robert, and his parents-in-law Gordon and Joan. This volume of *The Undergraduate Review* is dedicated to his memory.

As an avid sailor, scuba diver, underwater photographer, and fisherman, Erik had a personal investment in water resource protection. And as a non-traditional student who returned to college after many years of working in maritime trades, he applied his interest in water and wetlands protection to studying hydrology at BSU. It was his Study Tour experience in Cambodia with Dr. Kevin Curry, Professor of Biological Sciences, in 2012, though, that truly committed Erik to work for water resource protection and to help address the immense need for access to safe drinking water around the world. As Erik put it, “Meeting impoverished but hopeful families in rural Cambodian villages really cemented within me that I want to use the science I am learning at Bridgewater State to actually make differences in the environment.” In the research paper he wrote after that experience, “Hydrogeologic Analysis Critical to Sustainable Development in the Kingdom of Cambodia,” he explained the fundamental importance of geological conditions in meeting that country’s challenges of water-resource management.

Erik’s deep concern for people in Cambodia without access to clean drinking water led him to return to Phnom Penh and Siem Reap in January 2013 to continue his research and work for sustainable, safe water resources. On that research trip, he focused on the geological conditions of the Kbal Spean River and Siem Reap River, both within the Tonle Sap Watershed—a setting with particular complexities created by the influx of tourists to Angkor Wat, the largest religious monument in the world, visited by nearly two million people a year. Erik’s study, unfortunately incomplete because of his sudden death, may nonetheless inform future studies on the efficacy and sustainability of clean drinking-water initiatives in the Tonle Sap Watershed.

Erik’s research last summer (published in this journal), mentored by Dr. Richard Enright, Professor of Geological Sciences, and funded by BSU’s Center for Sustainability, brought his commitment to safe drinking water close to home: to the public water supply in Marshfield, Massachusetts. The magnitude of this water resource issue is evident to several constituent groups with whom Erik shared his findings, many of whom urged him to continue collecting data and reporting the findings long after his summer research officially finished. Erik’s data will undoubtedly help to minimize environmental impacts upon the Furnace Brook watershed in Marshfield and maximize the use of the town’s water resources as a safe drinking-water supply—results that benefit the 25,000 residents of Marshfield and countless others whose communities are likewise working to safeguard water supplies.

Erik’s family requests memorial donations be sent to Water For Cambodia, c/o Middletown Rotary Charitable Trust, PO Box 4258, Middletown, RI 02842 (www.waterforcambodia.org) or to Faxon Animal Rescue League, 474 Durfee Street, Fall River, MA 02720.

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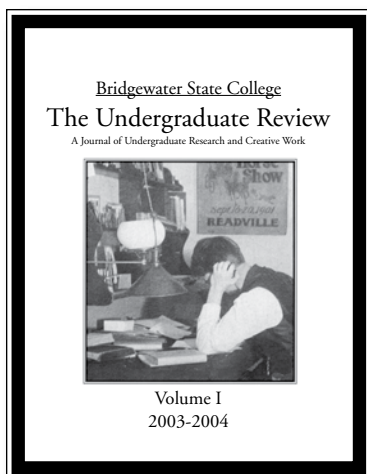
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Inaugural Volume

The Power of Undergraduate Research

Undergraduate research has truly come to prominence across the country—and in many other parts of the world—as university administrators and faculty recognize the efficacy of this “high-impact practice.” George Kuh (2008) famously identified several “high-impact practices,” which data from myriad institutions of higher education have shown to make significant positive differences in the lives of students. Along with attesting to tremendous benefits provided by undergraduate-research opportunities, Kuh highlighted the advantages accorded to students who study abroad, participate in internships and service learning, live in a residence-hall “Living and Learning Community,” and take writing-intensive courses across the curriculum, among other practices.

To me, the most compelling evidence of Bridgewater State University’s excellence in serving its students is its major investments in *every one* of the high-impact practices. In an address to the American Association of Colleges and Universities this year, Kuh spoke of the forthcoming publication of long-term data on high-impact practices: what he and his colleagues have found by following up with college graduates many years after graduation. Their results show that high-impact practices not only correlate with success and satisfaction during the undergraduate experience (higher GPAs, more timely graduation rates, greater engagement in learning, etc.), but they are still benefiting graduates after their tenth- and twentieth-year reunions. In advancing opportunities such as Adrian Tinsley Program undergraduate-research grants, Study Tours, internships, and other high-impact practices, BSU is ensuring students’ success today as well as long after their graduation.

Kuh’s and others’ research on high-impact practices quantifies what we have witnessed in inspiring example after inspiring example here at Bridgewater. Spring is the season of graduate-school acceptance letters, which makes working in the Office of Undergraduate Research especially gratifying at this time of year, as students drop by to tell us they earned a spot in their first-choice program, often with full funding. They want us to know that their undergraduate research experience, presenting their work at national conferences, and even publishing in this very journal, were noted with enthusiasm by graduate admissions committees. In the weeks leading up to May commencement we hear the stories of students who found their passion for an area of study and future career when they were invited by a faculty mentor to join a lab group or apply for an ATP grant to fund their creative writing. And Spring is also when we send this journal of student research and creative work to the publisher, filled with admiration and delight for the “high impact” these undergraduate-research projects now make on us. Congratulations on your fine work. Many thanks for sharing it with us.

JENNY OLIN SHANAHAN, PH.D.
Director of Undergraduate Research

Reference

Kuh, G. D. (2008). *High-impact educational practices: What they are, who has access to them, and why they matter*. Washington, D.C.: Association of American Colleges and Universities.

See Astin, 1997; Brownell & Swaner, 2010; Pascarella & Terenzini, 2005; Tinto, 2008.

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The staff of *The Undergraduate Review* thanks these faculty reviewers for their time and effort in evaluating the record number of manuscript submissions we received for this issue. Thank you to the Adrian Tinsley Program (ATP) for funding the journal and the Office of the President and Division of Academic Affairs for outstanding support of undergraduate research at Bridgewater State University. And many thanks to the dedicated students and faculty mentors whose excellent work is on display here.

Delineation and Characterization of the Furnace Brook Watershed in Marshfield, Massachusetts: Potential Impact of Water Supply Extraction

ERIK CROLL



An understanding of conjunctive use of surface water and groundwater is essential to resource management, both for sustained public use and watershed conservation practices. The Furnace Brook watershed in Marshfield, Massachusetts supplies a coastal community of 25,132 residents with nearly 45% of its town water supply (Marshfield 2012a). As in many other coastal communities, development pressure in Marshfield has increased in recent years, creating a growing demand for freshwater extraction. It has been observed, however, that portions of the stream and Furnace Pond disappear entirely at certain times of year, generally between June and August, depending on the rate of groundwater extraction. This has created a conflict between protecting the designated wetland areas and meeting public pressure for water resources, even within what is traditionally viewed as a humid region. “Exchange of groundwater and surface water occurs in most watersheds and is governed by the difference between the water-table and surface water elevations” (Healy 2010), even though public water supplies and wetlands are often viewed legally as separate resource entities.

Questions have arisen as to whether the town’s water extraction is excessively lowering the water table and potentially endangering the health of the stream. This study set out initially to characterize the lowered water table and identify possible anthropogenic and natural influences acting upon the watershed, including stream flow obstructions, water extraction, and geologic conditions. Water-table data were correlated with town pumping information, previous geologic surveys, and meteorological data. Previous analyses indicated that the stream behaved in an anomalous manner by decreasing in discharge, even while flowing downstream, despite normal precipitation inputs.

The behavior within this particular watershed appears to be influenced by four primary factors resulting in the stream “running dry” during the June-August period. These factors include: (1) A losing gradient induced by well pumping; (2) Obstructions to stream flow from the upper reaches to the lower reaches of the watershed; (3) A highly anisotropic layer of lower conductivity material regulating infiltration rates; and (4) Evapotranspiration that results in a deficit situation during the summer. Additionally, relationships between well pumping

and decreasing discharge, seepage flux loss rates, and hydraulic gradients, have demonstrated that even within humid regions, it cannot be assumed that aquifer recharge is sufficient to avoid conflict between surface water protection and groundwater utilization in watersheds. In other words, rainwater and melted snow do not provide sufficient public water supply. Timing of precipitation events combined with geological governance of aquifer recharge play critical roles in managing the conjunctive use of water resources and cannot be assumed to have a negligible effect, even within relatively humid regions.

Introduction

The Furnace Brook is a three-mile, first-order stream that flows from its origins in the Marshfield and Carolina hills, proceeds along a valley southward and onto the southeastern Massachusetts glacial coastal outwash plain, before ultimately joining the South River. The associated drainage basin (or watershed) for Furnace Brook has an area of 2.25 square miles. Topographically, the basin elevations range from 260 feet to near sea level at the South River, with the stream elevations ranging from 90 feet at its head to 10 feet at its convergence with the South River. The surficial geology of the watershed is typical of Southern New England, comprised of glacial tills outwash, and ice channel deposits left during the retreat of the Buzzards Bay Lobe of the Laurentide ice sheet. The northern sections of the watershed have a poorly sorted, unstratified sediment mixture ranging from clay to boulders, while the outwash flowing southward is typically horizontally bedded, glaciofluvial sands and gravels (SAIC 1990). The climate is considered humid by the Koppen Index, with an average annual precipitation of 50-54 inches in the form of rain and snow inputs to the basin (NCDC 2012).

While it is not unusual for a stream to have sections go dry intermittently in the summer, the Furnace Brook exhibits an abnormal pattern in its behavior during the summer dry periods. While it would be expected that a normally behaving stream might dry up in response to lower precipitation during dry summer months, the stream response to lack of input would begin with the upper reaches and then proceed downstream, depending on the length and severity of the drought condition. Furnace Brook, however, does not show this pattern; in the Furnace Brook stream, the mid-reaches go intermittent first, followed by the upper reaches; the lowest reaches actually stay wet. This abnormally intermittent stream behavior indicates that some other factor(s) besides drought must be at work and serves as an indicator of imbalance within the watershed.

Additionally troubling is the annual disappearance of Furnace Pond, which is located adjacent to Furnace Brook Well #1. The Pond lies within a topographic low in the watershed and is bounded on its southerly discharge end by a dam. It is highly likely that the pond owes its existence to the dam impeding stream flow. The current watershed ecosystem appears to have developed in response to the presence of the dam and the pond that it formed. The disappearance of the pond every summer, as with the disappearance of sections of the stream, indicates a watershed system in imbalance. The question then emerges: if the water input is normal for this humid region, where has the water gone? Is there sufficient recharge of the aquifer to support growing groundwater extraction in conjunction with watershed ecosystem protection?

Traditional water accounting methods simply compare average precipitative inputs (assets) to groundwater extraction, stream discharge and, if known, average evapotranspirative (ET) effects (deficits). Any remaining volume of water input is assumed to recharge the aquifer at rates controlled by the hydraulic conductivity of the geologic material within the region. Following this methodology, assets in this humid-region watershed outweigh the deficits; therefore the watershed should provide adequate water for current and projected extraction needs. It becomes readily apparent, however, that there are two potential flaws in this approach to water resource availability. First, this approach assumes that conductivity is uniform throughout the basin, and any remaining water will infiltrate into the subsurface at a known rate. Second, this approach fails to take into account that while the extraction rates may not be exceeding the recharge potential for continued public-water supply use, the amount that can be safely extracted before negatively impacting watershed ecosystems is likely to be far less than the overall aquifer capacity.

The main objectives of this research are to (a) characterize and gain insight into abnormal stream behavior at Furnace Brook watershed, and (b) to examine whether or not the town's water-extraction volumes are inducing the losing nature of the stream.

Methods

To seek answers to these questions regarding pond and stream intermittency abnormalities and the town's water extraction, an initial characterization of the watershed, including stream flow parameters, geological conditions, and water balance inputs/outputs, was undertaken over a six-week period between May and July, 2012. The study region was narrowed to the output

from Parsons Pond into the South River as its terminus, with the area of contribution subsequently plotted on the most recent USGS Topographic map (Chute 1965).

The basin perimeter and stream courses were evaluated in the field to check for obstructions and diversions and to verify the accuracy of the area of contribution delineations. This field survey was integrated with existing Town of Marshfield planning maps to create a watershed basin map for this study. Within this framework, the town extraction wells were plotted on the map, and sub-basin monitoring stations were established in relation to the areas of interest, i.e., the town wells, the disappearing reach designated as sub-basin #2, and Furnace Pond. At the terminus of each sub-basin the monitoring stations (MS-#) were established; they consisted of (a) an elevation reference baseline from which to measure depth to stream, depth to groundwater, and stream cross-section area; (b) a seepage meter for volume gain/loss through the streambed; and (c) mini-piezometers for groundwater level/gradient measurement. It should be noted that while each reference baseline was leveled and plotted by GPS for reference consistency, elevation measurements cannot be taken as absolutes since full survey teams were not employed.

Stream discharge calculations were made at each location utilizing a Marsh-McBirney Flowmate 2000 in conjunction with a wading rod. Due to stream depths being 2 feet or less, measurements were conducted in 1-foot, cross-sectional areas at 60% measured stream depth, in accordance with standard protocols (Carter and Davidian, 1968). Volume of stream discharge was thus calculated as: $Q = \sum (A_n * V_n)$ where the discharge Q is equal to the Sum of the Areas of sub-cross sections, A_n multiplied by the corresponding water velocity of that cross-section, V_n . The data were interpolated to fill in gaps created by the fact that physical measurements could not be conducted every day. A simple progressive/regressive average was utilized in graphing and analysis of trend behaviors. Station and basin discharges were then plotted in cubic feet per second (cfs) and in comparison with town extraction volumes in cubic feet per day (cfd).

Correlation analysis was conducted using a Pearson method correlation to determine if there was a statistical relationship between extraction rates and discharge responses.

Seepage meters were fabricated utilizing a modified design from Lee and Cherry (1978) and Rosenberry et al. (2008).

Due to stream size, designs were modified to use a 1-gallon can with smooth sides rather than 55-gallon drums of the original design, to yield a cross-sectional area of seepage measuring 0.23 feet². The meter was sunk into the streambed to a depth of 8 inches. The outlet consisted of a ¼ ID hose barb sealed to the meter body with hose, a check-valve coupler, and impervious chemical media bag. At the start-time of seepage measurement, the chemical media bag, filled to half-capacity with 500ml of water, was attached to the hose to begin flow. One hour later the bag was removed, and the volume of water gained or lost through the meter was measured. The rate of water volume gained/lost through the streambed in the hour time (seepage flux rate or Q) was then calculated as: $Q = dV/dt = V_{final} - V_{initial} / \text{Elapsed Time}$. This result was then converted into foot³/day for comparison with other parameters, such as pumping-extraction volumes and stream discharges.

Mini-piezometers were constructed with ¾ in. PVC as described in Lee and Cherry (1978) and driven to a depth whereby the screen was within 4 inches of the surface water table, as indicated by the stream level at a lateral distance of 4 to 6 feet from the stream bank, as allowed by local geology. In cases where the groundwater was at lower elevation or dropped below original piezometer depth during the period, separate piezometers were added in 6-inch-depth increments to create a nest of piezometers for groundwater measurement. Meteorological data were provided by Stanwyck Avionics, Ltd at Marshfield airport (KGHG) and three nearby National Weather Service Stations (Stanwyck 2012; NWS 2012), while the water-extraction volumes were supplied by the Town of Marshfield for the five wells located within the study basin. Basin geologic data were obtained from geophysical and monitoring well studies conducted by SAIC Engineering, Inc. (1990).

FINDINGS

Stream Behavior

Field observations during the study period noted multiple factors affecting the watershed behavior. First, various obstructions to stream flow prevented normal contribution from the upper reaches to the lower reaches of the basin, resulting in free standing pools of water. The obstructions consisted of deadfalls and debris, perched culverts, modified flow channels, and the two dam structures located at Furnace Pond and Parson's Pond. It was observed that during most of the study period, the stream water level was too low to pass

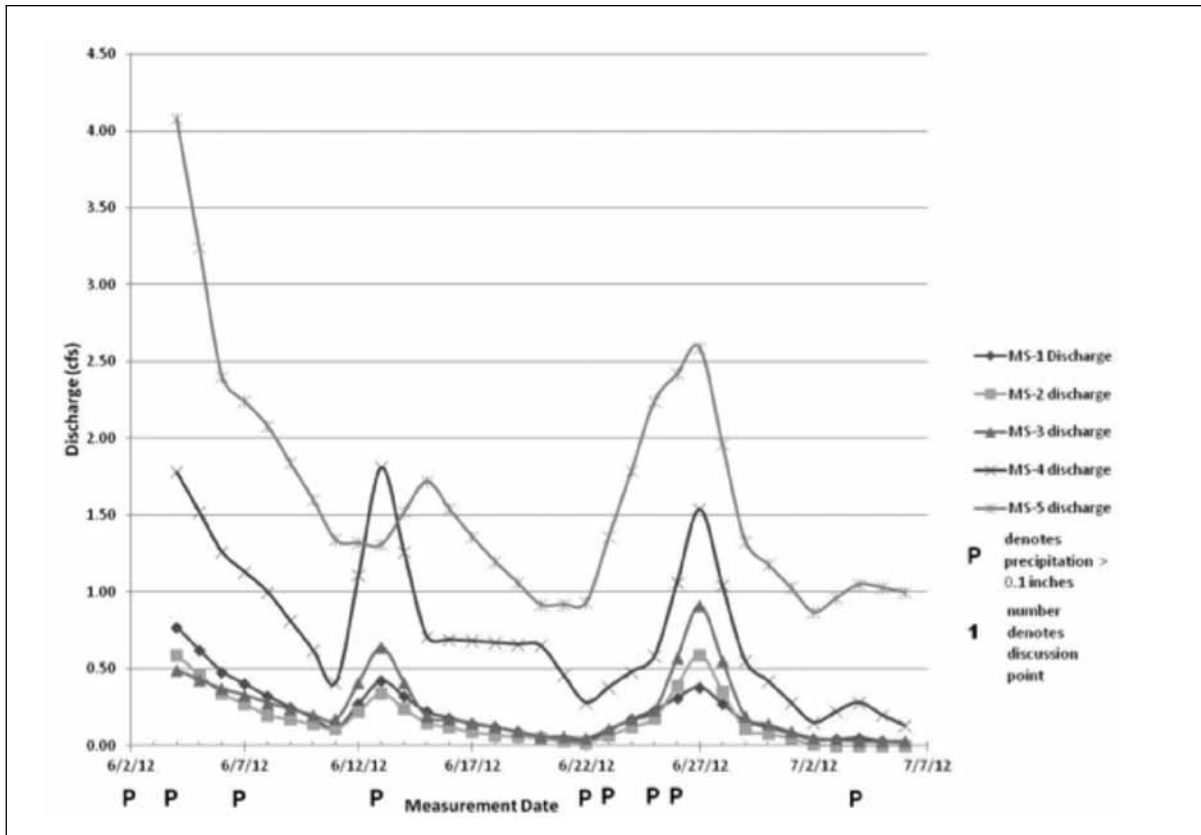


Figure 1. Furnace Brook Stream Discharge from June 4-July 6, 2012 at each sub-basin Monitoring station.
Sources: field data collection.

these obstructions; therefore, surface water contributions from the upper reaches failed to get to the lower reaches, which reduced stream discharge. In Figure 1, the stream discharge pattern over the study period can be observed.

When overall stream discharge was correlated with basin extraction volumes, a pronounced negative correlation became apparent (Fig. 2).

Throughout the sub-basins, similar correlations could be observed in relation to the pumping rates. When this finding is further examined in relation to the rate of water loss through the streambed to groundwater throughout the basin (as seen in Table 1), it appears that stream losses are correlated with public water-supply extraction.

Table 1. Seepage Flux Basin Summary

Basin Mean:	-0.083
alpha:	0.050
Sample (n):	31.000
Correlation (r):	-0.568
r critical:	0.349

While seepage flux rates did not always correlate at individual sub-basin stations, this was expected due to the anisotropic nature of the glacial outwash and till throughout the basin, as reported by SAIC.

Gradient data from piezometers were inconclusive in providing a clear picture of surface and groundwater interaction. While it is interesting to note that, as could be expected, certain reaches had a gaining gradient, while others experienced a losing gradient, the few piezometers installed (in some cases only 1 or 2 per station), did not provide enough data to build a comprehensive groundwater flow picture. In addition, piezometers were not installed specifically at Furnace Pond to determine if there was a sharp losing gradient to the adjacent well. Data did show, however, that the reaches with the greatest losing gradients also happened to be in locations with the greatest pumping extraction volumes. Notably, the two stream reaches of greatest concern, that of the MS-2 sub-basin and the Furnace Pond, which both go dry annually, coincided with the highest town extraction volumes of 2,259,707 and 1,863,335 ft³ extracted from the adjacent Furnace Brook #4 and Furnace Brook #1 wells (Marshfield 2012b).

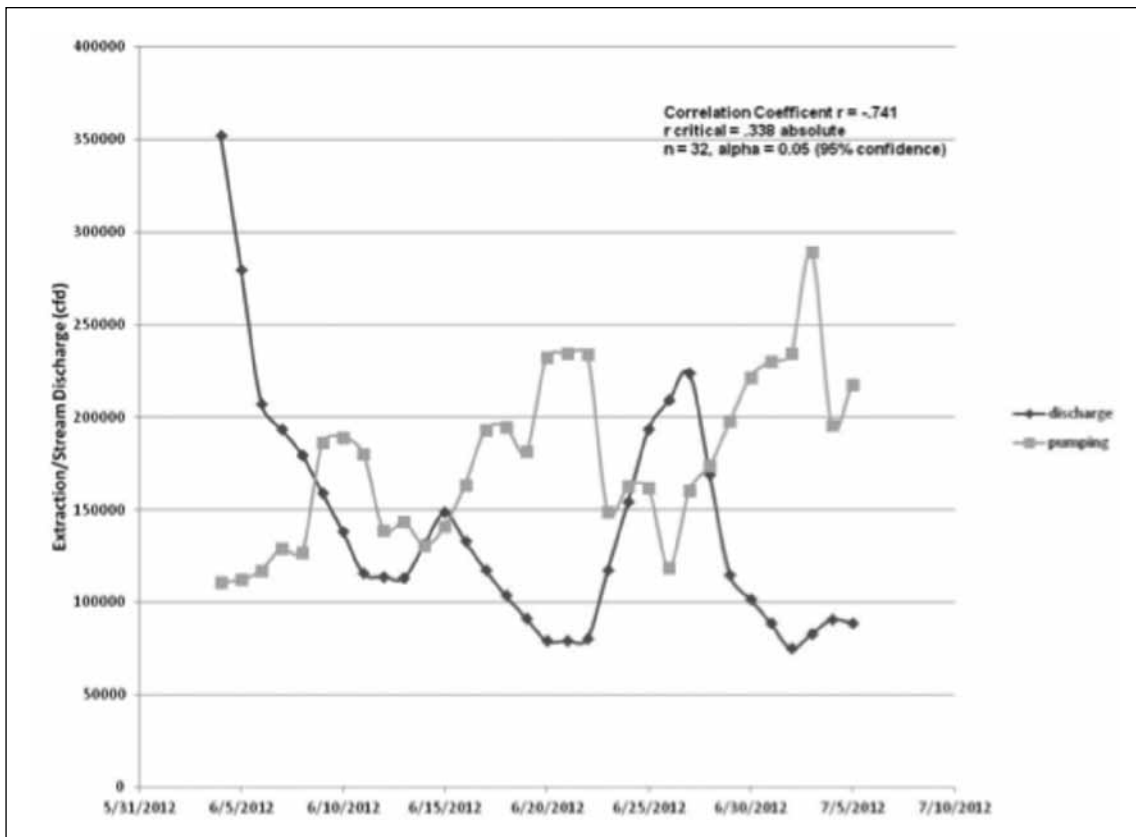


Figure 2. Pumping rate and stream discharge vs. time for the Furnace Brook in cubic feet/day for the Furnace Brook Watershed Basin from June 4-July 6, 2012. Sources: field data collection and Town of Marshfield unpublished raw data 2012.

Meteorological/Climate Data

Meteorological data indicate a normal rainfall input to the basin during the study period: 3.68 inches, or 0.31 ft (Stanwyck 2012; NWS 2012). This rainfall data is consistent with National Climate Data Center (NCDC) information that records an average June precipitation input of 3.55 inches (NCDC 2012). It should be noted, however, that average regional ET effects calculate that 4.49 inches, or 0.37 ft (GeoSyntec 2010), are lost during the June period, indicating that the basin is potentially in a deficit situation even without any aquifer extraction, as summarized in Table 2.

Sources: Stanwyck Avionics, Inc. Meteorological Data Reports, 2012. National Weather Service Daily Meteorological Reports, 2012. GeoSyntec Consultants 2012.

These data indicate that for recharge calculations, the annual precipitation trends, especially winter precipitation, become critical. Data collated from the NCDC regarding average annual precipitation indicated that 50.4 inches of precipitation fell the previous year. This precipitative input was found to be 3.63 inches lower than the normal median annual precipitation

of 54.03 inches. When precipitation input to the basin over the preceding year was examined, it was found that the region received only 1.2 inches of precipitation in the form of melted snow, compared to the annual average of 5.49 inches of melted snow. (WeatherSource 2012).

Discussion

In observing Furnace Brook during the study period the most immediate aspect that became apparent was the extremely low contribution that the upper half of the basin makes to the lower reaches. This is quantified by examining the stream discharge patterns at MS-1 through MS-3 (Figure 1). Other than during actual precipitation events, the discharge at each station was extremely low. In the case of the MS-2, the most rapid disappearance of discharge was *downstream* (at the intermediate reach), which is highly unusual. It is concluded that very little if any contribution is being made to subsequent reaches of the stream. This decrease appeared, based on field observations, to be a condition created by numerous stream obstructions, including perched culverts, tree deadfalls, and in one case within the MS-1 sub-basin, a hiking trail built across the stream with a blocked or non-existent culvert. Due to these

Table 2. Precipitation/Evapotranspiration Summary June 4 – July 6, 2012

	Monitoring Stations/Sub-Basin					Total Study Basin Area
	MS-1	MS-2	MS-3	MS-4	MS-5	
Total Input EUD (ft):	0.31	0.31	0.31	0.31	0.31	0.31
Evapotranspiration (ET) (ft):	0.37	0.37	0.37	0.37	0.37	0.37
Sub-Basin/Basin Area (ft ²):	23,139,072	4,181,760	18,120,960	10,872,576	6,412,032	62,726,400
Precipitation Input Vol. (ft ³):	7,173,112	1,296,346	5,617,498	3,370,499	1,987,730	19,445,184
ET Output Vol. (ft ³):	8,561,457	1,547,251	6,704,755	4,022,853	2,372,452	23,208,768
Volume Gain/Loss (ft ³):	-1,388,344	-250,906	-1,087,258	-652,355	-384,722	-3,763,584

conditions, each of the upper sub-basins essentially became isolated, reducing overall stream flow throughout the system.

During precipitation events these obstructions could be overcome initially, but once water levels decreased, flow became isolated again, with only limited seep past the obstructions, which contributed in a normal pattern to subsequent reaches downstream. The net result was that each sub-basin was isolated in its area of contribution and if, as in sub-basin #2, there was a smaller geographic area of contribution, the isolated sub-basin became increasingly susceptible to negative impacts from groundwater extraction.

The stream discharge curves in Figure 1 show a rapid response to precipitation and an extremely sharp recession following peak events. This is indicative of a stream that is highly responsive. If stream flow were normal, gradual sloped recession curves would be expected; there would be phasing of flow peaks from the upper reaches to lower reaches over time. Instead, there are mirror images of increase and decrease on either side of the precipitation event, which highlights the isolated nature of each sub-basin caused by the obstructions. The erratic behavior of MS-4 discharge is believed to be a result of the dam structure at Furnace Pond; however, a more definitive study would need to be conducted on this structure to further investigate the stream behavior in relation to the dam condition.

By examining these discharge curves in relation to the surficial geology, the idea that the aquifer is comprised of an anisotropic mix of unstratified glacial till upstream with increasing outwash downstream, seems to be supported. An examination of the area of contribution for the lower reaches at MS-4 and 5 shows that despite their having small areas of contribution coupled with limited input from upper reach sub-basins, they retained the highest discharge flows and stream water levels.

In addition to those observations at MS-4 and 5 (small areas of contribution, limited input from upper reaches, yet high discharge flows and water levels), sub-basin seepage rates in those lower reaches are also slower. Slow seepage rates at MS-4 and 5 indicate that the lower reaches likely have lower conductivity layers of outwash silts/clays, which reduce the rate of infiltration from surface water to groundwater. Conversely, the upper reaches of the stream experienced the highest seepage loss rates; that is consistent with the upper half of the basin having a greater hydraulic conductivity of unsorted glacial material. While a further geologic survey is needed to determine the full extent of the lower conductivity regions, the limited data from the SAIC study of 1990 seems to support the idea that while the upper half of this basin is more suitable to groundwater extraction, it is also more susceptible to negative impacts from the extraction.

Given these observations, the question of whether town water-extraction influenced stream and pond loss the correlation between stream discharge, seepage flux loss rate, and town extraction volumes is hard to ignore. This, however, does not tell the whole story. It must be acknowledged that at the time of this study while the monthly rainfall input was normal, the preceding year was one of reduced input, especially with regard to water-equivalent snow input.

Further, the regional evapotranspiration (ET) effect indicates that during the primary growing season, ET exceeds precipitative input, which means that the watershed is in a deficit situation prior to any extraction of groundwater. This data is preliminary at best, however, and additional studies are needed to study the actual evapotranspiration within this watershed (rather than a regional average) to determine whether the basin truly is in deficit situations during the primary growing spring season.

Conclusion

The correlation between the town's increased water-extraction rates and decreased stream flow simply cannot be ignored. While correlation does not mean causation, in absence of other definitive explanations, the town's water pumping must be considered a significant factor in decreased stream flow. However, it is highly unlikely that the stream and pond disappearance observed in the Furnace Brook watershed are the result of this single cause (public-water extraction). While the town's water-extraction volumes do appear to be inducing seepage loss through the stream bed as a result of losing gradients, there are numerous other factors influencing the behavior of the stream and specifically the summer disappearance of the stream at the intermediate reach of sub-basin 2 and of Furnace Pond itself. The isolation of sub-basin areas caused by obstructions, variable hydraulic conductivity of geologic material, evapotranspiration effects, and climate/meteorological trends, all exert significant controls upon aquifer recharge and stream discharge; all of these factors should be taken into consideration when determining sustainable, safe yields that may be extracted from the watershed. While traditional methods of calculating aquifer recharge may be sufficient in estimating water available for extraction, these other controls appear to reduce the amount of water that may be safely extracted before there is a negative impact on overall watershed health. As seen in the Furnace Brook during this study, often the stream itself can be the first indicator of a conjunctive-use watershed being under stress, and therefore should be monitored in relation to the controlling factors presented in order to effectively balance the needs of both public-water supply demand and watershed protection.

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The Effects of Earlier School Start Times on Cognition and Sleep in Children Ages 7-10

KIMBERLY BRYANT



Kim Bryant graduated in May 2012 from Bridgewater State University with a Bachelor of Science

in Psychology. This research began in the spring of 2011 as part of the Adrian Tinsley Program Summer Grant under the direction of Dr. Sandra Neargarder. She presented this research at the 2011 ATP Summer Symposium, at the 2012 National Conference on Undergraduate Research in Ogden, Utah, and at Bridgewater State University's 2012 Undergraduate Symposium. This research was also part of her Honors Thesis in Psychology. Kim continues to work in research as a Clinical Research Assistant in the Neuropsychology Program at Rhode Island Hospital.

Adolescent sleep deprivation has been the focus of recent research; its primary cause is a shift in adolescents' biological rhythms (Carskadon, Wolfson, Acebo, Tzischinsky, & Seifer, 1998). As a result, many school systems have chosen to restructure their school start times to allow high school students to start school later, resulting in younger students going to school earlier. Despite the research describing the benefits this change in school start times will provide adolescents, there has been virtually no research regarding its effects on younger children. This study examines the effects that a change in school start time between 2nd grade and 3rd grade has on younger children's cognitive performance (CPT II and Digit Symbol) and sleep (actigraph and CSHQ). Participants consisted of two groups: a control group, who started school at 9:00 a.m. in 2nd and 3rd grade, and an experimental group, who changed to an earlier start time from 2nd (9:10) to 3rd (7:45) grade. Results showed no significant within or between group differences in 2nd or 3rd grade on the cognitive measures. Three trends were present from 2nd to 3rd grade, in the experimental group (total number correct, hit reaction time) and the control group (hit reaction time). Correlations existed between some of the sleep and cognitive measures. Results suggest that earlier school start times do not have adverse cognitive effects on school-aged children.

Sleep deprivation has negative effects on adolescents. Specifically, lack of quantity and quality of sleep has been associated with impaired school performance (Lack & Wright, 2007; Drake et al., 2003) and cognitive abilities (Pilcher & Huffcutt, 1996; Sadeh, Gruber, & Raviv, 2003), including impaired sustained attention (Sadeh et al., 2003), response inhibition (Sadeh et al., 2003) speed of processing (Fallone, Owens, & Deane, 2002), and short-term/working memory (Beebe, DiFrancesco, Tlustos, McNally & Holland, 2009). Adolescents on average require 9.25 hours of sleep a night in order to function normally (Carskadon, Wolfson, Acebo, Tzischinsky, & Seifer, 1998; National Sleep Foundation, 2006). It has been suggested that adolescents should adopt an earlier bedtime to ensure they receive an adequate amount of sleep given their early wake time on school days. Research suggests, however, that this solution is problematic as there are both biological and social/environmental barriers preventing adolescents from doing so (Carskadon et al., 1998; Steinberg, 1996; Wolfson & Carskadon, 1998). Examples of social/environmental barriers include social life (going out/hanging out with friends), after school jobs, extra curricular activities, homework, as well as unlimited access to technology (internet, cell phone, TV, etc.).

This change in sleep in adolescence may be due to a biological barrier called a “sleep phase shift” which refers to the body’s natural shift in its circadian rhythm or 24-hour sleep cycle (Carskadon et al., 1998; Lack & Wright, 2007). The National Sleep Foundation (2010) indicated that regardless of level of sleepiness, adolescents have trouble falling asleep before 11 p.m. This makes it extremely difficult for adolescents to get the amount of sleep they need each night, especially on school nights. Drake et al. (2003) conducted a study of 450 eleven to fifteen year olds (sixth, seventh, and eighth grade) and found that 70% of eighth graders, 43% of seventh graders, and only 38% of sixth graders reported going to bed at 11 p.m. or later on weeknights. In addition, a 1998 survey of approximately 3,000 high school students from ninth through twelfth grade indicated they had an average total sleep time on a school night of seven hours and twenty minutes (Wolfson & Carskadon). This is a large discrepancy from the 9.2 hours of sleep a night that adolescents biologically need (Carskadon, Harvey, Duke, Ander, & Dement, 1980) in order to achieve optimal alertness during the day (Carskadon et al., 1980; Carskadon, 1982). In the same survey, results also indicated that students with higher grades reported longer and more regular sleep, and earlier bed-times on school nights than students with lower grades.

An alternate solution in dealing with this biological barrier is to start school at a later time thereby providing students with extra time to sleep. Lufi, Tzischinsky, & Hadar (2011) conducted a study examining the effects of different school start times on cognition. Results showed that when the school start time was delayed by one hour for five days, the participants in the experimental group slept an average of 55 minutes longer each night compared to the control group, who attended school at the regular time. Also those who slept longer performed better on a continuous performance test known as the Mathematics Continuous Performance Test (MATH-CPT; Lufi, 2006), which is a test that assesses attention. The authors recommend delaying school start time by at least one hour, as it would improve attention and decrease mistakes due to impulsivity. Carskadon, Acebo, Richardson, Tate, & Seifer (1997), made a similar recommendation stating that high school should begin after 8 a.m. This approach is currently being adopted by various high schools throughout the United States (Kirby, Maggi, & D’Angiulli, 2011). Because most schools run on a tiered bus system, however, this new plan often forces the elementary school children to start school much earlier than they had previously by switching the elementary school and high school start times. This is done to eliminate any costs that changing the bus schedule might cause. These findings highlight the inconsistencies that exist between adolescent sleep needs and the schedules that are imposed on them (i.e. school start time). Specifically, the 9.25 hours of sleep adolescents require each

night cannot be achieved if they biologically have trouble falling asleep before 11:00 p.m. (in addition to any environmental/social factors) and start school before 8:00 a.m. Adolescents cannot be expected to perform well in school if they are deprived of necessary sleep.

Unlike adolescents, there are currently no known biological or social barriers preventing school-aged children from going to sleep earlier. The only known potential barriers in healthy school-aged children are environmental (Stein, Mendelson, Obermyer, Amromin, & Benca, 2001), for example, having a TV in a child’s bedroom that keeps them up later than they would naturally stay up, which the caregiver can easily manipulate. As a result, many school systems have implemented this change in school start time for school-aged children, with the impression that it will have no adverse effects on their school performance or cognitive abilities. The purpose of this study, therefore, was to examine the effects of earlier school start times on school-aged children’s sleep and cognitive abilities.

PRESENT PROJECT

It appears that a later school start time may be beneficial for adolescents, but the effects of an earlier start time on school-aged children is unknown. The present study attempts to address this gap in the literature by longitudinally examining sleep and cognition in a control and an experimental group of school-aged children. The school start time for the experimental group was shifted to an earlier time (7:45 a.m. from 9:10 a.m.) as the children entered third grade and remained the same for the control group (9:00 a.m.). Sleep patterns were measured with actigraphy for three nights in second grade and again in third grade. In a within group design, sleep variables and cognitive performance scores were compared from second to third grade. Between groups analyses were used to compare the experimental and control groups from second to third grade to determine if there was a significant change in sleep variables and cognitive performance. This experiment had a two-tailed hypothesis as it was unclear whether or not school start times would adversely affect the experimental group.

METHOD

Participants

There were 10 participants (three males, seven females) ages seven to ten years old, all of which were in the second grade for the first data collection period (time₁) and the third grade for the second data collection period (time₂) with a one-year inter-test interval. The control group consisted of six participants (three females, three males) from Pembroke, MA and the experimental group consisted of five participants (four females)

from Duxbury, MA. Both towns were relatively similar socio-economically and demographically and the schools began at similar times during time₁, 9:00 a.m. and 9:10 a.m. respectively and shifted to 7:45 a.m. for the experimental group during time₂. Informed parental consent and child assent approved by the Boston University Medical Center Campus Institutional Review Board was obtained. Exclusion criteria consisted of the use of the Child Behavior Checklist (Achenbach & Rescorla, 2001) as a parental report of any neurodevelopmental disorders or psychiatric disorders, and the Children's Sleep Habits Questionnaire (CSHQ; Owens, Nobile, McQuinn, & Spirito, 2000) which provided reports of sleep disordered breathing and reports of the child taking medications that impacted sleep (psychostimulants). There were no participants excluded from the original group based on these criteria but one participant dropped out after the first data collection period so her data were excluded from the study.

Measures and Procedure

The measures administered to both the control (Pembroke) and experimental (Duxbury) groups included the Conners' Continuous Performance Test II (CPT II; Conners, 2000) and the Digit Symbol Coding B from the Wechsler Intelligence Scale for Children 4th edition (Wechsler, 2003). Sleep variables were measured using actigraphy (AW-64, Respironics, Bend, CO) and the Child Sleep Habits Questionnaire (CSHQ; Owens et al., 2000).

As mentioned previously, the focus of this paper is on the cognitive assessments. Descriptions of the sleep measures are provided, however, as correlations will be performed between the cognitive and sleep measures.

Cognitive Assessments

Conners' continuous performance test II. (CPT II; Conners, 2000) The Conners' Continuous Performance Test II is a computerized test of sustained attention and response inhibition, intended for individuals' ages six years and older. Both sustained attention and response inhibition are affected by sleep deprivation (Sadeh, Gruber & Raviv, 2003; Lufi, Tzischinsky & Hadar, 2011). This particular test was chosen for its complexity and length because if the test isn't complex enough or long enough it might not be sensitive to the attention deficits due to sleep deprivation (Sadeh et al., 2002). Each participant sat at a laptop computer and was instructed to press the space bar each time a letter appeared on the screen except for the letter "X." Each letter that appears on the screen is white and always appears on a black background; each letter is also the same size and same font. There is an inter-stimulus interval of one, two, and four seconds with each letter having a display time of 250 milliseconds. The test is divided into six separate

blocks and three sub-blocks with 20 letter presentations each. The different inter-stimulus intervals presented vary between blocks. Each participant was administered a short practice test to ensure they understood the task and then the actual test began and lasted for a total of 14 minutes. Measures include omissions or failure to respond to target letters (non-X's) (test-retest reliability .84), commissions or responses given to non-targets (X's) (test-retest reliability .65), and hit reaction time or the average speed of correct responses (test-retest reliability .55). The CPT is based on a database of 2,686 clinical and non-clinical participants.

Digit symbol coding b. (Wechsler, 2003) This is a test of attention and speed of processing and is intended for participants' ages eight to sixteen years old. The participant was given an 8.5" x 11" sheet of paper and at the top was a key that included a row of numbers 1-9, each had a corresponding symbol underneath. Below were six rows with 21 boxes in each row, containing randomly ordered numbers (1-9) with an empty box below each number. After the key was explained to the participant, they were asked to complete seven empty boxes by filling in the corresponding symbol as a practice exercise. After completing the practice exercise, the participant was instructed that they had two minutes (120 seconds) to write as many correct symbols under their corresponding number as they could. At the end of two minutes, the paper was removed and the participant was then asked to do a free recall. For the free recall, the participant was given a blank sheet of paper and instructed to write down any symbols they could remember from the assessment. At the end a total raw score is calculated of the number of correctly drawn symbols with 119 representing the maximum score. The test is then broken down into 15-second increments and the number correct and incorrect is recorded for each of the eight increments. Measures include total number correct and total number incorrect.

Sleep Behavior

Actigraphy. (AW-64, Respironics, Bend, CO) Actigraphy is a commonly used method of continuously recording gross motor activity in order to determine the sleep pattern for an individual in a naturalistic environment (as opposed to a laboratory setting). This is advantageous for keeping the participant's sleep schedule as routine as possible, which is difficult to do in a laboratory setting. Each participant was fitted with an actigraph, (a watch-like device) on their non-dominant wrist and was worn day and night without being removed for three nights. According to Gruber et al. (2010) a minimum of three consecutive nights of actigraphy recording is required for reliable measures. The actigraph records each movement that is made by the participant and each movement is visually represented as a tic mark. Areas with a lot of movement are

Table 1. Summary of Cognitive Analyses

	Control vs Experimental Time 1	Control vs Experimental Time 2
CPT II		
Omissions	n.s.	n.s.
Commissions	n.s.	n.s.
Hit Reaction Time	n.s.	n.s.
Digit Symbol		
Total Number Correct	n.s.	n.s.
Total Number Incorrect	n.s.	n.s.
	Time 1 vs Time 2 Control	Time 1 vs Time 2 Experimental
CSHQ		
Omissions	n.s.	n.s.
Commissions	n.s.	n.s.
Hit Reaction Time	n.s.	p = .07 (lower at Time 2)
Digit Symbol		
Total Number Correct	n.s.	p = .07 (lower at Time 2)
Total Number Incorrect	n.s.	n.s.

shown as much more dense with tic marks and areas with less or no movement are shown as very few tic marks or as blank space. The actigraph was used in conjunction with a sleep diary. The sleep and wake times recorded in the sleep diary for each participant were manually entered into the actigraph data and used to calculate the actigraph variables.

The sleep measures pertinent to the current project included total sleep time, sleep fragmentation, and sleep efficiency. Total sleep time refers to the amount of time that an individual actually spends sleeping as opposed to the time spent in bed (Paavonen et al., 2010). Sleep fragmentation refers to how many times an individual wakes during the night (Paavonen, Raikonen, Pesonen, Lahti, & Komsa, 2010; Sadeh et al., 2003; Sadeh et al., 2002). Sleep efficiency refers to the percentage of time spent in sleep during the reported time in bed (Acebo et al., 1999; Paavonen et al., 2010).

Children sleep habits questionnaire. (CSHQ; Owens et al., 2000) This questionnaire is intended for children ages four through twelve to screen for common sleep problems prominent in this age group. This questionnaire was given to the

parents to fill out while the child was being fitted with the actigraph and was then collected upon completion of the data collection. Questions included items such as, "Child sleeps the same amount each day," "Child awakens more than once during the night," and "Child takes a long time to become alert." Each of the questions is answered "usually," "sometimes," or "rarely," with "usually" representing five to seven times a week, "sometimes" representing two to four times a week, and "rarely" representing zero to one time a week. In addition, it is asked whether or not each question is a problem sleep habit and answers include "Yes," "No," or "Not applicable N/A." There are 33 individual questions included in the total score and 35 when broken into subscales, as there are two questions that are used in two of the subscales. In both the total score and the subscale ratings, a higher score indicates more sleep problems. The measures that were used in the present project included sleep duration (test-retest reliability 0.40), night wakings (test-retest reliability 0.63), and daytime sleepiness (test-retest reliability 0.65). The reliability and validity data for the Children's Sleep Habits Questionnaire is based on a sample of 469 children ages four to ten years old (community sample) and a clinical sample of 154 patients that have been diagnosed with sleep disorders.

RESULTS

To assess the effects of an earlier school start time on cognitive measures, results were calculated using a series of non-parametric t-tests called the Mann-Whitney U test (Mann & Whitney, 1947) as the between-subject comparison (comparing the experimental [Duxbury] and the control [Pembroke] groups at time₁ and time₂) and the Wilcoxon sum-rank test (Wilcoxon, 1945) as the within-subject comparison (comparing the experimental group at time₁ and time₂ and comparing the control group at time₁ and time₂), which were chosen because of the project's small sample size (control, $n = 6$; experimental, $n = 4$). Three different dependent variables were analyzed with regard to the CPT II including omissions, commissions, and hit reaction time. Two different dependent variables were analyzed for the Digit Symbol coding B test including total correct and total incorrect. Both group (Mann-Whitney U test) and time (Wilcoxon sum-rank test) were the independent variables utilized, equaling a total of twenty analyses (see Table 1 for a summary of analyses). In addition, Spearman's Rho was used to correlate the previously mentioned cognitive, dependent variables with several sleep variables including sleep efficiency, total sleep time, and sleep fragmentation, all actigraphy variables, and sleep duration, night wakings, and daytime sleepiness from the CSHQ.

Cognitive Measures

Conners' continuous performance test II. Omissions in the experimental group ($Mdn = 2.5$) did not differ significantly from the control group ($Mdn = 5$) at time₁, $U = 5.00$, $z = -1.52$, $p = .13$. At time₂, omissions in the experimental group ($Mdn = 1.5$) did not differ significantly from the control group ($Mdn = 4.5$), $U = 6.00$, $z = -1.29$, $p = .20$. Omissions in the experimental group at time₁ ($Mdn = 2.5$) did not differ significantly from omission in the experimental group at time₂ ($Mdn = 1.5$), $z = -.73$, $p = .47$. Moreover, omissions at time₁ for the control group ($Mdn = 5$) did not differ significantly from omissions for the control group at time₂ ($Mdn = 4.5$), $z = -.31$, $p = .75$ (see Figure 1).

Commissions in the experimental group ($Mdn = 19$) did not differ significantly from the control group ($Mdn = 28$) at time₁, $U = 5.50$, $z = -1.39$, $p = .16$. At time₂, commissions in the experimental group ($Mdn = 15.5$) did not differ significantly from the control group ($Mdn = 28$), $U = 5.50$, $z = -1.39$, $p = .16$. Commissions at time₁ for the experimental group ($Mdn = 19$) did not differ significantly from commissions for the experimental group at time₂ ($Mdn = 15.5$), $z = -1.47$, $p = .14$. Moreover, commissions time₁ for the control group ($Mdn = 28$) did not differ significantly from commission for the control group at time₂ ($Mdn = 28$), $z = 0.00$, $p = 1.00$ (see Figure 2).

The hit reaction time in the experimental group ($Mdn = 506.18$) did not differ significantly from the control group ($Mdn = 470.61$) at time₁, $U = 6.00$, $z = -1.28$, $p = .20$. At time₂, the hit reaction time in the experimental group ($Mdn = 475.27$) did not differ significantly from the control group ($Mdn = 466.72$), $U = 9.00$, $z = -.64$, $p = .52$. There was a trend present between the hit reaction time at time₁ for the experimental group ($Mdn = 506.18$) and the hit reaction time for the experimental group at time₂ ($Mdn = 475.27$), $z = -1.82$, $p = .07$, $r = -.58$. Moreover, the hit reaction time at time₁ for the control group ($Mdn = 470.61$) did not differ significantly from the hit reaction time for the control group at time₂ ($Mdn = 466.72$), $z = -1.15$, $p = .25$ (see Figure 3).

Digit symbol coding b. The total number correct in the experimental group ($Mdn = 40.5$) did not differ significantly from the control group ($Mdn = 40$) at time₁, $U = 10.50$, $z = -.32$, $p = .75$. At time₂, the total number correct on the Digit Symbol coding B test in the experimental group ($Mdn = 48.5$) did not differ significantly from the control group ($Mdn = 43$), $U = 8.50$, $z = -.75$, $p = .45$. There was a trend present between the total number correct at time₁ for the experimental group ($Mdn = 40.5$) the total number correct for the experimental group at time₂ ($Mdn = 48.5$), $z = -1.84$, $p = .07$, $r = -.58$. There

was also a trend present between, the total number correct at time₁ for the control group ($Mdn = 40$) and the total number correct for the control group at time₂ ($Mdn = 43$), $z = -1.80$, $p = .07$, $r = -.58$ (see Figure 4).

The total number incorrect in the experimental group ($Mdn = 1$) did not differ significantly from the control group ($Mdn = 1$) at time₁, $U = 10.00$, $z = -.46$, $p = .65$. At time₂, the total number incorrect in the experimental group ($Mdn = .05$) did not differ significantly from the control group ($Mdn = 0$), $U = 10.50$, $z = -.36$, $p = .72$. The total number incorrect at time₁ for the experimental group ($Mdn = 1$) did not differ significantly from the total number incorrect for the experimental group

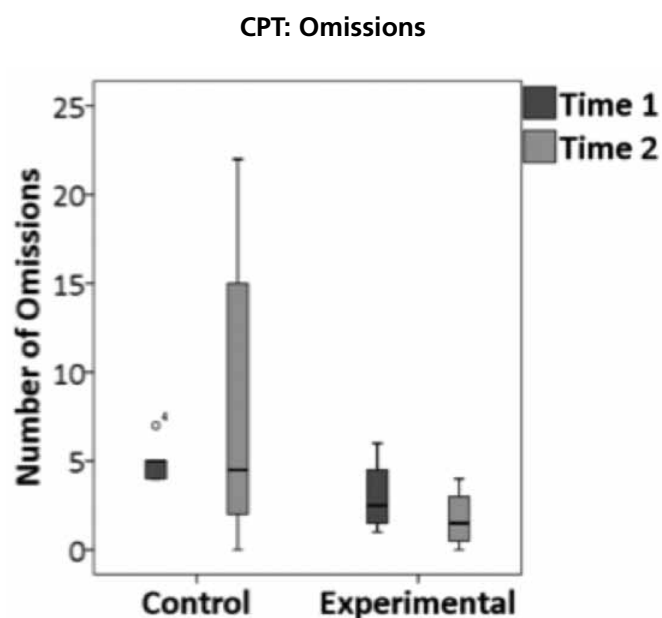


Figure 1. The total number of omissions or the failure to respond to target letters (non-X's) on the Conners' Continuous Performance Test II (CPT II) for both the experimental and control groups from time₁ to time₂. This is a box-and-whisker plot. The box represents 50% of the data, the line running horizontal through the box represents the median value, and everything above and below the median value to the end of the whisker also represents 50% of the data. The top and bottom whisker represent the maximum and minimum values excluding the outliers, and the circle above the box represents the outliers.

at time₂ ($Mdn = .05$), $z = -1.13$, $p = .26$. Moreover, the total number incorrect at time₁ for the control group ($Mdn = 1$) did not differ significantly from the total number incorrect for the control time₂ ($Mdn = 0$), $z = -.71$, $p = .48$ (see Figure 5).

Sleep and Cognition

Hit reaction time was significantly correlated to daytime sleepiness $r_s(4) = .83$, $p < .05$, in the control group at time₂. Hit reaction time was also significantly related to total sleep time

$r_s(4) = -.89, p < .05$, in the control group at time₂. Correlational trends in the experimental group at time₁ were noted between omissions, commissions, hit reaction time and night wakings,

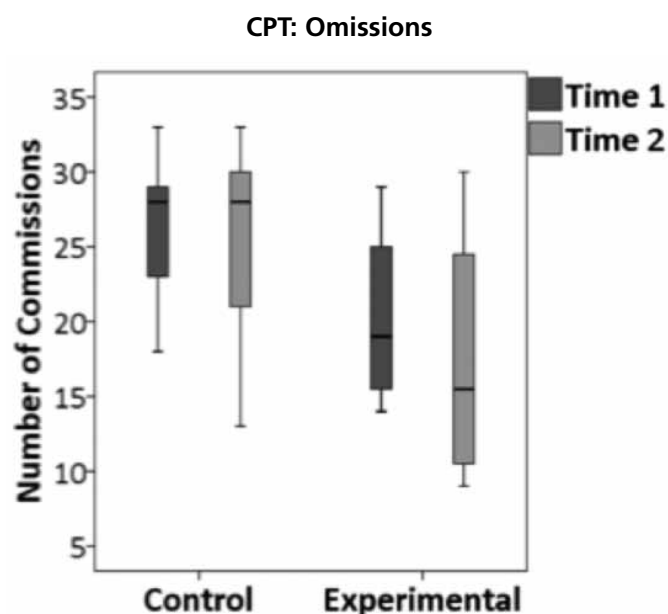


Figure 2. The total number of commissions or responses that are given to non-targets (X's) on the Conners' Continuous Performance Test II (CPT II) for both the experimental and control groups from time₁ to time₂.

$r_s(2) = .95, r_s(2) = -.95, r_s(2) = .95$, all p 's = .051. In the experimental group at time₂, a trend was found between hit reaction time and sleep duration $r_s(2) = -.95, p = .051$.

Discussion

This study examined whether a change to an earlier school start time in elementary-aged school children would adversely affect their cognition, similar to that shown in adolescents. As illustrated below, the results indicate no substantial change in the cognitive variables both within and between the control and experimental groups.

Cognition

There were no significant within or between group differences at time₁ or time₂ for any of the cognitive measures. This illustrates that there was no difference in cognitive performance for the experimental group at time₂ both when compared to the experimental group performance at time₁ as well as to the performance of the control group at time₂. Although results are preliminary, they indicate that cognitive performance was not impaired in the experimental group by their shift from 9:10 a.m. to 7:45 a.m., which could indicate an ability to adapt to earlier school start times. The lack of significant findings, however, could also be the result of the small sample size used in the present project.

CPT: Hit Reaction Time

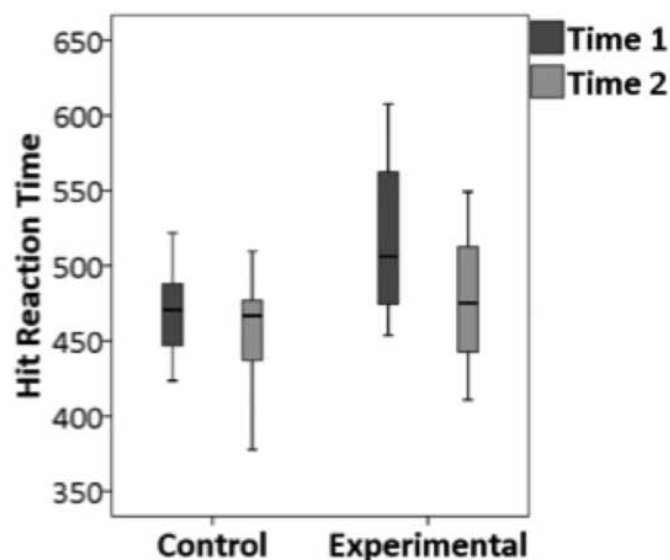


Figure 3. The hit reaction time or the average speed of correct responses on the Conners' Continuous Performance Test II (CPTII) for both the control and experimental groups from time₁ to time₂.

Digit Symbol: Total Correct

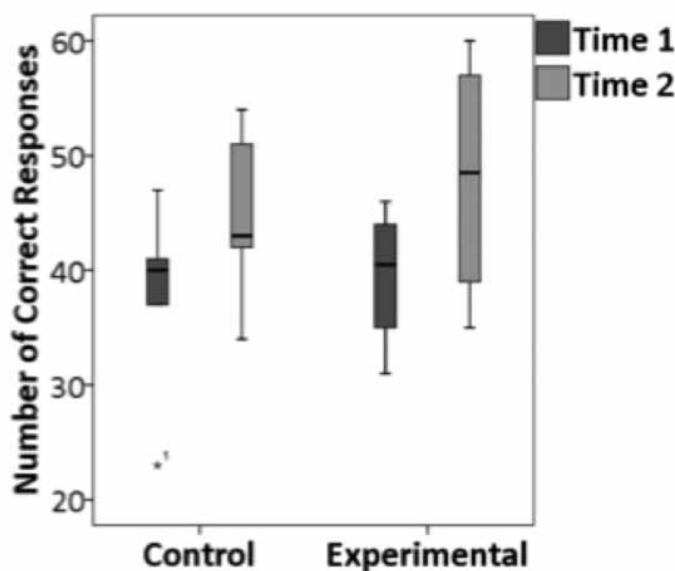


Figure 4. The total number of correct responses on the Digit Symbol Coding B test for both the experimental and control groups from time₁ to time₂.

There were, however, three trends present in the within group analysis, indicating that the experimental group (hit reaction time and total number correct) and the control group (total number correct) showed improvements with the change in school start times, which is the opposite of what one would expect. Despite these findings, results do not indicate that there were any significant differences between the experimental and

control groups from time₁ to time₂, which supports the main focus of the study that there were no negative effects on cognitive performance.

Sleep and Cognition

The two significant correlations that were present were both found in the control group at time₂, the first was a positive

The biggest limitation of this study was the small sample size for both the experimental and control groups. A second limitation of this study was the dropout rate from the first year to the second year because with such a small sample size to begin with it's important to have a high retention rate. The retention rate would have been better if we had a larger time frame for data collection and were able to better accommodate schedules. A third limitation was that the sample used was a convenience sample rather than a random sample as a result of the controversial nature of the topic in the recruitment area. A final limitation was the fact that although the two groups were similar to each other socioeconomically, they both had relatively high SES's which is not generalizable to other populations.

Conclusion

Overall, the findings of this study suggest that the change in school start time had no effect on the cognitive performance in school-age children. This may indicate that going to school earlier does not have negative effects on younger children because, unlike adolescents, they may be better able to naturally adjust their sleep schedule to accommodate an earlier school start time. If so this might be a solution that works for many school systems. Further research on whether there is an impact of sleep on cognitive performance in this age group is warranted.

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Digit Symbol: Total Incorrect

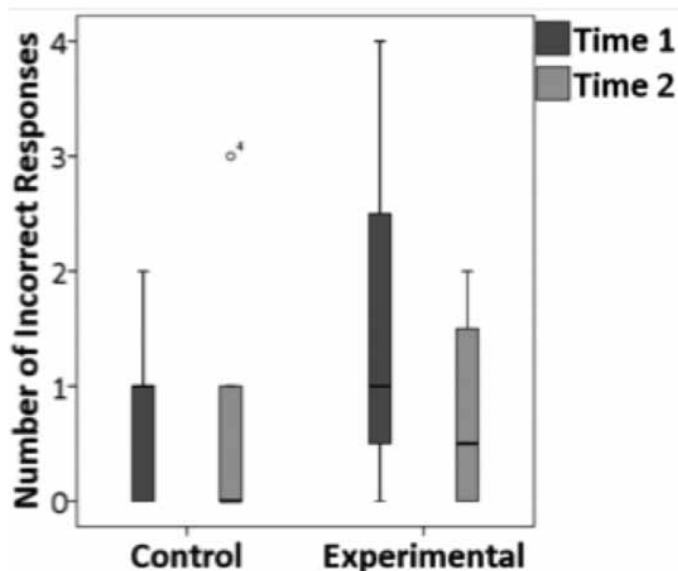


Figure 5. The total number of incorrect responses on the Digit Symbol Coding B test for both the experimental and control groups from time₁ to time₂.

relationship between daytime sleepiness and hit reaction time, indicating that as daytime sleepiness increased, hit reaction time also increased (got slower). The second significant correlation was a negative relationship between total sleep time and hit reaction time, with this inverse relationship indicating that as total sleep time increased, hit reaction time decreased (got faster). Overall, the correlations do show relations between measures of sleep and cognition in the predicted directions.

Additional Factors and Limitations

When making decisions regarding changes in school start times, many factors must be taken into consideration. One factor is school schedules of all the individuals involved, from teachers to local business owners that employ students (CAREI, 1998; Wahlstrom, 2001). Additional factors include scheduling after school activities as well as the issue of the cost of changing the buses. This information simply illustrates the various factors involved, besides sleep, in trying to establish school start times for various groups of school-aged children and adolescents.

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Fluency in Bilingual Preschool Children

JENNA DECHRISTOPHER



Jenna DeChristopher is a graduating senior majoring in Special Education with a concentration

in Communication Disorders. Her project was completed in the summer of 2012 under the mentorship of Dr. Suzanne Miller (Communication Disorders) and made possible through the funding of an Adrian Tinsley Program summer research grant. This project was presented at the Bridgewater State University's Summer Research Symposium in 2012. This project was also presented at the National Conference on Undergraduate Research in La Crosse, Wisconsin in April of 2013.

Purpose: 1) To examine the spontaneous speech fluency of typically developing bilingual children obtained during an oral narrative task involving a conversational interview. 2) To determine what type of disfluencies may be present and 3) To investigate if there is a difference between fluency data obtained live and fluency data obtained from audio recordings during fluency sampling.

Method: Two examiners were used for this study. A corpus of one hundred words was obtained from eight participants by both examiners, audio taped, and transcribed. Live data was also obtained during the time of speech sampling. The participants were preschoolers between ages three and five who spoke Brazilian Portuguese or Spanish in the home. The Teacher Questionnaire (Gutierrez-Clellen & Kreiter, 2003) was used to determine if the participants were proficient enough speaking and understanding English to appropriately interact with the examiners.

Results/Findings: 1) Results showed a low frequency of occurrence of developmental disfluencies for both live data and audio recording data. 2) There were no observed non-developmental disfluencies during the sampling. 3) There was a significant difference between the data recorded live and data obtained from audio recording.

Conclusion: The participants were acquiring and using two languages simultaneously, yet demonstrated the same types of normal disfluencies as children who are in the process of acquiring one language. The difference between the data obtained live and the data obtained from the audio recording support similar findings of Rousseau, Onslow, Packman, & Jones (2008) that suggest that one means of collecting data may be more efficient than another.

Preschool is a period of growth and development. Children are beginning to expand their communicative interactions beyond their family members. They are forced out of their linguistic comfort zone and must learn how to form new bonds with their peers. Children's early social experience contributes to the development of their capacity to build relationships with family or peers, and it is also an important foundation for learning (Shankoff & Philips, 2000 as cited in Yow & Markman, 2001). It is during this time that the onset of normal developmental speech disfluencies typically takes place.

For bilingual children, this time of transition can be especially stressful. Bilingual children have the added stress of monitoring which language is being communicated to them and how to appropriately respond in that language (Yow & Markman, 2011). According to the National Center for Education Statistics, approximately 21% of children ages five to seventeen speak a language other than English at home (<http://nces.ed.gov/fastfacts/display.asp?id=96>).

Bilingual children can be described as: Simultaneous Bilingual Children, Sequential Bilingual Children and English Language Learners. Simultaneous Bilingual Children are children who learn two or more languages from birth or begin learning both languages sometime before the age of 3. In effect, children who are simultaneous bilinguals have two first languages. Simultaneous bilinguals can be exposed to languages in different ways, i.e., from their parents or siblings in the home, from child care workers in the home or child care centers, or from grandparents or relatives. Sequential bilingual children are children who begin learning an additional language after three years of age; that is, after the first language is established. Second language learners are often exposed to their additional language through schooling. English language learners are language minority students in the US who are learning English, the majority language, for social interaction and educational purposes. There is no definitive demarcation at three years of age, but this is the most widely used cut off point between children who are simultaneous bilinguals and children who are second language learners. (Paradis, Genesee, & Crago, 2011)

Disfluency (Stuttering) in Young Children

The onset of disfluency (stuttering) typically occurs around the preschool age of 20 to 48 months (Yairi & Ambrose, 2005). Children at this age often demonstrate developmental disfluencies such as: part word repetition, single syllable repetition, multisyllabic repetition, phrase repetitions, interjections, revision-incomplete phrase, prolongation, and tense pauses (Guitar, 1998). "There are no secondary behaviors (eye blinks, head nods, or interjections of extra sounds) associated with normal disfluency" (Guitar, 1998). Children who begin to demonstrate non-developmental disfluencies develop tension during speech attempts, phonatory arrests, and significant frustration during speaking (Guitar, 1998). Natural recovery is extremely common for young children who stutter. Natural recovery is described as "when stuttering ends of its own accord without any formal treatment" (Yairi & Ambrose 1999, as cited in Yairi & Ambrose 2005). It is estimated that 75% of children who stutter will stop spontaneously (<http://www.asha.org/public/speech/disorders/StutteringCauses.htm>).

Much of the available research on stuttering is derived from

monolingual speakers. Therefore, the outcomes of these studies should be applied to bilingual children with caution. Research on identification and intervention with bilingual preschool children is lacking (van Borsel, 2001). Identifications of stuttering are extensive. "Individual prognosis for each child regarding the risk for chronic stuttering and choosing between a waiting period or immediate treatment can be scientifically based" (Yairi, 1999). However, these outcomes should only be applied to monolingual children. Research aiding identification and intervention with bilingual preschool children is lacking (van Borsel, 2001). Van Borsel concludes that although there are many theories about stuttering in bilingual children, there is a general belief that bilingual children are at a higher risk of developing disfluency; however, this remains unsupported by the research. There is some evidence to support the notion that the number of bilingual and monolingual stutterers is similar (Au-Young, 2000), but investigations of bilingual preschool children who stutter are sparse.

The implications of early identification are substantial for successful intervention of preschooler's speech fluency disorders. Early intervention in the field of speech-language pathology has shown that the earlier the disfluency is treated, the greater the chances of developing normal communication skills (Guralnick, 2001). If a child remains undiagnosed, he or she may stutter into adulthood. Adults who stutter are more likely to demonstrate anxiety, mood disorders, social phobia, and substance abuse (Lverach, 2010). Data in this topic area are needed in order to more fully understand the nature of bilingual preschool children's speech fluency to ensure that they are provided the appropriate services.

Data Collection Methods

The use of video and audio recording is well established in literature. There are many fluency studies that involve the use of audio and audio visual recordings. "Audio recordings of stuttered speech can be used for clinical and research purposes" (Howell, Davis & Bartrip, 2009).

There are data that suggest that the mode of data collection influences the results of the study, although "there is evidence that mode of assessment does not influence the measure of stuttering severity" (Rousseau, et al., 2008). This information, however, was obtained from adult studies and therefore should not be applied to children.

This study addressed the following questions:

- 1) Do bilingual preschool children demonstrate typical developmental speech disfluencies during their production of a narrative?

- 2) What is the frequency of occurrence of typical developmental speech disfluencies during the production of a narrative?
- 3) Do bilingual preschool children demonstrate non-developmental speech disfluencies during their production of a narrative?
- 4) What is the frequency of occurrence of non-developmental speech disfluencies bilingual preschool children?
- 5) Does a difference exist between the frequency of occurrence of normal developmental speech disfluencies obtained from live data and audio recorded data?

Method

Setting Two Head Start locations in Southeastern Massachusetts.

Research Design This study was designed as a cross-sectional, prospective, nonrandomized investigation. Institutional Review Board approval was sought and obtained from Bridgewater State University.

Inclusionary/Exclusionary Criteria Inclusionary criteria included: children who spoke either Spanish or Brazilian Portuguese in the home, children who were competent in English in both use and proficiency, and children who were three to five years of age. Our exclusionary criteria included: children who were receiving speech or language intervention services, children with cognitive disabilities, and children with genetic disorders.

Recruitment Our original plan was to recruit twenty to thirty bilingual preschoolers from area Head Start programs. However, many of these children return to their home country during the summer months when the data were collected. Therefore, we recruited ten participants from two Head Start programs. Consent forms (see Appendix A & A1), translated into the home language, were distributed to the caregivers by the Head Start faculty when the participant was brought to the facility for their normally scheduled school day.

Participants The participants (Table 1) consisted of ten children ages three to five years. Five of the participants were male and five were female. Eight of the participants spoke Brazilian Portuguese and two participants spoke Spanish. Seven of the participants were five years of age, two were four years of age, and one participant was three years of age. However, two children, Participant 9 and Participant 10 failed to complete the study. Participant 9 was suspected to demonstrate selective mutism though this was an unconfirmed diagnosis. Participant 10 was new to the program and was in the process of acclimating to her new environment. This participant retained her right of refusal and did not speak to the examiners.

Participants 1-8 completed the study. Four of the remaining participants were male and four were female; two spoke Spanish and six spoke Brazilian Portuguese. Six of the children were five years of age; two were four years of age.

Materials The SSI-4 Stuttering Severity Instrument (Riley, 1994) was used for this study. The SSI-4 is a norm-referenced stuttering assessment that can be used for both clinical and research purposes. It measures stuttering severity in children and adults in multiple areas such as: frequency, duration, physical concomitants, and naturalness of speech (Riley, 1994).

The Teacher Questionnaire (Gutierrez-Clellen & Kreiter, 2003) (see Appendix B and B1) was also used and chosen for the purpose of documenting the children's level of receptive and expressive English without formal testing. The participants' teachers completed the questionnaire which was a subjective assessment of the participants' use and proficiency with English.

Speech Fluency Sample A corpus of one hundred words was obtained by both examiners. The participants were interviewed by the examiners in a room separate from their classroom and their classmates. A Head Start teacher was present during the time of interviewing. The speech sample was audio taped and transcribed. Live data also was also obtained during speech sampling by investigators using a system of dots and slashes.

Table 1. Demographics Information for Ten Participants

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Age	5	4	5	5	5	5	4	5	3	5
Gender	Female	Male	Female	Female	Male	Male	Female	Male	Male	Female
Home Language	BP	BP	BP	SP	BP	SP	BP	BP	BP	BP

Note. BP-Brazilian Portuguese; SP- Spanish

Dots represented spoken words and slashes represented a stuttered event (Riley, 1994). Utterances were not restricted to true sentences; sentence fragments, sentence revisions, rephrasing of previous utterance, lexical and non-lexical fillers were considered as separate utterances if occurring initially or at the end of the utterances in accordance with SSI procedures (Riley, 1994). Unintelligible or partially unintelligible utterances were excluded from the sample.

Speech Fluency Sample Analysis Each participant's speech sample was coded subjectively by Examiner 1 and Examiner 2 as either fluent or disfluent using the aforementioned system of dots (for fluent utterances) and slashes (disfluent utterance).

Inter-rater Reliability Inter-rater reliability was established in the following manner: two speech samples from five participants were chosen, one from each examiner ($n=10$). The coded data from selected participants collected by each examiner were analyzed using non-parametric Related Samples Wilcoxon Signed Ranks Test. No significant differences between examiners were found ($p=.121$) meaning that between examiners, no speech sampling bias was found.

Results

This investigation focused on the occurrence of developmental disfluencies and whether there was a significant difference between data obtained live and that obtained via audio recording.

Typical Developmental Speech Disfluencies Developmental speech disfluencies were observed by examiners for all participants regardless of language spoken.

Frequency of Typical Developmental Speech Disfluencies

The frequency of occurrence of typical developmental speech disfluencies for live data (Table 2 & Table 3) obtained from both investigators never exceeded three and never occurred more than three times. The frequency of occurrence of typical developmental speech disfluencies obtained from audio data (Table 4 & Table 5) never exceeded five and never occurred more than five times.

Non-developmental Speech Disfluencies None of the participants produced any non-developmental speech disfluencies during their narratives

Comparison between Live Data and Audio Transcribed

As can be seen in Table 6, Related Samples Wilcoxon Signed Ranks Test shows the median of differences between live data and audio data obtained by Examiner 1 ($p=.017$). Therefore, the findings show that there is a significant difference between the data obtained live and the data obtained from the audio recording.

Table 2. Examiner 1 Live Data of SSI-4 Frequency

Number of Stuttered Events	Frequency	Percent
0	1	12.5
1	1	12.5
7	1	12.5
8	1	12.5
10	1	12.5
11	1	12.5
17	1	12.5
25	1	12.5

Note. SSI-4= Stuttering Severity Instrument for Children and Adults (4th ed)

Table 3. Examiner 2 Live Data of SSI-4 Frequency

Number of Stuttered Events	Frequency	Percent
0	3	37.5
2	1	12.5
6	1	12.5
7	1	12.5
13	1	12.5
24	1	12.6

Note. SSI-4= Stuttering Severity Instrument for Children and Adults (4th ed)

Discussion

We endeavored to determine if bilingual children demonstrate developmental and non-developmental speech disfluencies. Additionally we sought to determine the frequency of occurrence of developmental and non-developmental disfluencies in a sample of eight bilingual children. And, to investigate if there is a significant difference between fluency data obtained during live speech sampling and from audio transcription.

The participants were acquiring and using two languages at the same time, yet they demonstrated the same types of disfluencies as children who are in the process of acquiring one language. Developmental disfluencies present included: part-word repetition, single-syllable word repetition, multisyllabic word repetition, phrase repetition, interjection, revision-incomplete phrase, prolongations, and tense pauses (Guitar, 1998). These children can be considered English Language Learners and were still using their first language daily, yet they developed the

Table 6. Comparison Between Live and Audio Transcribed Data from Examiner 1

Null Hypothesis	Test	Sig.	Decision
The mean difference between Examiner 1 Live and Examiner 1 Audio Data equals 0.	Related- Samples Wilcoxon Signed Ranks Test	.017	Reject the null hypothesis.

Note. Asymptotic significances are displayed. The significance level is .05.

Table 4. Examiner 1 Audio Recorded Data of SSI-4 Frequency

Number of Stuttered Events	Frequency	Percent
0	2	25
4	2	25
6	1	12.5
10	1	12.5
16	1	12.5
23	1	12.5

Note. SSI-4= Stuttering Severity Instrument for Children and Adults (4th ed)

Table 5. Examiner 2 Audio Recorded Data of SSI-4 Frequency

Number of Stuttered Events	Frequency	Percent
0	5	62.5
4	1	12.5
6	1	12.5
22	1	12.5

Note. SSI-4= Stuttering Severity Instrument for Children and Adults (4th ed)

same normal speech disfluencies as children their age who were monolingual speakers (see Appendix C).

All of the disfluencies can be characterized as normal developmental disfluencies. Non-developmental disfluencies were not observed, nor were any physical behaviors observed by the examiners. The frequency of occurrence for non- developmental disfluencies was zero. The frequency of occurrence for developmental disfluencies for both live and audio data never exceeded five.

The significant difference obtained between the live and audio data support findings from Rousseau et al., (2008) (who reported that their results when using audio only and audio visual methods) were significantly different. Similar to the results in this study, their results differed depending on the method in which the data was collected.

This study, however, differed in several ways from Rousseau, et al., (2008). First, the investigators listened to the audio samples multiple times. This was decided because the participants maintained the articulatory, phonatory, and intonation patterns of their home language while speaking English. This made it very difficult for the investigators to understand what the child was saying and, as a result, it was difficult to document their fluency. Secondly, in some cases, the participant spoke in their home language when they did not know the intended word in English. Third, the participants in this study were normally developing children with no factors that would affect speech or language acquisition.

Though these studies differed in multiple ways, their results supported the hypothesis of Rousseau et al., (2008) that one method of data collection appears to be more efficient than another. Our results suggest that audio recording is a more efficient method of data collection than data collected live.

Clinical Implications The implications for early identification are substantial for successful intervention of preschooler's speech fluency disorders. Early intervention in the field of speech-language pathology has shown that the earlier the disfluency is treated, the chances of developing normal communication skills increases (Guralnick (2001) as cited in Paul & Roth, 2011). If disfluency is undiagnosed in early childhood, the child may stutter into adulthood (Iverach, Jones, O'Brien, Block, et al., 2010).

The implications of this study can be applied to not only bilingualism and fluency but also to data collection. This study provides further support that audio recorded data is more reliable than live data.

This study adds evidence to a topic area that is lacking empirical data. The fluency of bilingual preschool children is an area that is significantly under-researched, yet the importance of this area is great. Bilingual children deserve an equal opportunity at early intervention, but in order for clinicians to choose appropriate interventions, normative data are needed for accurate identification and diagnosis. Furthermore, evidence in this topic area is needed in order to more fully understand the nature of bilingual preschool children's speech development to ensure that they are provided appropriate fluency intervention services when needed.

Limitations of the Study: The author acknowledges that the small sample size restricts generalization of the results of this investigation. Also, inclusion of children from a wider range of socio-economic families would allow a broader understanding of bilingual preschooler's speech fluency development. However, this study has taken the first step toward that end.

Acknowledgements

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Websites

<http://nces.ed.gov/fastfacts/display.asp?id=96>

www.asha.org/public/speech/disorders/StutteringCauses.htm

Appendix A

Parental Consentimento Bridgewater State University

Titulo da pesquisa: O discurso bilingüe fluência em crianças pré-escolares.

Pesquisadores:

Jenna DeChristopher: Distúrbios Educação Estudante, Especial e Comunicação, Bridgewater State College, Bridgewater MA
Suzanne M. Miller, PhD CCC / SLP Professor Assistente, Educação Especial e Distúrbios da Comunicação, Bridgewater State College, Bridgewater MA

Ele pediu permissão para o seu filho para participar de pesquisas. Para você ser capaz de tomar uma decisão informada sobre se você quer que seu filho a participar deste projeto, você deve entender que o projeto é de cerca de, e os possíveis riscos e benefícios. Este processo é conhecido como consentimento informado. Esta forma descreve a finalidade, os procedimentos, os potenciais benefícios e riscos. Ele também explica como as informações pessoais do seu filho vai ser usado e protegido. Depois de ler este formulário e suas perguntas são respondidas no estudo serão convidados a assinar. Isso vai permitir a participação do seu filho neste estudo. Você deverá receber uma cópia deste documento para levar com você.

Explicação de Estudo

Este estudo foi realizado para examinar o desenvolvimento bilingue da oralidade de crianças pré-escolares.

Se você concorda em permitir que seu filho participe, o seu filho terá que falar com investigadores cerca de 10-15 minutos. A interação da criança com os pesquisadores registrados através de gravador de áudio digital para garantir que os dados obtidos durante a sessão estão corretas.

A criança não deve participar deste estudo se ele ou ela está recebendo serviços de necessidades especiais, fala ou linguagem, ou ter um atraso cognitivo diagnosticado.

Riscos e desconfortos

Sem riscos ou desconfortos são antecipados.

Benefícios

Seu filho não se beneficiarão pessoalmente da participação neste estudo. Este estudo é importante para a sociedade porque fonoaudiólogo ajudar a identificar as crianças bilingües que estão começando a gaguejar.

Appendix A1

Confidencialidade e Registros

Os dados do estudo do seu filho serão mantidas em sigilo pela atribuição de números aos dados de cada criança. Nenhum nome será usado.

Além disso, embora todos os esforços serão feitos para manter as informações confidenciais estudo do seu filho, pode haver circunstâncias em que essas informações serão compartilhadas com: Representantes da Bridgewater State University, incluindo o Conselho de Revisão da Instituição, uma comissão supervisiona a pesquisa em BSU.

Compensação

Nenhuma compensação será dada.

Informações para contato

Se você tem alguma dúvida sobre este estudo, por favor entre em contato com Dr. Suzanne M. Miller, 508-531-2972.

Se você tiver qualquer dúvida sobre os direitos do seu filho como participante da pesquisa, por favor entre em contato com o Conselho de Revisão Institucional, Bridgewater State University, 508-531-1242.

Ao assinar abaixo, você concorda que:

- Você leu este formulário de consentimento (ou leram para você) e ter sido dada a oportunidade de fazer perguntas e receber uma resposta.
- Você foi informado dos riscos potenciais para a criança e ter sido explicado a sua satisfação.
- Você entende Bridgewater State University não tem recursos alocados para os ferimentos de seu filho pode receber como resultado de sua participação neste estudo.
- Você tem 18 anos de idade ou mais.
- A participação do seu filho nesta pesquisa é totalmente voluntária.
- A criança pode retirar a qualquer momento. Se seu filho decidir parar de participar no estudo, não há nenhuma sanção para o seu filho e ele / ela não vai perder todos os benefícios a que ele / ela tem direito.

Assinatura do Pai _____ Date _____

Nome Impresso _____

Nome da Criança _____

Appendix B

TEACHERS' QUESTIONNAIRE*

Questionnaire for teachers about the child's language at school

Child's Initials: _____ School: _____
Age of Child: _____ Teacher: _____

Use refers to how much the child uses each language. Circle appropriate rank for each language (Spanish and English) for all the questions.

- 0 Never uses the indicated language. Never hears it
1 Never uses the indicated language. Hears it very little.
2 Uses the indicated language. Hears it sometimes.
3 Uses the indicated language sometimes. Hears it most of the time.
4 Uses the indicate language all of the time. Hears it all of the time.
DK Don't know

Use

Questions	Spanish						English					
Speaks with you in class	DK	0	1	2	3	4	DK	0	1	2	3	4
Speaks with aides or other teachers	DK	0	1	2	3	4	DK	0	1	2	3	4
Speaks with classmates	DK	0	1	2	3	4	DK	0	1	2	3	4

Proficiency refers to how well the child speaks each language. Circle the appropriate rank for each language.

- 0 Cannot speak the indicated language, has a few words or phrases, cannot produce sentences. Only understands a few words.
1 Cannot speak the indicated language, has a few words or phrases, understands the general idea of what is being said.
2 Limited proficiency with grammatical errors, limited vocabulary, understands the general idea of what is being said.
3 Good proficiency with some grammatical errors, some social and academic vocabulary, understands most of what is being said.
4 Native-like proficiency with few grammatical errors, good vocabulary, understands most of what is said.
DK Don't know

Proficiency

Questions	Spanish					English						
Speaks with you in class	DK	0	1	2	3	4	DK	0	1	2	3	4

Applied Psycholinguistics 24:2

Gutierrez-Clellan & Kreiter (2003): Understanding child bilingual acquisition using parental and teacher reports

Do you think the child has language problems?	YES	NO
Do you think the child has academic or learning problems?	YES	NO
Do you think the child has behavioral or social problems?	YES	NO
Do you think the child has physical problems?	YES	NO

On the continuum circle the percentage of time that the child is exposed to each language at school:

English	0%	20%	40%	50%	60%	80%	100%
Spanish	0%	20%	40%	50%	60%	80%	100%

Appendix B1

Applied Psycholinguistics 24:2

Gutierrez-Clellan & Kreiter (2003): Understanding child bilingual acquisition using parental and teacher reports

TEACHERS' QUESTIONNAIRE*

Questionnaire for teachers about the child's language at school

Child's Initials: _____ School: _____
Age of Child: _____ Teacher: _____

Use refers to how much the child uses each language. Circle appropriate rank for each language (Brazilian Portuguese and English) for all the questions.

- 0 Never uses the indicated language. Never hears it
1 Never uses the indicated language. Hears it very little.
2 Uses the indicated language. Hears it sometimes.
3 Uses the indicated language sometimes. Hears it most of the time.
4 Uses the indicate language all of the time. Hears it all of the time.
DK Don't know

Use

Questions	Brazilian Portuguese					English						
Speaks with you in class	DK	0	1	2	3	4	DK	0	1	2	3	4
Speaks with aides or other teachers	DK	0	1	2	3	4	DK	0	1	2	3	4
Speaks with classmates	DK	0	1	2	3	4	DK	0	1	2	3	4

Proficiency refers to how well the child speaks each language. Circle the appropriate rank for each language.

- 0 Cannot speak the indicated language, has a few words or phrases, cannot produce sentences. Only understands a few words.
1 Cannot speak the indicated language, has a few words or phrases, understands the general idea of what is being said.
2 Limited proficiency with grammatical errors, limited vocabulary, understands the general idea of what is being said.
3 Good proficiency with some grammatical errors, some social and academic vocabulary, understands most of what is being said.
4 Native-like proficiency with few grammatical errors, good vocabulary, understands most of what is said.
DK Don't know

Proficiency

Questions	Brazilian Portuguese					English						
Speaks with you in class	DK	0	1	2	3	4	DK	0	1	2	3	4

Applied Psycholinguistics 24:2

Gutierrez-Clellan & Kreiter (2003): Understanding child bilingual acquisition using parental and teacher reports

Do you think the child has language problems?	YES	NO
Do you think the child has academic or learning problems?	YES	NO
Do you think the child has behavioral or social problems?	YES	NO
Do you think the child has physical problems?	YES	NO

On the continuum circle the percentage of time that the child is exposed to each language at school:

English	0%	20%	40%	50%	60%	80%	100%
Brazilian Portuguese	0%	20%	40%	50%	60%	80%	100%

Appendix C

Type of Developmental Disfluency

Example

Interjections

"um coloring"

Phrase repetition

"and then and then an elephant came to say hi"

Single syllable repetition

"if if somebody going to the parade"

The Effect of Hydrochloric Acid Strength on the Nanometer-Scale Dissolution Topography of Calcite Crystal Surfaces

JENNIFER FRUZZETTI



Jennifer Fruzzetti graduated from BSU in May 2012 with a Bachelor of Science degree in

Earth Sciences and a concentration in Environmental Geosciences. This research was conducted during the spring 2012 semester with her advisor Dr. Stephen E. Kaczmarek and was funded by the ATP Semester Grant Program. Her research was presented at the spring 2012 Undergraduate Research Symposium. Jennifer currently works as a geologist for an environmental engineering and consulting firm and is thankful for the opportunities provided to her through the Office of Undergraduate Research and her mentorship under Dr. Kaczmarek.

The physico-chemical mechanisms by which rock-forming minerals dissolve in natural fluids are controlled by a number of environmental factors. In this study, we investigate dissolution mechanisms by observing how the nanometer-scale surface topography of calcite is affected by the acidity of etching solutions. Here we report atomic force microscope (AFM) observations of calcite crystal surfaces both before and after chemical etching for 10 seconds in 0.01%, 0.1%, and 1.0% HCl solutions. AFM observations show that unetched, freshly-cleaved calcite {10 $\bar{1}$ 4} crystal surfaces are characterized by flat layers separated by steps oriented parallel to calcite cleavage planes. Calcite {10 $\bar{1}$ 4} crystal surfaces etched in 0.01% HCl are characterized by relatively flat surfaces with deep, well-defined V-shaped (pointed bottom) etch pits. Calcite {10 $\bar{1}$ 4} crystal surfaces etched in 0.1% HCl are characterized by more irregular surfaces, with poorly-defined flat-bottom etch pits. Calcite {10 $\bar{1}$ 4} crystal surfaces etched in 1.0% HCl are characterized by a highly irregular surfaces with a high density of poorly-defined, round-bottom etch pits. The findings from this study are consistent with previously published observations that indicate fluid acidity strongly controls the resultant surface topography of etched calcite. Agreement between the nanometer-scale observations made here and those from previous studies provides greater confidence that the new AFM on the campus of Bridgewater State University is fully calibrated and can accurately resolve nanometer-scale topographic features on the surfaces of natural materials.

When exposed to Earth surface processes, minerals undergo chemical weathering, the physico-chemical process by which solid mineral material is removed (dissolved) from the solid mineral and transferred to an aqueous solution. Understanding the exact mechanisms by which dissolution occurs at the mineral-fluid interface is critical to calibrating both bulk laboratory dissolution rates and continental weathering rates as calculated using numerical models (MacInnis and Brantley, 1993). Previous studies investigating dissolution mechanisms in a wide variety of minerals have utilized atomic force microscopy (AFM) to characterize the nanometer-scale topography of dissolved crystal surfaces (Hochella et al., 1991; Teng 2004; Kaczmarek and Sibley, 2007).

Calcite, CaCO₃, is one of the most abundant, and geologically important, rock-forming minerals on Earth. Because the dissolution topography of calcite crystal surfaces has been extensively characterized (Hillner et al, 1992;

MacInnis & Brantley, 1992; Rachlin et al, 1992; and Teng, 2004), the present study attempts to use observations from previous studies to calibrate Bridgewater State University's new AFM. The objective of this study is to replicate previous observations of calcite dissolution in solutions with variable acidities in order to confirm that the new AFM is capable of accurately recording nanometer-scale dissolution topography on calcite crystal surfaces. Calibrating the new AFM with previously acquired observations will minimize erroneous interpretation of artifacts and will provide greater confidence in observations of mineral surfaces where previously published studies do not exist.

Methods

Three experiments were conducted to evaluate the effect of acid strength on calcite surface topography and to evaluate the accuracy of Bridgewater State University's new atomic force microscope (AFM). Three pieces of calcite (approximately 1 mm x 1 mm x 0.3 mm each) were obtained by cleaving a single large crystal of Iceland spar calcite (Wards Scientific) with a rock hammer. Freshly cleaved samples were briefly rinsed in distilled water to remove any particulate matter that may have adhered to the crystal surfaces. All AFM observations were performed on the {10 $\bar{1}$ 4} crystal surface using an atomic force microscope (Nanosurf easyScan2) using a sicona tip with a tip radius of approximately 20 nm.

Three different chemical etching solutions were prepared by diluting laboratory-grade hydrochloric acid (HCl) with distilled/deionized water; 0.01%, 0.1% and 1% (by volume). Calcite sample #1 was completely submerged in 15 ml of 0.01% diluted HCl for ten seconds. After ten seconds the sample was removed from the etching solution and rinsed with distilled water to halt the etching process. Calcite samples #2 and #3 were submerged for ten seconds in 15 ml 0.1% and 1.0% diluted HCl, respectively, and rinsed with distilled water. Etching times were chosen to best accentuate surface features and are based on previous experimental work with the mineral dolomite (Kaczmarek and Sibley 2007). All samples were dried, mounted face-up on metal AFM imaging disks and stored in a vacuum desiccator.

AFM images of calcite crystal surfaces were acquired using constant force mode. AFM images represent shaded relief (topography) maps of the crystal surface. Dark areas represent lower areas on the crystal surface while light areas are characteristic of higher elevations. Three different surface scan dimensions were acquired: 100 x 100 μm , 50 x 50 μm , and 16.6 x 16.6 μm . Crystal surfaces were scanned at a rate of approximately 0.2 seconds per line with 512 sampling points per line and 0° rotation. The x- and y-slopes were set to 0° with an over scan of

5%. Z-Controller parameters, which control the force between the cantilever tip and the sample surface, were set to 25 nano-Newtons (nN) with a P-gain of 10,000 and an I-gain of 1,000. Tip voltage was set to -0.5 volts.

Results

Unetched {10 $\bar{1}$ 4} calcite crystal surfaces are characterized by broad, flat layers with parallel steps that are approximately 25 μm to 50 μm high (Figure 1a). No pits were observed on the surface of the unetched calcite crystal. The cross-section of the crystal in Figure 1b shows relatively flat surfaces separated by steps.

Calcite {10 $\bar{1}$ 4} crystal surfaces etched in 0.01% HCl are characterized by relatively flat layers intersected by deep, V-bottom etch pits (Figure 2a). Etch pits are rhombic in shape and measure 7 μm long by 7 μm wide by 130 μm deep. The cross section shown in Figure 2b shows a deep, V-shaped etch pit surrounded by a relatively flat surface.

Calcite {10 $\bar{1}$ 4} crystal surfaces etched in 0.1% HCl are characterized by wider and deeper, but poorly-defined etch pits on a highly irregular inter-pit surface (Figure 2c). These etch pits measure approximately 16 μm long by 20 μm wide by 250 μm deep. The cross section in Figure 2d shows pits have flatter bottoms, and lack the well-defined V-shape of Figure 2b.

Calcite {10 $\bar{1}$ 4} crystal surfaces etched in 1.0% HCl are characterized by a highly irregular topography with irregularly shaped, coalescing etch pits with poorly defined outlines. The etch pits measure approximately 25 μm long by 20 μm wide by 100 μm deep. The cross section in Figure 2f shows a very shallow, bowl-shaped pit surrounded by a very irregular and jagged surface.

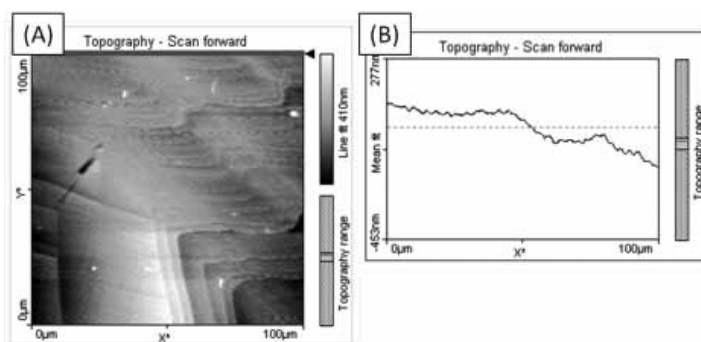


Figure 1. Unetched calcite {10 $\bar{1}$ 4} crystal surface. (A) Crystal surface is relatively flat and displays the intersection of two cleavage planes. The large, elongated black object in the center-left of the image is most likely from a piece of dust encountered by the AFM tip. (B) Cross section of horizontal line at the top of Figure 1a. Crystal topography is characterized by flat layers separated by steps.

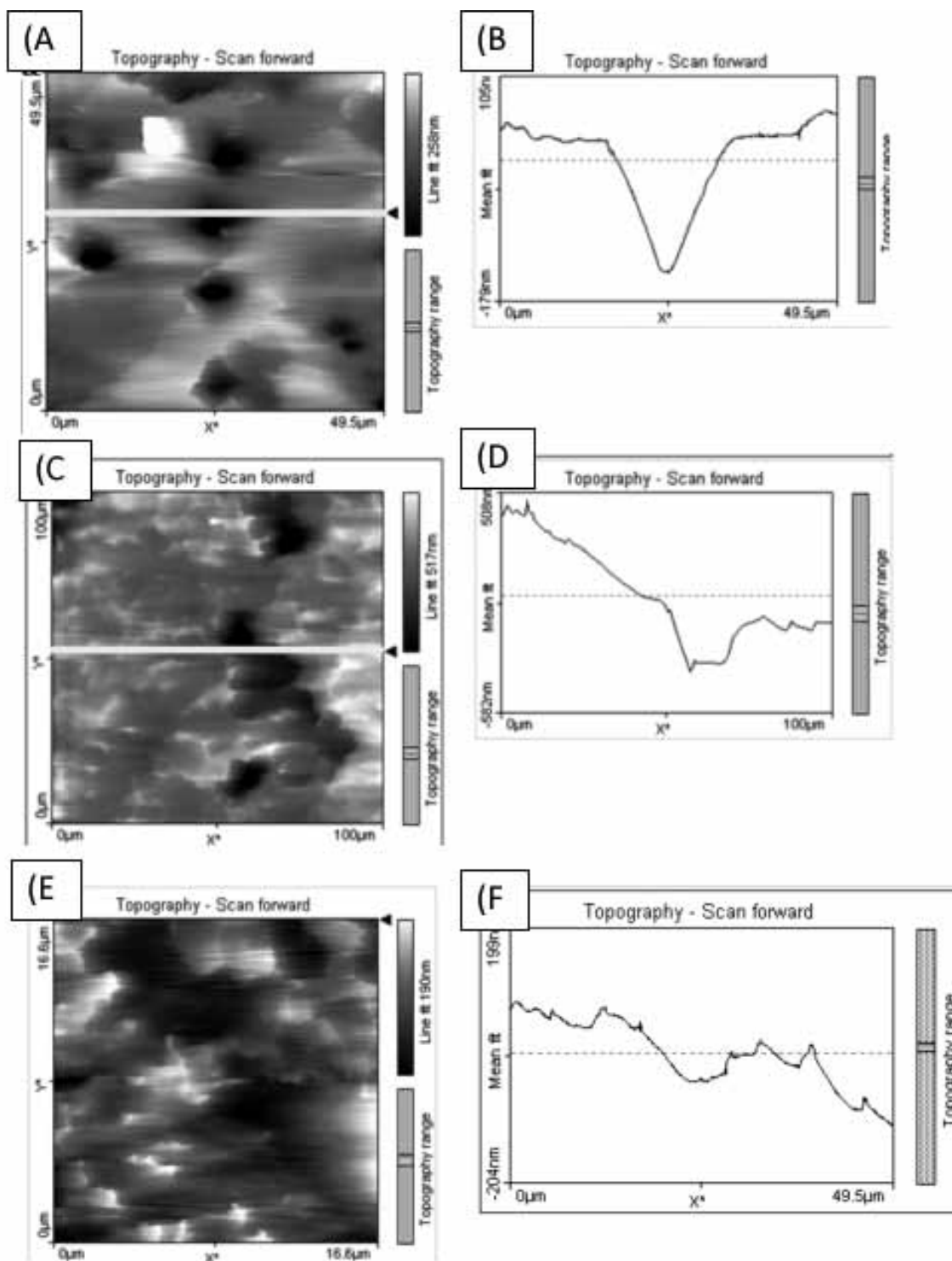


Figure 2. AFM observations of etched calcite {10ī4} crystal surfaces. (A) Calcite {10ī4} crystal surfaces etched in 0.01% HCl showing well-defined rhombic etch pits on a relatively flat surface (B) Cross-section of horizontal line at the top of Figure 2a showing deep V-shaped etch pit with flat surrounding surface. (C) Calcite {10ī4} crystal surfaces etched in 0.1% HCl characterized by a more irregular surface and less defined etch pit shape. (D) Cross-section of horizontal line at the center of Figure 2c showing a bowl-shape etch pit. (E) Calcite {10ī4} crystal surfaces etched in 1% HCl showing several etch pits that are coalescing together. Pits are poorly defined and the surrounding surface is choppy and irregular. (F) Cross-section of line at the top of Figure 2E showing a highly irregular and choppy surface with round-bottom etch pit.

Discussion

Calcite crystal surfaces etched in the lowest acid concentration are characterized by flat surfaces with well-defined, deep, V-shaped etch pits, whereas crystal surfaces etched in highly concentrated acid are characterized by a highly irregular surfaces with poorly-defined etch pits. In this respect, the results of the present study are consistent with previously published observations of etched calcite crystal surfaces (Hillner et al., 1992; MacInnis and Brantley, 1992; Teng 2004).

Hillner et al. (1992) showed that in mildly acidic fluids, when etched in solutions that are only slightly undersaturated with respect to calcite, crystal surfaces are characterized by deep, V-shaped etch pits. Hillner et al. (1992) observed that deep, V-shaped etch pits formed most readily where line defects intersected the crystal surface, and that with prolonged exposure to etching solutions, etch pits continue to grow in length, width and depth. Teng (2004) also showed that at higher acid concentrations, etch pits were absent from crystal surfaces. He interpreted this observation to be the result of the stronger acid attacking all areas of the crystal indiscriminately such that both vertical dissolution along crystal defects and lateral dissolution in inter-defect areas occurred at similar rates. Teng (2004) showed that with decreasing acid concentrations, calcite crystal surfaces were characterized by flat layers with V-shaped etch pits. He interpreted etch pit formation as faster dissolution at the defect compared to dissolution at defect-free areas.

The observation that linear defects are the site of preferred dissolution at low acid concentrations is not unique to calcite. Kaczmarek and Sibley (2007) used AFM to demonstrate that dislocations form preferentially at the intersection of linear defects and dolomite crystal surfaces when etched in dilute sulfuric acid. Aragonite etching experiments conducted by Kaczmarek (2005) also support a model of etch pit formation at low acid concentrations.

Observations from calcite $\{10\bar{1}4\}$ crystal surfaces etched in 0.01% HCl are consistent with previous studies. Etch pits are interpreted to form along linear crystalline defects, perpendicular to the crystal surface, where the surrounding topography remains relatively flat and unaffected by the acid. The pits formed in 0.01% HCl were small in size, but deep and V-shaped compared to the pits formed in higher HCl concentrations. This suggests that the acid targeted specific dislocations in the crystal and that the acid preferentially attacked these areas instead of dissolving the entire crystal surface at the same rate.

Calcite $\{10\bar{1}4\}$ crystal surfaces etched in 0.1% HCl have very deep, flat-bottom pits with an irregular surrounding surface. This is interpreted to represent a scenario where the acid targeted weak spots in the crystal (e.g., linear defects), but because the concentration of the acid was higher, the surrounding crystal surface area was also subjected to the acid's dissolving effects. Etch pit dimensions are also larger, which suggests that the acid attacked the crystal faster laterally than it did in the 0.01% diluted HCl sample.

It was much more difficult to distinguish between etch pits and the irregular surface layers in the calcite sample etched in 1% HCl. The pits were much shallower in these images. Therefore, the acid must have dissolved laterally as well as vertically, not giving pits as much time to develop before spreading to the surrounding surface. Also, observations indicate that etch pits coalesced by growing into one another laterally. Calcite $\{10\bar{1}4\}$ crystal surfaces etched in 1% HCl yield calcite surface that have low topographic relief but when comparing the extremely irregular area surrounding the pits to the flat, even surfaces of the calcite etched in 0.01% HCl, it is obvious that the acid has greatly affected most areas of the crystal surface.

Conclusions

Dissolution topography of calcite crystal surfaces suggests that the acidity of a fluid dramatically affects mechanism by which calcite dissolves. Unetched calcite $\{10\bar{1}4\}$ crystal surfaces are characterized by broad, flat surfaces with parallel steps and no etch pits. Calcite $\{10\bar{1}4\}$ crystal surfaces etched in 0.01% diluted HCl, are characterized by flat layers with deep, V-shaped etch pits that are interpreted to form at line defects. Calcite $\{10\bar{1}4\}$ crystal surfaces etched in 0.1% HCl are characterized by more irregular surfaces with flatter bottom, less well-defined etch pits. Calcite $\{10\bar{1}4\}$ crystal surfaces etched in 1.0% diluted HCl are characterized by a very irregular surfaces with shallow, poorly-defined pits that were concave bottoms.

The results presented here are consistent with previous studies. This suggests that BSU's new AFM is capable of accurately characterizing nanometer-scale surface topography of natural mineral samples. These findings give greater confidence to future researchers who want to utilize the AFM to characterize mineral surfaces that have not been previously characterized.

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Exploring Diagonals in the Calkin-Wilf Tree

MATTHEW GAGNE



Matthew Gagne graduated from Bridgewater with a degree in Mathematics in January 2013. His

research, made possible by an Adrian Tinsley Summer Research Grant, was patiently and skillfully mentored by Dr. Shannon Lockard of the BSU mathematics department. She has his deep gratitude. He would also like to thank his wife, Eunice, for her love, understanding, and support during his time at BSU. Matthew extends his thanks to the dedicated staff at the BSU Undergraduate Research Office. They provided an environment in which research can flourish. Lastly, he wants to thank the entire BSU community which made his time there so enjoyable. He looks forward to helping others to develop an understanding and appreciation of the beauty and utility of mathematics.

For centuries, people have been interested in patterns. Even in that which appears random, humans have been trying to understand the underlying order of things. Mathematicians throughout time have studied many phenomena, including infinite sequences of numbers and have been able, at times, to see structure. Many have found the satisfaction, even joy, of discovering patterns in sequences. A typical way to describe this is by a recursive formula. A recursive definition defines a term in the sequence using the previous terms in the sequence. Even more satisfying than a recursive formula is a closed formula. With this, one can find the number at any position in the sequence. A closed formula is like a locksmith cutting a master key for every lock in a building.

For this project, we focused on patterns formed in the Calkin-Wilf tree. The Calkin-Wilf tree was used by Neil Calkin and Herb Wilf to give a new enumeration of the rational numbers in their 1999 paper, "Recounting the Rationals." The paper spurred much research, to which we add this paper.

The Calkin-Wilf tree is a binary tree, where each vertex has a left and right child. These children are vertices on the tree labeled by fractions. At the top, or root, of the tree is the fraction $1/1$. At each level in the tree, the labels of the left and right children of an arbitrary vertex a/b are formed as shown in Figure 1.

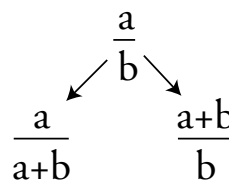


Figure 1. Left and Right Children

This diagram is used to produce labels for every vertex on the tree. The left child coming from a vertex retains the numerator of its parent and adds the numerator and denominator of its parent to form its denominator. The right child retains the denominator of its parent and forms its numerator from the sum of its parent's parts. Each of these children has two children whose labels are found using the same criteria. The infinite repetition of this process labels every node on the tree with a fraction. The first five levels of the Calkin-Wilf tree are as seen in Figure 2.

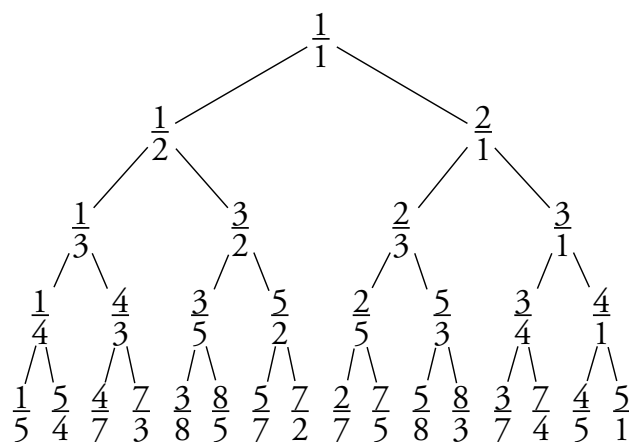


Figure 2. The Calkin-Wilf tree (1st 5 levels)

The sequence of fractions in the tree possesses many interesting properties as shown in (Calkin & Wilf, 1999) and (Aigner & Ziegler, 2010). Several of these properties follow. On each level of the tree, the corresponding left and right fractions are the inverses of the other. For instance, on the 3rd level, the 3rd fraction from the left is 3/5 and the 3rd fraction from the right is 5/3. This pattern is found throughout the tree. Additionally, every fraction is in fully reduced form. There will not appear a numerator and denominator which have a common factor. Calkin and Wilf first showed that this sequence of fractions gives an enumeration of the rationals, that is, every positive rational number will appear once and only once on the tree (Calkin & Wilf, 1999).

The sequences of numerators and denominators considered separately prove interesting as well. The sequence of numerators in the tree begins as:

1, 1, 2, 1, 3, 2, 3, 1, 4, 3, 5, 2, 5, 4, 1, 5, 4, 7, 3, 8, 5, 7, 2, 7, 5, 8, 3, 7, 4, 5, . . .

The sequence of denominators in the tree begins as:

1, 2, 1, 3, 2, 3, 1, 4, 3, 5, 2, 5, 4, 1, 5, 4, 7, 3, 8, 5, 7, 2, 7, 5, 8, 3, 7, 4, 5, . . .

We notice that if we remove the first term of the sequence of numerators, we get the sequence of denominators. So these are essentially the same sequence. We name the sequence of numerators $b(n)$, for all $n \geq 0$, with n being the position in the sequence. Then for all $n \geq 1$, the sequence of fractions is given by.

$$\frac{b(n-1)}{b(n)}$$

In (Calkin & Wilf, 1999), the authors showed that the sequence $b(n)$ satisfies the following equalities:

$$b(2n+1) + b(n) \quad (1)$$

$$b(2n) + b(n) + b(n-1) \quad (2)$$

We will use these results later.

The paper, "Linking the Calkin-Wilf and Stern-Brocot Trees," discusses the concept of diagonals in the Calkin-Wilf tree (Bates et. al., 2010). Diagonals are sequences of fractions which share the same relative position on consecutive levels of the tree. The left diagonal L_i contains every fraction which lies i positions from the left edge of the tree. The right diagonal R_i contains every fraction which is i positions from the right. Fractions in the left diagonals are the inverse of their corresponding fraction of the opposing right diagonal. This is due to the property we discussed earlier concerning inverses in the tree. Through our research we found that the fractions in each diagonal followed certain patterns. For example, consider L_2 the diagonal containing the 2nd fraction from the left on each level of the tree. Let us consider the 1st several fractions in L_2 . The first several fractions in the left diagonal L_2 are:

$$\begin{array}{ccccccc} 2, & 3, & 4, & 5, & 6, & \dots \\ 1 & 2 & 3 & 4 & 5 \end{array}$$

We can see a pattern from these first terms. Starting from 2/1 we add 1 to the numerator and 1 to the denominator. This provides us a way of determining a fraction based on the preceding fraction. We would like to find a closed formula. A closed formula would enable us to find the fraction at any specific position in the diagonal. For L_2 it was straightforward. As we can see in the above sequence, the numerator is 1 more than the denominator. If we let the denominator be j , its position in the sequence, then the numerator would simply be $j+1$. The formula for the j^{th} fraction in L_2 is $\frac{j+1}{j}$.

We recall that we can express each fraction on the tree by $\frac{b(n-1)}{b(n)}$. Therefore,

$$\frac{b(n-1)}{b(n)} = \frac{j+1}{j}$$

for all fractions in L_2 . We will show that this is true after proving the following lemmas.

Lemma 1: $b(2^j - 1) = 1$ for all $j \geq 1$

Proof: Base case: If we let $j = 1$, then $b(2^j - 1) = b(2^1 - 1) = b(1) = 1$. Thus this is true for the base case.

We will assume that $b(2^j - 1) = 1$.

We want to show that $b(2^{j+1} - 1) = 1$.

$$\begin{aligned} b(2^{j+1} - 1) &= b(2(2^j - 1) + 1) \\ &= b(2^j - 1) && \text{by equation 1} \\ &= 1 && \text{by induction hypothesis} \end{aligned}$$

Therefore, $b(2^j - 1) = 1$ by the Principle of Mathematical Induction. Q.E.D.

Lemma 2: $b(2^j) = j + 1$ for all $j \geq 1$ for all

Proof: Base case: If we let $j = 1$ then $(2^1) = b(2^1) = b(2) = 2$. Thus this is true for the base case.

We will assume that $b(2^j) = j + 1$.

We will show that $b(2^{j+1}) = j + 2$.

$$\begin{aligned} b(2^{j+1}) &= b(2(2^j)) \\ &= b(2^j) + b(2^j - 1) && \text{by equation 2} \\ &= j + 1 + 1 && \text{by induction hypothesis and Lemma 1} \\ &= j + 2. \end{aligned}$$

By showing that $b(2^{j+1}) = j + 2$, we show that $b(2^j) = j + 1$. Q.E.D.

Lemma 3: $b(2^j + 1) = j$ for all $j \geq 1$

Proof Base case: If we let $j = 1$ then $b(2^1 + 1) = b(2^1 + 1) = b(3) = 1$. Thus this is true for the base case.

We will assume that $b(2^j + 1) = j$. We want to show that $b(2^{j+1} + 1) = j + 1$.

$$\begin{aligned} b(2^{j+1} + 1) &= b(2(2^j) + 1) \\ &= b(2^j) && \text{by equation 1} \\ &= j + 1 && \text{by Lemma 2} \end{aligned}$$

Therefore, we here see that $b(2^{j+1} + 1) = j + 1$. From this, we show that, $b(2^j + 1) = j$. Q.E.D.

From the above propositions, we can find a formula for all fractions in L_2 . This is shown below.

Proposition: The j^{th} fraction in the left diagonal L_2 of the Calkin-Wilf tree is given by $\frac{j+1}{j}$.

Proof: Recall, we know that the n^{th} fraction in the Calkin-Wilf tree is given by $\frac{b(n-1)}{b(n)}$.

Since the j^{th} level of the tree contains 2^j entries for $j \geq 0$, The fractions in L_2 are in the $2^j + 1$ position on the tree and so, in this case, $n = 2^j + 1$. Moreover, since one fraction from each level is selected to form the L_2 sequence, we note that j also represents the index of the fraction in L_2 . Therefore,

$$\frac{b(n-1)}{b(n)} = \frac{b(2^j)}{b(2^j + 1)}$$

In Lemma 2 we showed that $b(2^j) = j + 1$. In Lemma 3, we showed that $b(2^j + 1) = j$. Therefore,

$$\frac{b(2^j)}{b(2^j + 1)} = \frac{j + 1}{j}$$

Thus every fraction in L_2 can be expressed as $\frac{j+1}{j}$. Q.E.D.

We now see that the j^{th} fraction in L_2 is $\frac{j+1}{j}$.

We were able to conjecture formulas for the first 38 diagonals on the Calkin-Wilf Tree. The chart below shows the conjectured formulas for the first 10 left diagonals.

L_1	$\frac{1}{j}$	L_6	$\frac{3j+2}{2j+1}$
L_2	$\frac{j+1}{j}$	L_7	$\frac{2j+1}{3j+1}$
L_3	$\frac{j+1}{2j+1}$	L_8	$\frac{3j+1}{j}$
L_4	$\frac{2j+1}{j}$	L_9	$\frac{j+1}{4j+3}$
L_5	$\frac{j+1}{3j+2}$	L_{10}	$\frac{4j+3}{3j+2}$

Examinations of the formulas in the chart above lead us to ask questions such as, "Could we quickly find the formula for the 101st diagonal?" In essence, "Is there a formula for the formulas?" As is often the case in mathematics, we looked for patterns in the formulas. We first notice that the denominator of one diagonal is often the same as the numerator of the following diagonal. However, this didn't happen for the diagonals of a power of 2 and the following one. The pattern was re-established on the next diagonal and continued until the next diagonal that was one after a diagonal of a power of 2. We soon discovered that each fraction in every diagonal of a power of 2, L_2^i was predictable. Below, we have the formulas for the first few diagonals which are a power of 2.

L_1	L_2	L_4	L_8	L_{16}	L_{32}
$\frac{1}{j}$	$\frac{j+1}{j}$	$\frac{2j+1}{j}$	$\frac{3j+1}{j}$	$\frac{4j+1}{j}$	$\frac{5j+1}{j}$

When we isolate these formulas, we see the pattern emerge. To find any numerator in L_{2^j} , we had only to multiply i by j , its position in the diagonal, and then add 1. So the numerator of L_{2^j} is given by $ij + 1$. It appears from the chart that the denominator is always j . For example, L_{2^2} is the 4th diagonal, so $i = 2$. Then, the j^{th} fraction in L_{2^j} is $\frac{2j+1}{j}$. Based on these examples, we offer these conjectures:

Conjecture 1: The j^{th} fraction in the diagonal L_{2^j} is $\frac{ij+1}{j}$.

We surmised a formula for $L_{2^{j+1}}$ the diagonals immediately following L_{2^j} . If we examine the formulas for $L_{2^{j+1}}$ another pattern emerges.

L_2	L_3	L_5	L_9	L_{17}	L_{33}
$\frac{j+1}{j}$	$\frac{j+1}{2j+1}$	$\frac{j+1}{3j+2}$	$\frac{j+1}{4j+3}$	$\frac{j+1}{5j+4}$	$\frac{j+1}{6j+5}$

As we can see above, the numerator is $j + 1$. The denominators of the fractions in $L_{2^{j+1}}$ are formed by multiplying j by $i + 1$ and then adding i .

Conjecture 2: The j^{th} fraction in the diagonal $L_{2^{j+1}}$ is

$$\frac{j+1}{j(i+1)+i}.$$

The Calkin-Wilf tree is an interesting mathematical structure which provides intriguing patterns to investigate. Whether in puzzles, art, or mathematics, patterns stir our curiosity and wonder. When we see an order develop, we want to explore more. When we can accurately predict what comes next, it brings tremendous satisfaction. It can also produce a feeling of over-arching order. Because the Calkin-Wilf tree provides such order, it is a joy to explore.

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Ex-Prisoners' Perceptions of the Availability and Effects of Programs and Services in Correctional Settings

JENNA HOUSTON



Jenna Houston is a Departmental Honors student majoring in Social Work. This research project began

in the Fall 2011 semester as part of a research project toward an honors contract requirement in Research Methods in Social Work. This research was made possible through the Adrian Tinsley Summer Research Grant in 2012, under the mentorship of Dr. Judith Willison L.I.C.S.W., Ph.D. Not only was the aim of this research to empower its participants, but also to promote social justice through creating awareness of the disadvantage and oppression this population experiences. This project was presented in April 2013, at the National Conference on Undergraduate Research in La-Crosse, Wisconsin. Jenna will attend Bridgewater State University in the fall of 2013 to pursue an Advanced Standing degree in the Masters of Social Work program.

The U.S. system of retributive justice drives punitive measures, rather than interventions that could reduce recidivism. If prisoners' needs are not met while serving time within the penal system, their chances of re-offending are greater (Baillargeon, 2010). The purpose of this study was to gather information about correctional programming from male ex-prisoners who have been involved in community re-entry services at Span Inc. in Boston, MA. Furthermore, this study also examines whether or not the programming contributed to positive coping skills during their incarceration as well as adaptation upon reentering the community. Data were collected during ten interviews, using a semi-structured interview guide at a community reentry program named Span Inc., in Boston, MA. Interviews were audio recorded, transcribed, and analyzed for themes. Results indicate that, prisoners describe a wide variety of needs while incarcerated. Seven of the ten participants reported that their needs were not addressed in prison through programming and services. Participants also noted that programming helps in adjusting to being separated from the community while incarcerated, as well as helping them to reenter into the community. Strong themes of 'prisonized' behaviors were apparent in the experiences described by participants, as well as in the available services that were offered to them. It is hoped this research will aid program creators as well as inform the public of prisoners' needs and how to better address them based on this first-hand data.

Keywords: male-offenders, incarceration, re-entry, adaptation, needs, institutionalizing, forensic social-work to services, strengths-based perspective

According to the United States Bureau of Justice Statistics (2012), almost 7 million individuals constituted the correctional population in 2011. Of this large correctional population, 3,971,319 were on probation and 853,852 were on parole. Over 2.2 million of these individuals were incarcerated in jails and prisons as of December 31, 2011 (Glaze and Parks, 2012). Of the 2.2 million, 1,504,150 are in federal and state prisons and 735,601 are in local jails. Eighty-seven thousand two hundred individuals are considered to have multiple correctional statuses (Glaze and Parks, 2012). There are limited services offered to incarcerated individuals, due to lack of funding as well as a culture of non-acceptance of those who commit crimes (Baillargeon, 2010). More services are needed to adequately meet the complex needs of prisoners in order to reduce recidivism and protect potential victims of crime. The Bureau of Justice Statistics describes recidivism as being measured by criminal

acts that, in turn, result in the re-arrest, reconviction, or return to prison with or without a new sentence, within a three year time period (2012). During 2007, a total of 1,180,469 persons on parole were indicated to be at-risk of re-incarceration. Of these parolees 16% returned to prison (Bureau of Justice Statistics, 2011).

Programming and Services

The main areas of programming in prisons are religious services, mental-health treatment, and educational programming. Failure to provide prisoners these basic services while incarcerated contributes to increased recidivism rates (Baillargeon, 2010) and simultaneously results in long-term warehousing costs at the taxpayers' expense (Hall and Killacy, 2008; Soderstrom, 2007). Each of these types of programs will be described briefly below.

Faith-based Programs

Faith-based programs connect prisoners with their faith of choice and are found to be effective in reducing anti-social behaviors in extreme situations, such as prison (Kerley, Matthews, and Blanchard, 2005). Kerley et al., (2005) found involvement in religious programming directly reduced arguing between prisoners and indirectly reduced fighting. A separate study concluded that faith-based programs help prisoners deal with guilt, finding a new direction in life, and dealing with the loss of their freedom (Clear and Sumter, 2002). However, not all prisoners feel a connection to a "higher power." Many prisoners seek faith-based programming for other reasons such as material comforts and social support which help them deal with the hostile environment (Clear and Sumter, 2002).

Mental-health Programming

A great influx of mentally-ill people entering prisons began with the deinstitutionalization of state mental hospitals over the past decades (Soderstrom, 2007). Prisoners may experience symptoms of mental health disorders, including but not limited to: loss of interest or pleasure in activities, insomnia or hypersomnia, feelings of worthlessness or extreme guilt, delusions, and hallucinations (James and Glaze, 2006). Mental-health programming for prisoners also provides evidence of effectiveness in addressing specific emotional and behavioral disorders. Soderstrom (2007) found that including mental-health programming in prison is an opportunity for clinicians to identify, diagnose, and begin treatment with prisoners. A study conducted in a county jail examined the impact of mental-health program on over 240 prisoners with co-occurring mental health disorders. A statistically significant correlation between the higher number of treatment sessions and decreased recidivism rates was found (Rothbard, Zubritsky, Jacquette, and Chatre, 2009).

Educational Programming

Educational programming offered in prisons includes GED classes, adult literacy sessions, as well as vocational training (Hall and Killacy, 2008). Such programs have been found to dramatically reduce recidivism (Esperian, 2010). Job training in prisons is also significant to individuals post-release. It is believed that productivity inside prisons promotes productivity outside of prisons as individuals are released into society (Travis, 1999). Therefore job-training contributes to a reduction in recidivism while also aiding individuals in successful integration into their communities.

Motivation

Some literature suggests that prisoners have the potential to be insincere, and participate in programming and services solely due to extrinsic motivations (Clear, Hardyman, Stout, and Drammer, 2000; Clear and Sumter, 2002). Extrinsic motivations include, safety, material comforts, access to outsiders, and inmate relations or social support (Clear et al., 2000). Yet results of the same study, conducted by Clear et al., (2000) indicated that inmates also participate in programming as a result of intrinsic motivations. These types of intrinsic motivations include, helping to deal with guilt, finding a new way of life, and dealing with the loss of freedom.

Prisonization

As the era of deinstitutionalization of mental and state hospitals has long passed us, institutionalizing (or "prisonizing") behaviors continue to cultivate in correctional settings. Goodstein (1989) wrote that inmates may attempt to cope with their environment by beginning to view the prison as "home." Goffman (1961) suggested that once inmates are placed in a correctional setting they are subsequently stripped of their identities and social roles. Goffman contended that this created a process of "Conversion" whereby the inmate will internalize the views of one's self from the perspective of authority figures, such as the administrative and correctional staff. People who are in these institutional settings are subject to degrading experiences and have harsh limitations imposed on their freedom. The institutionalization of the prisoner involves a lack of control over one's environment, a paucity of goods and services, one's needs being handled in an uncongenial and bureaucratic fashion, a lack of decision making occasions, and as a result the individual is forced to be dependent on their environment (Goodstein, 1989; Haney, 2001; Weinstein, 1982). Consequently this renders the inmate completely unprepared to re-enter their community where functioning independently and taking initiative is vital. The idea of being "institutionalized" is conceptualized as being psychological, which in turn means its effects are reversible (Haney, 2001).

Strengths-based Approaches in Correctional Facilities

Brunette and Maruna (2006) write about the lack of theoretical foundations in prison-based programs/services prior to their creation. The authors find prison programming to be based on the idea of “earning redemption.” In order to conquer the deficits of institutionalizing behaviors in the prison environment, integrating a strengths-based approach in working with people in such facilities can be effective. This perspective’s foundation is that each individual possesses the inherent ability and resources required to overcome challenges as they present themselves. Despite the fact that some people may present themselves as “hopeless”, it is believed that with some assistance a person can overcome their issues. This approach is especially effective in empowering an individual to re-gain control over their environment, which enables them to furthermore utilize their apparent strengths (Brun and Rapp, 2001; Brunette and Maruna, 2006). A prisoner who is empowered to re-gain control over their environment, may then also be able to succeed in having the capacity to be held accountable for their crime; and, furthermore, work actively to change such negative behaviors. This research aimed to empower ex-prisoners by enabling them to be advocates for other prisoners. They did this by giving first-hand data on what they perceived were useful elements of prison programming; and to better inform program creators as well as inform the public of their needs and how to better address them.

Methodology

Ten in-depth interviews with adult male ex-prisoners were completed at Span, Inc. in Boston, MA. Span is an organization that provides services to people who have been in prison. A semi-structured interview guide was created to inquire about four main areas, 1) What are a prisoner’s needs during incarceration? 2) Do ex-prisoners believe their needs were met in prison? 3) Does programming foster positive coping skills while incarcerated? 4) How does programming help prisoners upon release into the community?

Participants were recruited using mixed avenues. The study was presented to groups of ex-prisoners prior to scheduled group sessions, and flyers were posted in a frequented recreational room. Interviews lasted from 40-60 minutes on-site in counseling rooms at Span Inc.. The interview guide consisted of open-ended questions. For example:

Many individuals who have spent time in prison report that they identified needs such as educational, mental health, spiritual/religious, or related to substance abuse.

Please tell me about what kind of needs you experienced while you were incarcerated.

The series of open-ended questions were followed by probing questions on the same topic. Such questions were used to attain greater insight on their perspective of needs while in prison. For example: *What needs of yours in particular were met? What needs of yours in particular were not met?* Interviews were audio recorded and transcribed in order to interpret qualitative data accurately. Detailed field notes of the environment at Span, Inc. were consistently completed, as well as prior and subsequent to each interview. Field notes were formatted similarly by first recording subjective observations, followed by objective observations. A total of ten individuals who were members of Span Inc., in Boston, MA initially consented to interviews. Yet, at the time of the last interview, the final participant refused to have his interview audio recorded; therefore reliance on accurate and detailed notes was required.

The study was guided by the phenomenological approach. The participants’ complex experiences which were brought forth during interviews were simplified during coding, to enable the results to be organized into themes and communicated effectively with others (Bentz and Shapio, 1998; Padgett, 2004; Padgett, 1998). Data analysis was guided by narrative themes which were evident throughout each of the nine transcripts, notes, and field notes. Coding included multiple analyses of each transcript to identify themes and comparison of transcripts.

RESULTS

Demographics

Participants’ ages varied from twenty-five to fifty-eight. Locations in which the men were incarcerated included two Northeastern states and one Southwestern state. Levels of incarceration also were quite varied, including, county, state, and federal prisons. The length of participants’ prison sentences dramatically varied from two months to twenty-two years. Seven of the participants were convicted of drug-related offenses and three of the participants were convicted of violent offenses. Participants also indicated varied lengths in which they had been released into their communities from prison. These lengths range from two months to eighteen years.

Needs in Prison

Each of the ex-prisoners identified needs which had been met and/or unmet during the time they were incarcerated. Each of the reported needs were mentioned numerous times throughout the narrative analysis of the ten interviews.

Met Needs

Three out of the ten ex-inmates believed that their needs had been adequately addressed during the time they spent incarcerated.

The needs that were most frequently reported to have been met were: programming as comfort, having routine/structure, having “something to do”, positive influence from professionals, and talking about their emotions. Yet the foremost need that was described was programming as a means of “something to do.”

“I would mop the floors, clean the offices, do the garbage, do the laundry, stuff like that. Which helped because it passed time.” - Nick

Many of the other needs that were met were due to the ex-prisoners “helping themselves”. The majority of the participants reported that they took initiative to meet their own needs during their incarceration. The participants explained that this was accomplished by teaching themselves, building their own support systems, protecting themselves, and running their own programs.

“Ya, what happened was instead of them helping me, I helped myself.” - Javier

“I went to the library a lot and read. I actually taught myself some of the math stuff. I took out some math books and just kinda got busy on my own.” - Matthew

Notably, the three participants who reported that their needs were met in prison all had been convicted of drug and/or alcohol related crimes. The participants’ needs were met due to the available drug and alcohol programs which are made accessible only by the prisoner’s choice to attend. Yet, these specialized programs are not always accessible to all inmates who report having substance abuse issues.

Unmet Needs

Seven of the ten participants reported that their needs were inadequately addressed by programming and services during their incarceration. Participants reported numerous barriers to getting their needs met including: not being given the tools to succeed, impersonalized programming, program criteria as a barrier for participation, the lack of programs, and programs being imposed upon them. Many of the participants reported that these unmet needs were due to the unprofessional conduct of authoritative figures and professionals alike. Participants also reported their own internal obstacles to getting their needs met in prison which included: resistance to structure, participating due to fear of showing emotion and furthermore being labeled, feeling a lack of support, and lack of social skills. Participants frequently reported that the misconduct of correctional and professional personnel was a barrier to using time in prison programming constructively. These types of misconducts included labeling and categorizing the inmates. For example:

[On feeling labeled by a psychiatrist.]

“Ya, I felt like that was their opinion. And that was their opinion coming from officers, the officers would tell them what was going on. And they wouldn’t spend the time to evaluate me and talk to me about a lot of things.” - Glen

Many participants also reported that their needs were not adequately met because others determined what their needs were without seeking feedback from the inmates themselves.

[On personal mental health issues.]

“All they wanted to do is heavily medicate me and throw a label on me. You know, ‘Anti-social personality disorder.’” - Alan

Programming/Services and Adjustment in Prison

Programming in prison was noted by participants to help them adjust to being separated from the community. The most common description of how programming helped participants adjust to prison life was that programming provided structure and as a means to “pass time”. A common theme in participants’ description of programming was the reciprocity between inmates and programs. Various participants discussed taking away from programming only what they put into it.

[On skills learned through programming.]

“I learned how to turn my survival skills into coping skills.” - Ed

Programming/ Services and Re-entry

Although many individuals expressed that their needs were not met in prison, they did, nevertheless, discuss programming aiding in re-entry to the community. It is notable that various study participants described that creating routines while incarcerated assisted them in their adjustment to the community. Several participants expressed that they would have been more successful in re-entry if they had acquired basic education or vocational education during their incarceration.

“If there was more programming. More educational type programming, that way they could cope with coming out.” - Sylvester

Motivation

This current study contradicts previous literature by putting forward evidence that some prisoners can be extremely motivated individuals. Particular areas in which the participants described being motivated include: getting out of prison, staying out of prison, learning new skills, receiving a quality education,

and putting in time and work in programming. Participants believed that their motivation in these areas ultimately contributed to a better quality of life in and out of prison.

“I’m just grateful they had something for me to do. I didn’t sit around talking about ‘poor me’, I put myself in here, I’m getting myself out.” - Paulo

Not only did the participants demonstrate a high level of motivation while incarcerated, they continued to be motivated post-release. After release, participants reported having gained meaningful and competitive employment, completing vocational course-work, strengthening familial relationships, and continuing to attend constructive programming in the community.

Discussion

The purpose of this study was to gather information about correctional programming from male ex-prisoners who were involved in community re-entry services at Span Inc. in Boston, MA. It is hoped that this research will aid in understanding the following: 1) what prison programming was offered and utilized, 2) if this programming addressed the prisoner’s perceived needs, and 3) if this programming had perceived positive effects on adaptation in the hostile environment of prison, as well as successful re-entry into the community.

Participants included in this research were forthright in discussing the oppression, deprivation, and unique challenges set-forth during their incarcerations. Study participants were able to directly indicate during the interviews what their needs were, if their needs had been met or unmet, and continued by addressing how they believe their needs could have been satisfied. The findings of this research indicate that the prison environment and programming institutionalizes individuals rather than seeks to engage prisoners in identifying their own needs.

Prisoners are not given the opportunity to identify their own needs as well as not given the attention required to locate appropriate resources. Many of the ex-prisoners had been harshly and inaccurately categorized by diagnoses, sexual orientations, and behaviors or infractions. The participants reported that this is problematic due to the implication that not only are the prisoner’s proper needs not being addressed, but also unrelated and/or non-existent needs are being treated which takes time and funds away from appropriate interventions. Factors that contribute to the fulfillment of needs experienced by the study participants included smaller populations, personalized care, and acquiring trust from officials. Yet, this research suggests that such opportunities are not evident in traditional prisons. The participants of this research indicated that the number

one reason for entering into prison programming was to “pass time”, yet, many skills, values, and lessons were acquired during their time in programming. Participants reported that these skills, values, and lessons aided each participant in positively coping with their environment. Even if the participant did not obtain the concrete information from programming/services, each participant was still able to list at least one thing that was learned, or that they learned about themselves.

Also worthy of attention was the blatant invasion of confidentiality which was noted by many of the individuals. Participants reported not being able to adequately adjust emotionally to their environment due to feeling unsafe and feeling unable to express their emotions. One participant described his counseling intake as taking place in the “mess hall” alongside twenty other men. Such a violation of autonomy rendered the participant to be much lower functioning in his environment because he was not given an opportunity to fully disclose issues to the counselor.

Several participants reported that re-entering their communities was difficult. A few participants reported that their discharge planning was inadequate and suitable resources had remained unresolved at the time of release from prison. Yet, many of the participants were also able to directly identify skills, lessons, or values they acquired from programming/services and then apply them in re-entering their community.

This current study puts forth evidence that prisoners may be more motivated than is generally thought. Understanding that these individuals have the competence to be so highly motivated, in a less than optimal environment, speaks volumes as to the potential, resiliency, and strengths of these participants.

These topics of research should be approached with a strengths-based perspective, in order to address the institutionalizing, or “prisonizing”, behaviors which are apparent throughout this data. This research indicates that prisoners may have an untapped potential for motivation, and that they also have a myriad of inherent strengths. In order to address prisoners’ and ex-prisoners’ needs, individuals should be considered unique and be given the dignity to identify their own problems. Also, each individual’s strengths should be assessed in order for them to be able to capitalize on their strengths in the available programs. Another aspect in assessing needs is for the assessment to be carried out in a manner which respects autonomy of the individual. This will ultimately enable them to find a level of mastery over their environment, and, therefore, cope with the harsh reality of the prison environment and re-entry more effectively.

Perceived limitations of this study include the small sample size, and the narrow focus of location. These hinder the capacity to generalize results to the inmate population in sum. Yet, these findings remain helpful to program creators and advocacy workers in constructing more effective programs and services and, furthermore, gaining an understanding of unique needs in which men experience within prison in this locale. Another limitation of this study is the all-male focus. Men and women put forth very different and complex needs, yet perhaps some of the general data may still apply to their unique programming and services.

This research can be of use by giving the ex-prisoners an opportunity to be advocates for other prisoners. Participants do this by giving first-hand data on what they perceive are useful elements of prison programming to better inform program creators as well as inform the public of their needs and how to better address them.

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Modeling Plaque Aggregation on the Neuronal Network

THOMAS HOWARD



Thomas Howard graduated in May 2012 from BSU with a BS in Mathematics and is currently a graduate student earning an MS in Computer Science at BSU. This research was developed as part of an ATP Summer Research Grant under the direction of Dr. Irina Seceleanu. Tom presented his research at the Joint Mathematics Meeting, the largest annual mathematics meeting in the world, and at the National Conference on Undergraduate Research in the spring of 2012. Tom is looking forward to completing his MS and joining the work force as a programmer.

Alzheimer's disease is a condition linked to plaque aggregation in the brain. Despite being the focus of many studies, current treatments are of questionable significance in the overall improvement of a patient's condition. In recent years, computer models have been used to better understand complex biological systems and simulate the effects of various treatments. In the following paper we present a mathematical model studying the effects of plaque aggregation on the neuronal pathways of the human brain. To create our mathematical model we employ tools from the theory of dynamical systems and stochastic processes, and simulate the passage of a signal through a healthy and a plaque-affected brain. Moreover, our model simulates the increased resistance of the neuronal network to plaque disruption as a result of cognitive stimulation through learning and cerebral exercises, and measures the increased connectivity in a plaque-affected neuronal network when cognitive stimulation is present. Our mathematical model shows promise as a first step in modeling the complex interactions of plaque deposits in the human brain and studying the influence of behavioral treatments on Alzheimer patients.

Alzheimer's disease is a condition linked to plaque aggregation in the brain which has a great impact on the population in the United States and worldwide. Projections show that fifty percent of Americans over 85 will suffer from dementia, and fifty million Americans are expected to have some form of dementia by 2030 according to the Alzheimer's Association (2012). The debilitating effects on patients include memory disturbances, high incidence of emotional outbursts, communication difficulties, daytime wandering, hallucinations, delusions, physical violence, and incontinence. Moreover, Alzheimer's disease impacts the vast number of caregivers, linked to their higher incidence of alcoholism, anger, sadness, fatigue, and depression. Care giving increases likelihood of disease and familial conflict (Rabins, Mace, & Lucas, 2008). In 2012, an estimated \$200 billion dollars will be spent on Alzheimer's disease alone, not to mention the variety of other forms of dementia. However, the current medicines have had questionable significance in the overall improvement on patients' conditions, and side effects vary from mild incontinence to severe liver damage (Qaseem et al., 2008).

Effective pharmacotherapeutic treatments for Alzheimer's disease have been difficult to find despite being the focus of many studies. Most drugs used for dementia are limited by side effects, restricted duration of efficacy, and

the need for frequent monitoring of blood levels or other laboratory values to prevent toxicity. In recent years, the creation of computer simulations of the human brain to investigate the interaction of plaque granules and the neural network has become a target for researchers. In the following, we present a mathematical model of this complex biological system using tools from the field of dynamical systems to better understand the aggregation of these undesirable proteins and their interference with neurons. This type of computer modeling has potential for evaluating drug and behavioral interventions.

The Theory Of Dynamical Systems

The study of dynamical systems seeks to describe structures which change with respect to time. An abundance of examples exist: blood pumped by the atria and ventricles flowing through the chambers of the heart, planetary motion, a pendulum swinging back and forth from its axis, a population of rabbits growing and declining in a field, etc. Many dynamical systems can be described via mathematical models allowing for the prediction of state information (Devaney, 2003).



Figure 1. Henri Poincaré

Sir Isaac Newton (1642-1726) is credited with the development of the study of dynamical systems as an articulated field. Newton was driven to develop methods of calculus to describe the motion of the planets over time, which he introduced in his *Principia*. Henri Poincaré (1854-1912) contributed to the study of dynamical systems by introducing a wide variety of tools and methods for the advancement in this area.

Through work on the three-body problem (introduced by Newton), Poincaré noted the complexity of the behavior which could arise from simple nonlinear systems. Famously stating, "...small differences in the initial conditions produce very great ones in the final phenomena" (Poincaré, 1914), Poincaré is considered one of the forebears of Chaos Theory, a field focused on this high sensitivity to the starting circumstances.

Gaston Julia in his work, *Mémoire sur l'itération des fonctions rationnelles* (1881), and Pierre Fatou helped explain the orbits of particles using recursively iterated functions. A recursively iterated function is of the type $f_{n+1}(x) = f(f_n(x))$; that is the input to the subsequent iteration of the function is the current output.



Figure 2. Julia Set

By analyzing the dynamics of iterated complex polynomials, Julia introduced a geometric object of particular interest called the Julia Set (see Figure 2), which gives rise to beautiful graphs exhibiting properties of self-similarity, and an accessible, intuitive way to understand the behavior of chaotic systems.

In the 1960s, Edward Norton Lorenz set off to make a computer modeling program for meteorological forecasting. Truncating a variable to save time in his computations, Lorenz noticed how dropping a seemingly insignificant portion of a number led to a great discrepancy in the resultant. His discoveries contributed greatly to the modern theory of chaos. His observations led him to popularize the Butterfly Effect, the notion that "The fluttering of a butterfly's wing in Rio de Janeiro, amplified by atmospheric currents, could cause a tornado in Texas two weeks later (Krüztzmann, 2008)." Along with the rise in computer processing speeds, a renaissance to the field of dynamical systems took place, in that previously intractable problems could be approached with processing power which standard analytics could not match. The iteration of functions at a very fast rate led self-described "nomad-by-choice" (Gleick, 1987) of the sciences Benoit Mandelbrot to begin his investigation into visualizations of certain mathematical sets using computers. Mandelbrot saw the regular in the irregular objects often found in nature and developed fractal geometry, allowing for the description of many complex patterns in a systematic way.

Mathematical Model

Computer simulations have been indispensable in understanding of the dynamics of various complex phenomena (Anderson, 1986). Computer models are now used in diverse scientific are-

nas from physics, to astrophysics, biology, and chemistry. In the following, we describe our mathematical model created to study the effects of plaque deposits on the neuronal pathways of the human brain. To start, a recursive algorithm is used to generate a set of points to graph a fractal image resembling the complex neural network. Given that plaque deposits exhibit clustering patterns of formation, a probabilistic model using a non-homogeneous Markov process is employed to simulate their aggregation. To study the effects of the plaque granules on the neuronal network, we integrate the two models into one and identify the neurons affected by the plaque. Moreover, graph theoretical tools are used to measure the number of neuronal connections that a signal travels before and after plaque deposition. To emphasize the resemblance of our model to reality, we present computer generated graphs, from our simulations, in juxtaposition to the actual image of plaque deposits in the human brain. Finally, we model the increased connectivity in a plaque-affected neuronal network as a result of learning and cognitive exercises, by making the neuronal connections more resistant to plaque disruption when cognitive stimulation is present. We then contrast this improvement in signal passage through the neuronal network to the reduced connectivity of a brain affected by plaque without cognitive stimulation. Our mathematical model shows promise as a first step in modeling the complex interactions of plaque deposits in the human brain and studying the influence of different pharmacological and behavioral treatments while weighing these results against side effects.

Generating The Neuronal Network

To model the neuronal network in the human brain we employ a fractal generating algorithm. Fractal, a term coined in 1975 by Benoit Mandelbrot from the Latin *fractus* (derived from the past participle of *frangere* to break apart), describes a type of

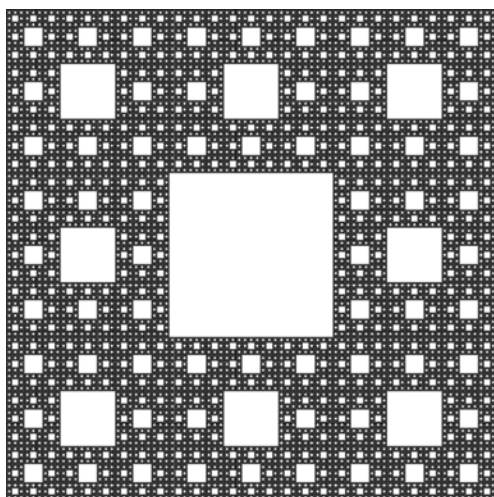


Figure 3. Sierpinski Carpet

geometry which is self-similar at different scales. Mathematicians are able to model complex systems by “breaking” these complex structures into simple pieces using properties of self-similarity. In wide-ranging arenas, from computer graphics to cellular data transmissions to noise cancellation, fractals have provided insights and have led to new engineering solutions. In modern cell-phone antennas bandwidth has increased while size has diminished by incorporating the self-similar structure known as the Sierpinski Carpet (see Figure 3). In our model of the neuronal network, we use a recursive algorithm to generate a fractal tree acting as a topological map of the human brain. By modeling the neuronal network as a symmetric geometric object with regular plots, we are able to use relatively simple algorithms to simulate the flow of signal in the network and measure the effects of the deposits. The fractal generating algorithm uses the following steps (see also Figure 4):

1. The first stage graphs a horizontal line.
2. In the next step, three more lines are drawn, two perpendicular to and one straight out from the original segment. At each step, the new lines drawn are half the length.

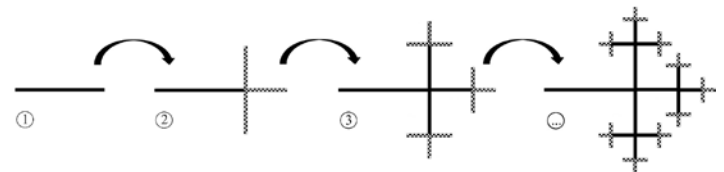


Figure 4. Generating the Fractal Tree

3. In the n^{th} iteration, each new line branches off to produce 3^{n-1} new lines of length $\frac{1}{2^{n-1}}$ relative to the first line. For instance, the first stage produces $3^0=1$ of length 1; the second $3^1=3$ of length $1/2$; the fifth $3^4=81$ lines of length $1/16$.

The output of our fractal tree program is transformed into a directed graph (see Figure 5). Each vertex (representative of a neuron) and edge is numbered. A signal flows across a directed graph in one direction, similar to the signal firing across the neural networks of the human brain.

We model the flow of a signal in a healthy neuronal network using the Bernoulli distribution, a discrete probability assignment designating low and high receptor values to the vertices in the fractal tree. In a biological setting, the action potential is more likely transmitted the higher the number of receptors on the dendritic side of the synapse. Similarly, in our model, the success of the signal passing is related to the receptor value associated with each vertex.

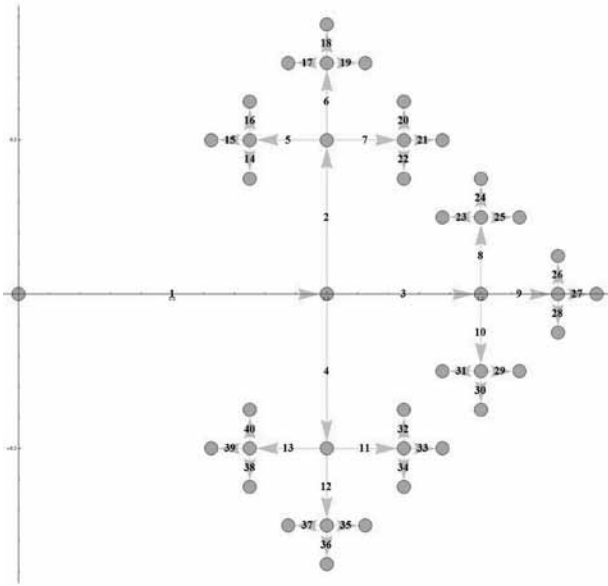


Figure 5. Fractal Tree in the form of a directed graph

After Swiss scientist and mathematician Jacob Bernoulli, the Bernoulli distribution gives the probability that a value will take one of two (discrete) predetermined values, be it high or low receptors; 0 or 1; success or fail. The probability for success is given as variable p and failure is given as $q=1-p$. The q and p values in this type of assignment will always total 1, meaning that a discrete value will be defined in every case. For instance if a p value is given as .6 the q value will be equal to .4. Moreover, the mean of assigned “successful” values will be around 60% and the mean of the failure value will be around 40%. In the receptor distribution portion of our model a high count of receptors is denoted by a 1, and a low count by a 0. We can formalize this as $P(X = 1) = 1 - P(X = 0) = 1 - q = p$.

For our model, the starting p value is .9; in this stage, about 90% of vertices get assigned a high receptor value, represented as 1, and in 10% of cases, the vertex would be assigned a low receptor value or 0. The assigned Bernoulli distribution value is descriptive of either a high, 1, or low, 0, number of receptors located at the terminus of the dendrites. A high number of receptors will increase the likelihood a vertex will receive the signal, whereas a low number of receptors has a lower probability of signal reception. A successfully transmitted signal represents an action potential (signal firing) being received, consequently passing through the neuron and triggering the release of neurotransmitters at the axon terminals, and further signal propagation. Since downstream neurons receive signal less frequently in the human brain, our model incrementally decreases the probability p of having high receptor values for vertices at each stage of the fractal tree. Consequently, q increases at each stage and further downstream vertices are more likely to have a low receptor values.

Once the receptor values have been assigned to each neuron in the fractal tree, we now simulate the passage of a signal through the fractal tree by using another Bernoulli distribution. The assigned probability that the signal passes through a neuron depends on the number of receptors: a relatively higher p -value (lower q -value) for those vertices with a high receptor value and a relatively lower p -value (higher q -value) for those with a low receptor value. Figure 6 shows an example of how the high (upper half of ring in black) and low (lower half of ring in black) receptor values end up being disbursed throughout the graph. The figure also depicts the passage of a signal over this network of a healthy brain, where signal reception is depicted by a shaded inner circle.

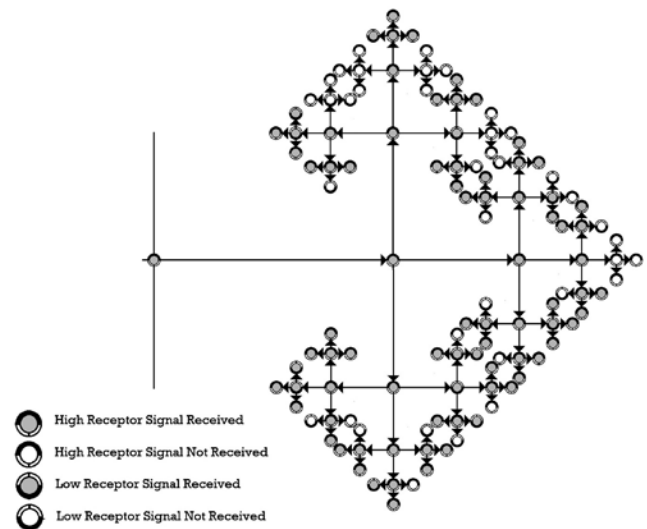


Figure 6. Distribution of neurons with High and Low number of receptors and signal passage through network

Modeling Plaque Formation

Plaque formation, a major contributing factor to Alzheimer’s disease and neuronal decay, is the second component of our model. In the human brain, plaques form in clusters posited to disrupt neuronal connections. After defining an $n \times n$ matrix,

	$a_{i-1,j-1}$	$a_{i-1,j}$	$a_{i-1,j+1}$		
	$a_{i,j-1}$	$a_{i,j}$	$a_{i,j+1}$		
	$a_{i+1,j-1}$	$a_{i+1,j}$	$a_{i+1,j+1}$		

Figure 7. High Probability Box defined around initial deposit

the first of our plaque deposits is randomly chosen from the entire field; any cell a_{ij} has a $1/n^2$ chance of being chosen in the first iteration. Next, a high probability box is defined around the initial grain (a_{ij}) along with its eight adjacent cells. The next grain is

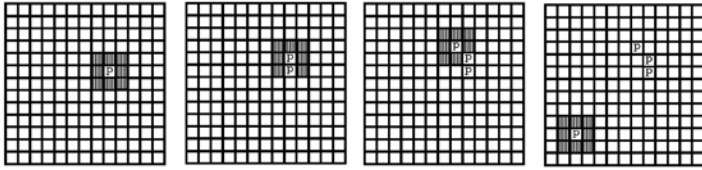


Figure 8. Iteration for plaque deposition

selected with 9/10 chance of being in the high probability box (each cell has a 1/10 possibility of being utilized). The remaining 1/10 of a chance is divided over the rest of the field (the complement to the high probability box), yielding a $1/(10n^2 - 90)$ likelihood of being chosen for the next placement. In the next step, a new high probability box is created around the new grain. We continue this process of generating a new granule at each stage recording its position in the two-dimensional matrix which, consequently, is layered onto the directed graph. As a result of the probability model employed, the granules generally form in clusters (see Figure 9).

Modeling The Effects Of Plaque On The Network

To measure the effects of the granules on the network, we measure the distance between each plaque deposition and the closest edge on the directed graph. If the particle and segment fall within a predetermined distance threshold of each other, the edge is considered affected by the deposit. Once a certain number of plaque granules fall within this distance, the edge is considered interrupted and signal passage is not allowed to downstream vertices. The number of plaques required to disrupt an edge is proportional to the length of the edge.

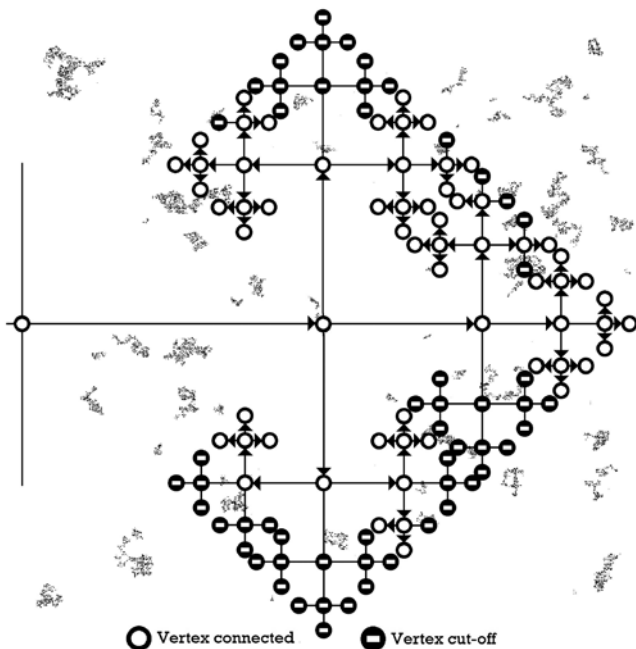


Figure 9. Plaque disrupted network

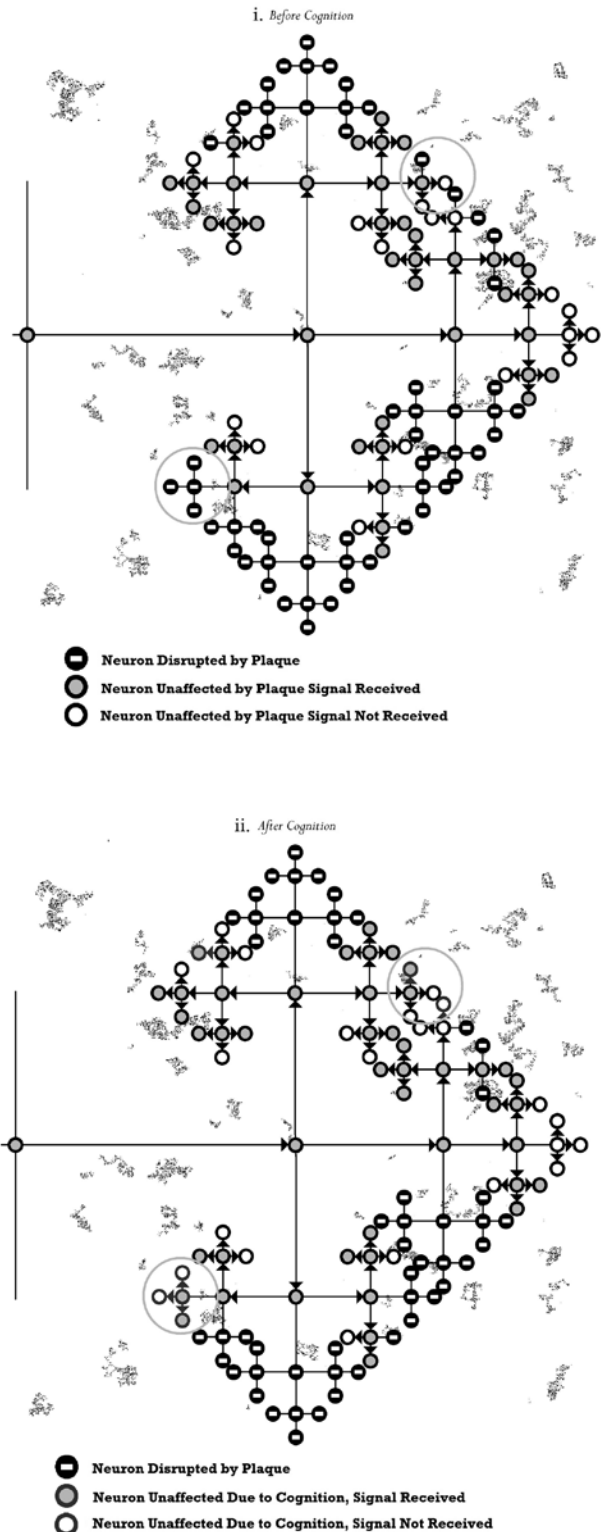


Figure 10. Path of signal through neuronal network affected by plaque degradation (i) without memory and learning exercises (ii) with memory and learning exercises.

In figure 9, we see the network after damage done by plaque deposition. Where plaque gets to within a predetermined proximity of the network, in great enough numbers, the signal does not reach the downstream neuron (depicted with shaded circle and white rectangle). The unfilled circles denote vertices connected to the network, ready to receive a signal; their preceding pathways have not been interrupted by the proteins. In figure 10(i), we see the signal passage through the network which has been degraded by plaque. The darkened circles with white rectangles are blocked; neurons ringed by circles are passable: the ones which are shaded in have successfully received a signal while the ones with white centers have not been reached by the signal. We contrast this graphic with figure 6 and easily see that the network without plaque degradation allows a substantially increased signal passage throughout the network.

Plaque disrupts signal flow on the neural network like downed trees interfere with traffic on a roadway. Signals, accustomed to traveling on a certain path, can still be delivered via a re-organization of available healthy neural branches. A variety of the brain's regions are pooled together to form a behavioral output. If the connection between these regions is disrupted, a person can possibly relearn a different way to connect the regions using a different neural substrate (set of neurons), resulting in an overall similar type of behavior. Certain modularity of basic tasks is common to many theories of neural branch configuration (Mogensen, 2011). Furthermore, mature astrocytes transform into radial glial cells to guide immature neurons to form fresh neural substrate (Pelvig, Pakkenberg, Stark, & Pakkenberg, 2008). Otherwise, factors, present in the adult brain, promote axon regeneration over more complicated trajectories, which may aid in finding new connections (Becker, et al. 2012). Like drivers taking detours to avoid road debris, the new routes are less direct. Passage of a signal across a network degraded by the influx of these plaque proteins results in fewer neurons being activated than in a disruption-free system.

Simulating The Impact Of Learning

The frequent use of neurons through cerebral exercises (Sudoku, playing piano, complex housing, physical tasks, and learning) decreases the impact of plaque deposits (Kolb, Arif, & Gibb, 2011). The effects of cognitive training have been shown to have a variety of implications on the health of the neural network. This long-lasting enhancement in signal transmission between two neurons that results from simulating them synchronously is called *Long Term Potentiation* (Cooke & Bliss, 2006). LTP enhances the ability of a signal to be received after crossing the synaptic cleft by adding new glutamate receptors to the membrane surface. As learning

occurs, the successful signal passage across the synchronous neurons promotes the likelihood of future propagation; LTP is a positive feedback loop. In addition, mice given learning tasks show delays in the onset of extracellular amyloid beta plaque and tau protein synthesis (Billings, Green, McGaugh, & LaFerla, 2007). Furthermore, preconditioning (learning prior to the arrival of deleterious effects) provides greater long term benefits compared to conditioning beginning in the pathological stages of Alzheimer's; plaque burdens are best reduced by lifelong learning regimens. On top of this, lacking the cognitive stimulation, plaque levels tend to return to their normal pathological state rapidly, suggesting learning enhances protective mechanisms. Moreover, learning increases the amount of synaptic connections; from postmortem autopsies, people who engage in mentally stimulating jobs have an average of seventeen percent more neuronal connections than those with less cerebrally demanding career paths.

In our model, we simulated the effect of learning by increasing the threshold values for the number of plaque granules needed to disrupt a neuronal connection, which resulted in the signal being able to pass through some regions previously disrupted by plaque. In figure 10(ii), we depict the signal passage through such a neuronal network after cognitive training. Contrasting this to the brain without cognitive stimulation represented in figure 10(i), we see areas (circled in grey) which are now reached due to the introduction of the cognitive exercises, but were disrupted in the other model.

	Path of Signal	Average Proportion of Neurons Reached
A	without Plaque	0.378
B	after Plaque	0.255
C	with Learning	0.301

Figure 11 Average proportion of neurons reached in 50 simulations

To quantify the effects of plaque on the neuronal network in each of the three models (healthy brain without plaque; brain affected by plaque; and brain affected by plaque with learning), we ran a large number of simulations and averaged the number of neurons reached by the signal. To allow for a valid comparison of how the signal travels through the neuronal network in the three different models, we ran our simulations with the same fixed parameters for the neuronal network and plaque formation. That is, all three models had the same underlying distribution of low/high receptor values for the neurons throughout the network. Moreover, we used the same plaque formation affecting the brain in both models

b and c . In figure 11, we show the result of our 50 trials on the network, and report the mean proportion of the 1093 neurons in our neuronal network that were reached in the 50 simulations for each of the three models. When the variables for each of the three programs are fixed, we note that $b = 0.255 = 279/1093$ (network after plaque deposition) is a substantially less than $a = 0.378 = 413/1093$ (before plaque deposition), and $c = 0.301 = 329/1093$ (network ameliorated by cognition) is a slight improvement on b .

Conclusion

In figure 12, we illustrate the results of (i) our computer generated model by juxtaposing it next to a picture of the (ii) human hippocampus affected by plaque deposits. Our model shows resemblance to reality and can be manipulated using several variables to better reflect the actual conditions seen in Alzheimer's patients and the clustering characteristics (amount and pattern) of the proteins. From our studies on the

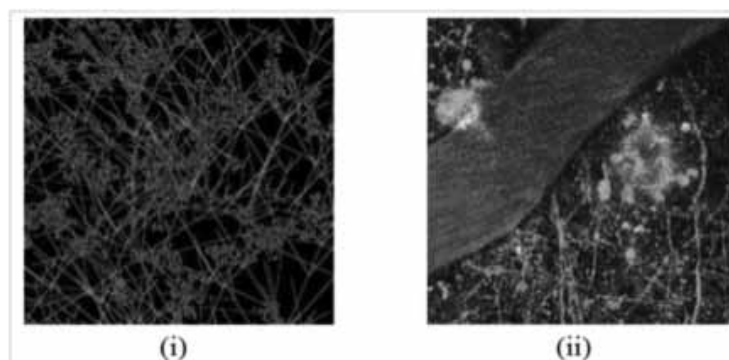


Figure 12 (i) Our computer generated model juxtaposed with (ii) biological network in the human hippocampus (Hampton, 2008).

model, strengthening the resiliency of the neural connections, such as occurs through learning, ameliorates the deleterious effects of plaque deposits on the network. We hope we have produced a rudimentary tool to better predict the outcomes of using certain treatments, possibly weighing them against any potential adverse side effects, and providing a framework to add features which enhance realism. Our model is the basis to which a variety of nuances could be added to more completely explain the system: Long Term Potentiation on the synaptic conductivity, differentiability of intraneuronal vs. extra cellular plaques, regeneration of axonal fibers, neurogenesis, etc. The complexity of the human brain is astounding, having roughly 1 quadrillion synaptic connections; our model consists of merely one thousand. In a subject which branches between mathematics; programming, neuroscience; and behavioral psychology; we hope to have made an inroad into a gigantic problem.

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Letter from Israel

MARJORIE HOWE



Marjorie Howe is a junior majoring in English with a Writing Concentration. This ethnographic essay is

the result of a Summer 2012 journey to Israel, made possible by a BSU Undergraduate Research Abroad grant. Portions of this article have appeared in slightly different form in the context of the blog the study group maintained while travelling, "Shalom! or What We Saw in Haifa." Marjorie is grateful for this opportunity, and for the continued encouragement and mentorship, before, during, and since the trip, of Dr. Lee Torda.

Theodor Herzl watches over me while I sleep. *The portrait of the Father of Zionism hangs on the wall next to my bed. Herzl is the namesake of the Hotel Theodor, our lodging on Herzl Street in the Hadar section of Haifa, and versions of his portrait hang on every floor of the hotel, in guest rooms, in corridors, in the lobby. In some pictures he appears in silhouetted profile, adapted from a picture taken at the First Zionist Congress in 1897. In others, he looks directly at the turn-of-the-century camera lens, arms folded, daring it to capture his image. In my room he faces forward, but his coal eyes look slightly left of the middle distance. They are heavy-browed, serious eyes. He wears a preposterously thick, dark beard. His even thicker black hair is combed straight back from his serious forehead. His name is everywhere in Israel, on main streets in cities and towns. The city of Herzliya, near Tel Aviv, is named after him, as is Mount Herzl in western Jerusalem, the home of Israel's national cemetery, where Herzl himself lies, his remains having been transferred from Vienna in 1949. Yad Vashem, Israel's massive memorial to the Holocaust, lies on Mount Herzl's western slope, overlooking the Jerusalem Forest.*

Zion: 1. the Jewish people 2. the Jewish homeland that is symbolic of Judaism or of Jewish national aspiration 3. heaven 4. utopia

Herzl was born in Budapest in 1860 to a well-off, mostly secular, Jewish family. They spoke German rather than Yiddish, and imagined themselves assimilated and accepted, as many European Jews of the late nineteenth century imagined. He first encountered anti-Semitism as a law student in Vienna in 1882. Then, in Paris as a journalist covering the Dreyfus Affair, he witnessed a level of vitriol against Jews that had been smoldering just under the surface of French society and which shocked him. He came around to the point of view that anti-Semitism was something of a natural state, that true assimilation was not possible, and that the only way for Jews to live as anything other than as despised interlopers was by gathering together from around the world and creating their own nation in a legally founded and internationally recognized state. He worked tirelessly, and by 1897 had gained enough support to convene the First Zionist Congress, resulting in the World Zionist Organization. Herzl was its first president. Zionism became the political movement that proposed and promoted a modern Jewish state in Ottoman-controlled Palestine. Herzl died in 1904 at the age of forty-four,

forty-four years before David Ben-Gurion declared to the world the existence of an independent State of Israel.

At the end of a long, productive, 94-degree day in Haifa, I pull the smooth white comforter under my chin, my room air conditioner set on “arctic,” and realize Herzl is not exactly watching over me, but rather, looking past me, to the future, to the Jewish state to which he has committed his life. Herzl and his Zionist followers, the young David Ben-Gurion of Poland among them, had envisioned a utopia in Palestine, a pluralistic, secular society where they believed, according to writer Simon Montefiore in *Jerusalem: The Biography*, “a socialist Jewish state would be created without violence and without dominating or displacing the Palestinian Arabs,” where “the Jewish and Arab working classes would cooperate” (401). Three days in Israel, and I’ve only seen a sample of Haifa’s working class Jewish and Arab neighborhoods, but I’ve seen and heard enough to wonder in amazement at the flawed optimism of these otherwise brilliant and charismatic leaders. Ben-Gurion lived to see the reality of it, but how would Herzl now interpret his utopia?

On a Thursday, the third day of our study group’s first week in Israel, we meet with two men who are colleagues at Haifa’s *Beit HaGefen* Arab Jewish Culture Center, located in the Arab neighborhood and a brisk ten-minute walk from our hotel. Asaf, a middle-aged man with close-cropped steel gray hair and wire-rimmed glasses, is the Jewish director of the center. He greets us with a smile and handshakes and he invites us to take a tour of the Arab neighborhood before it gets too hot in the morning sun. We walk along narrow streets and alleys that are crowded with tan stone buildings. We stand on narrow sidewalks as Asaf fills us in on local history. The sight of laundry hanging from a second-story porch reminds me that this is a living, breathing neighborhood, not a tourist attraction. I step off the sidewalk for a moment to let a young boy and his grandmother pass. He is wearing shorts, striped shirt, and sandals. He is holding his grandmother’s hand. I would like to be able to explain, even if only to myself, why the sight of those sandals made me feel like an intruder. I can’t explain why a little boy’s sandals made me feel like an intruder, but they did.

Asaf shows us outdoor sculptures from previous years’ art festivals. All of the sculptures are political and address the Jewish-Palestinian conflict on some level, some more subtly than others. One in particular, a large wrought iron representation of a skeleton key hanging on an outdoor wall next to a false wooden door, speaks to the issue of the Palestinians’ contested right of return to the homes they fled or were driven from in 1948, the time Jewish Israelis call the War of Independence and Arabs call the *Nakba*, the catastrophe. Our conversation with Asaf turns to serious issues: social inequality and Israel’s

Arab minority, protests, suicide bombings, personal tragedies and national tragedies.

We ask Asaf about his own background. He is of Ashkenazi heritage, born in Israel. He has served in the military, as almost all Israeli Jews do. I don’t remember now if unprompted, or if in response to a specific question, but Asaf takes a moment to tell us about the part of his service that involved going door to door and inspecting Palestinian houses. He is aware it must have been disturbing, especially to small children, to see soldiers with rifles in their homes. He explains that they tried to conduct these operations respectfully. It seemed to me that he was trying very hard to put, if not exactly a *good* spin on the processes of occupation, then at least an acceptable spin. I feel certain that if anyone could conduct house-to-house searches with respect for the occupants, it is Asaf. Doing the math, I figured he would have served in the early eighties, and I tried to remember which conflict, of Israel’s tortuous history of conflicts, was going on when Asaf had been a young soldier. I felt terrible that perhaps one of my questions about the Occupied Territories or checkpoints put him on the spot to explain the assignments he was involved with thirty years ago. Asaf’s twenty-year-old daughter is currently serving in the military; his sixteen-year-old twins, a boy and a girl, will serve two years from now. Young people in uniform are everywhere in Israel, sitting in two’s and three’s on park benches, praying at the Western Wall, napping through jarring city bus rides with their rifles across their laps. They are Israel’s newest generation of soldiers who will have to navigate the bumpy terrain between being defenders and being occupiers.

Back in Asaf’s office we are offered delicate cups of the best coffee I have ever had, and he narrows down the mission statement in the Center’s brochure to his two priorities: promoting shared living between Jews and Arabs in Haifa as an example that can spread to other parts of Israel, and increasing the Arab cultural presence in the community. Asaf is an optimistic person who has made an optimistic presentation.

Next, Asaf takes us across the street to meet Yusuf, the Arab director of the Children’s Library. Yusuf greets us with customary hospitality. I dearly wish I had a photo of Yusuf so I could picture him realistically. In my mind’s eye, Yusuf is a towering man. I asked a friend from the trip if she had a picture of him in her iphone, but no, she said there never seemed an opportunity to ask him if we could take a picture. She felt too intimidated to ask him. It seems I wasn’t the only one who found him intimidating.

Yusuf leads us to sit in a small circle around one of the library’s low tables. We are surrounded by shelves filled with

books printed in Arabic, Hebrew, and English. Yusuf's poised young son serves us cups of water on a tray. We learn Yusuf was educated in the United States and that his older son now attends school in the U.S. He describes a little bit about the library's unique role in providing children's books in Arabic to the community, and I relax a little, thinking we will learn about the library's mission within the greater context of the Culture Center. But then the talk turns antagonistic.

Yusuf has questions for us, rather than the other way around: "How much do you pay for gas back in the U.S.?" "Are any of you Jewish?" And then, "How many stars are on your flag?" Although he is baiting us, we dutifully answer, "Fifty." "Make it fifty-one," Yusuf replies.

Although Yusuf maintains a relaxed posture and smiles often, I feel uncomfortable with him. At times, when he looks away toward the window or the ceiling, formulating a question, his eyes, in my memory, become brooding and shadowy. His tone of voice is hostile and he expects us to answer for U.S. policy in the Middle East. Since returning home, I have emailed Yusuf several times hoping to initiate a long-distance dialogue, but have received no replies. I have spent a year, before, during, and since our trip, working to educate myself about Israel and Palestine. It is an ongoing process. In the Fall 2012 semester, I chose the course "Peoples and Cultures of the Middle East" with the specific goal of working through the conflicted feelings which began during the meeting with Yusuf. It occurred to me the other day that the right of return key sculpture, while it certainly represents the Palestinians in general, perhaps represents to Yusuf someone in his own family. I don't know, but I would like to know.

If I could talk to Yusuf again, if I had one question to ask, it would be a question about how he and Asaf deal with the conflict in the context of their friendship. Do they simply agree to set aside their conflicting narratives, the narrative of a persecuted people who found their homeland versus a persecuted people who lost their homeland?

Asaf and Yusuf had greeted each other with obvious affection an hour earlier, as if long-lost brothers. But it is as if they are brothers who were raised under the same roof by two entirely different sets of parents. Asaf refers to his Ashkenazi European ancestors and the War of Independence, while Yusuf speaks of the *Nakba* and of Palestinian refugees. Estimates of how many Arabs fled or were driven out to the West Bank and Gaza as well as to Lebanon and Syria in 1948 varies between 500,000 and 750,000. About 160,000 Arabs remained and became Israeli citizens after statehood. Along with their descendants several generations in, at 1.6 million, they make up twenty-percent

of Israel's population. Whether Arabs call themselves Arab Israelis or call themselves Palestinians has to do with whether they accept Israel as their nation and its government as their government. It has to do with whether they even recognize Israel's right to exist.

When I ask Yusuf what he calls himself, he replies, "I am Palestinian."

On Friday afternoon I go back to the Culture Center. Asaf has invited us to the four o'clock opening reception of the art exhibit, "Extraction Point." I am one of the first to arrive and climb the worn marble stairs to the second-floor gallery, a bright, high-ceilinged space with several small rooms surrounding a large center reception area. The place begins to fill quickly with visitors, mostly Arab young adults. The men wear jeans and trendy dress shirts, the women are in colorful sundresses. A young man makes last-minute adjustments to a large wall placard, consulting with Asaf. I wander into a small alcove and look at a group of photographs, a photo memoir by Reem Qassem, a twenty-five year old Arab-Israeli artist born in Nazareth, who now lives and works in Tel Aviv. Photos of bakery goods and fruit stands are alternated with close-up photos of newsprint in which the same three Hebrew letters are circled in red, over and over throughout the articles. I don't read or speak Hebrew, but a woman standing behind me translates, "That's the artist's name." She wanders off and another woman steps next to me and points to the red circles with a puzzled expression.

"The artist's name," I say.

"Ah, yes, yes," she says, nodding. "Your work is here?" she asks, gesturing to the surrounding rooms. She wonders if I am one of the artists.

"No, I am just a visitor," I reply. We introduce ourselves. Claire is a petite, slender woman in her sixties. She is French and a resident of Haifa the past five years. Her accent is something I haven't heard before: English, softly accented by French, and further accented by Hebrew, which she says she uses for most of her daily transactions. We wander the small exhibit together for the next hour, read the wall placards, speak in low voices as the place becomes more crowded. She asks me if I am Jewish. When Yusuf asked this question it felt confrontational, but when Claire asks, it seems she is hoping for an ally in the mostly-Arab crowd. I feel a little ill at ease, too, suddenly part of the minority.

I take the opportunity to ask Claire some of the questions I have come to Israel to ask, questions about levels of religious

observance, about keeping a Kosher home, lighting Shabbat candles, driving on the Sabbath. How Jewish are Israeli Jews? But I find out with Claire, as I will with other people I meet, that to talk to Israeli Jews about being Jewish leads to much more serious topics than candles and Kosher food.

Claire was born in France after World War II to parents who, along with Claire's older sisters, survived the Holocaust. The family's narrative is one of victimhood and survival, but Claire had a childhood free of persecution. She grew up in a moderately observant home. She saw herself as assimilated, French first, Jewish second. But as a teenager, she learned it was the French police, not the Nazis, who took her father away. Her parents had immigrated from Poland; Jews without secure French citizenship were the first to be rounded up. She carried the weight of this disillusionment into adulthood.

Claire went to medical school and became a gynecologist, and married Frederic, a psychiatrist. Once they had a child, she began to dream of coming to Israel. They tried in 1977, taking jobs at a kibbutz as general practitioners at much lower wages than they were accustomed to and studying Hebrew six hours a day. The economic reality of moving to Israel and living on dramatically decreased wages accounts for about a fifty percent first-time failure rate for emigres. Claire and Frederic returned to France, but when their son turned seventeen, he moved to Israel and stayed. His mother's dream had become his dream, and he now lives north of Haifa with his wife and three daughters. Claire and Frederic, their careers completed, came to Haifa five years ago. They live in a community with many neighbors who have also immigrated from France. She sees her granddaughters often. She teaches them French. They sing with her, and she is teaching them to play her piano.

I ask if she believes that she was meant to live here, as one of a chosen people.

"Oh, no," she says, "Not that biblical nonsense. I don't believe in that. This is the place I feel safe from another *Shoah*, another Holocaust," she says.

Is she religious? "No, we are secular. All of our friends here are secular."

Claire and Frederic have taken their small car across town, as the approaching Shabbat settles over Haifa, to the Arab Jewish Culture Center to see what they imagine will be Arab and Jewish art. Claire is dismayed.

"It is so angry," she says, "So political."

She asks me, "Is it what you expected, to see work of only Arab artists, and so political?" I mention to her the point that Asaf stressed the day before, that one of the center's missions is to promote the Arab cultural presence in the community.

Claire poses a question: "Wouldn't cooperation, Arab and Jewish artists working together, bring in more of all kinds of people, so the Arab artists would have more of an audience?" She searches for a word. "A more *diverse* audience."

We both have difficulty with the open-air installation on a patio at the back of the building. "Displacement," by Mahmood Kaiss, is a wood and chicken wire cage large enough for several adults to stand in and which for several months housed pigeons. But, we read on the wall notes, the pigeons in the weeks before the exhibit opened had been "driven away from their nests in a deliberate action taken by the artist, leaving behind bits and pieces that attest to their previous presence." The viewer is challenged by the artist, via the notes, to step inside the cage, to experience the feeling of being sheltered and protected, but also the feeling of being imprisoned, and then challenged again to contemplate the meaning of stepping out of the cage. Were the pigeons cast out to "an unknown fate – or possibly to their freedom"? I feel on some levels I should try to have the experience the artist intended, but I start to feel very self-conscious on the crowded patio. We go back indoors.

Claire loops my arm as I have seen European women do in movies. She looks both angry and hurt, but mostly hurt. Her eyes fill. "Does this artist feel a prisoner here? In this city where he is accepted, where he has freedom to be a creative person, and has the support of the community to live whatever life he wants? My family understands about being thrown out. About being the minority. This is not the same as the cages they were put in."

We continue to talk about minorities, but not only about Palestinians. I ask what she thinks about the Ultra-Orthodox Jews, the *Haredim*. "Oh, the fanatics! Old men yelling at little school girls, spitting at little school girls!" She shakes her head. "But everywhere there are fanatics, yes? And they want us to pay for them to study and to have their demonstrations." I ask her opinion about the West Bank settlers. "Oh, more fanatics," Claire says. "They are ruining a chance for peace. And do you know what they say to our young soldiers who are there to protect them? They call them Nazis. How can a Jew call another Jew a Nazi?"

It has been a number of days since we visited Yad Vashem, Israel's memorial dedicated to the victims of the Holocaust. How do I make sense of this experience? How do I begin?

Perhaps with an orientation to time and place. Yad Vashem was started in 1953 with a law passed by the Knesset. It is situated more than 2,600 feet above sea level on Mount Herzl and looks out over the Jerusalem Forest. On completing the walk through the Holocaust History Museum, we stepped into the warm, shaded air of a Jerusalem July afternoon and looked out on a view of the surrounding landscape and city, mountainside and sky. I thought of those who perished under the most unimaginable circumstances, never to see this or to feel warm summer air again. I tried to keep my thoughts with the victims only, tried not to selfishly make the experience about myself, about what their victimhood means to me.

The Yad Vashem complex is vast. The many buildings and memorials that make up the site are surrounded by expansive plazas and connected by winding pathways, all paved in the ubiquitous tan-white Jerusalem stone. Some paths are shaded by the surrounding trees, but the plazas are bright and flat, and I found them disorienting. I felt exposed and empty and lost as I walked across each open plaza.

Entering the Holocaust History Museum, I wondered how they began such a task. How did the curators bring this staggering volume of artifacts together? Thousands of photographs, documents, personal and household items are displayed in a sequence that carries the visitor through the years leading up to and through the Nazi's rise to power, describing the means by which six million European Jews were murdered. Was there a first pair of children's mittens, perhaps the pair in front of me in the display case, the yarn worn down at the palms, left behind on a wooden bunk in the barracks, or dropped from a pocket onto the frozen ground outside a crematorium?

Days later, what of this experience has me awake at two o'clock in the morning?

I am thinking about shoes under plexiglass. In one of the final galleries of the museum, I came to a display of hundreds of broken, blackened shoes, sheltered under sheets of plexiglass flooring in the shape of a rectangle large enough for ten adults to stand on at one time. But of course there is a great reluctance to stand on the glass, to walk over the display of shoes, as if stepping on a grave. It makes you feel like a violator. So at first I stand back. There is a group of girls and boys, fifteen or sixteen years old, in a semi-circle around the far end of the rectangle from where I am standing. They are wearing purple t-shirts with some sort of logo on them. A guide is in the center of the group – a young man whom I feel has been chosen for this particular group because he is close to their age. He steps squarely onto the plexiglass and asks the others to step onto the glass as well. Nobody moves. I try to move, but at first I cannot.

Someone says out loud that they don't feel they should.

"Why not?" the guide asks. No answer. There are self-conscious glances all around. Teenagers afraid to look or sound foolish in front of their friends. And then, a boy giggles. I believe it is explainable, nervous, self-conscious giggling. Ill-at-ease, immature, and explainable. The guide tries to control his temper.

"This reaction you are having, can you explain it to me? I am trying to understand why you think this is funny." The boy tries to stop smiling but cannot. He turns his face partly away. The guide, trying to ignore him and engage the others, kneels down and points to individual shoes, a worker's half-boot, a young lady's open-toed sandal, very much like what some of the girls in the group are wearing. Something turns in me, something tells me I need to step onto the glass, that doing so is the only way to acknowledge the reality of the lives lost, of the people who left these shoes behind. I force myself. One step forward. Two. I stand and weep. The group of boys and girls, the guide, are oblivious to me.

He continues his effort to teach: "You should step onto the glass," he tells them, "And if you cannot, you should think about why you can't. Why do you think there are so many shoes remaining?" Finally, another boy, speaking in a cultured British accent, takes a chance, gets past worrying what the others will think of him, "Because the Nazis had no use for them?"

"Yes," the guide says, "that is it. Nobody would want to wear the worn and broken shoes of dead people, so there was no profit to be made." I make my way out of the gallery.

In November of 2011 I had finally found Hanukkah candles in the third supermarket I checked, having pronounced and spelled and explained "Hanukkah" in all three locations. If I lived in a community with a higher Jewish population, I would probably have had a different experience. I wondered, holding my box of candles marked, "Product of Israel," if I'd have had trouble finding Hanukkah candles in Israel. And here was the start of my idea, the little question that grew into the questions about the Jews in Israel who buy those candles, or who don't, who may or may not have a menorah on the top shelf of the kitchen cabinet (as for years I didn't), who may or may not take it down and light the candles for the eight miraculous nights. Is there a single Jew in Israel without a menorah on the top shelf, I wondered? And what about Sabbath observance, or synagogue attendance? What does "Jewish" mean in a country that is 75% Jewish, rather than 2%? What do those Jews call themselves? I went to Israel not knowing what kind of Jew I

am, or what to call myself, imagining I was going to find out about Hanukkah candles.

What I found out is that there are Jews in Israel who have a ready and confident answer when asked about their level of religious observance: “I am secular,” they reply, or “traditional,” or “orthodox.” But there are many others who pause and then explain that, for example, they go to synagogue or keep Kosher, but hesitate to give themselves a name. Whether or not they have a quick answer about what kind of Jew they are *does not matter*. It only matters that they are Jewish and they are Israeli. What I saw and heard and felt was that Jewish and Israeli are part and parcel for them, two inseparable parts of their nationality, secular *and* sacred.

I found out that these Jewish people go about their daily lives with the same question, sometimes on the front pages of their newspapers and sometimes further in, on the editorial pages, but it is always in their minds: what are the chances for a peace agreement in their lifetimes, in their children’s lifetimes? I found that the Israeli Jews I spoke to believe in the two-state solution and want to see a Palestinian state. They express dismay at extremists on all sides in general, but in particular at the West Bank Settlers, and increasingly right-wing government policies, and stalled negotiations. I found out that to be a Jew is to question, and that the question every Jew needs to ask, as representatives of history’s persecuted people is: “But what about the Palestinian people?” I found out I had it in me to finally step onto the plexiglass, but not into the pigeon cage, and that a question I had rarely, if ever, asked myself was, “But what about the Palestinian people?”

I found out that there is a place in this world where I am welcome because I am Jewish, not in spite of it, and that I am more Jewish now, as I was told I would be, although I am not a religious Jew. I am a Zionist, a word I didn’t even understand one year ago. I found out that at 5.9 million, there are still fewer Jews living in Israel than were murdered in the Holocaust. That there are only 13 million Jews in the entire world. I am quietly desperate that Jews have a homeland and a right to exist. *But what about the Palestinian people?*

The writer Joan Didion says, “I write entirely to find out what I’m thinking, what I’m looking at, what I see and what it means. What I want and what I fear.” My writing worked for me in this way while I was in Israel. But I quote Ms. Didion now because, as it turns out, I went to Israel entirely to find out why I went to Israel: to find out that my right to exist, as a Jew on Planet Earth, is directly connected to Israel’s right to exist; to find out what it means to be able to walk up to the Western Wall of the Second Temple, in the walled Old City,

the City of David, and what it meant to touch the ancient surface, tentatively at first with my fingertips, then with the full palm of my hand, and finally to touch my forehead to the ancient Jerusalem stone and shed tears for every single soul that has come before me and every single soul I will someday leave behind; to find out that in leaving my dad’s name on a small piece of paper, folded over on itself and secured between the cracks in the stone, I truly believe I have given a part of him a resting place in Israel; to find out that Israel’s hard won access to the wall, and therefore my access to the wall, means that others are excluded. Perhaps this is how it had to be in a certain time and place, but I don’t understand why it still has to be so. It does not. I went entirely to find out what I want and what I fear. I want a Jewish homeland to exist and a Palestinian homeland to exist. I fear that opportunities to achieve this are being discarded daily, hourly, as we speak.

Here is what I am thinking now about Yad Vashem, about the shoes and the angry guide and the immature, smiling boy, about the more mature young man who found it in himself to speak up. All of us on this inexplicable planet in this inexplicable lifetime are potential victims and potential perpetrators, potential rescuers and potentially rescued. Knowledge of the Holocaust, such a place as Yad Vashem, cast into sharp focus who, for a period in human history, was one thing and who was the other. I am someone who, in a different time and place, would have been taken away. The two sons my husband and I have raised, by virtue of having a Jewish mother, might not have escaped, might have been rounded up and taken away, no matter whether they choose to call themselves Jews, or not.

I have no answer to this question: If I acknowledge that I could have been one thing, can I acknowledge that perhaps I could have been the other? If tested, could I be brave? Could I be strong and righteous? Given the life I have been given, free of persecution, can I find it in myself to speak up for others who continue to be persecuted? On this journey I begin to ask this question of myself. I begin to look for an answer.

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The Object of Desire: How Being Objectified Creates Sexual Pressure for Heterosexual Women in Relationships

TIFFANY HOYT



Tiffany Hoyt is a senior with a double major in Psychology and Criminal Justice and a minor in Spanish. She

began this research in March 2012 and completed an Adrian Tinsley Program Summer project under the direction of Dr. Laura Ramsey. Tiffany presented this research at the ATP Summer Symposium and the 2013 National Conference on Undergraduate Research in Wisconsin. Her research has been expanded in an honors thesis to include the study of both men and women, and her work will be presented at the 2013 BSU Undergraduate Research Symposium. Tiffany will attend the University of Rhode Island in the fall to pursue a Master's Degree and a career in Student Affairs.

The objectification of women is widespread in the United States (American Psychological Association, 2007). In heterosexual relationships, a woman can feel objectified by her partner. When a woman feels objectified by her partner, she may internalize the objectification, feel like she has less control, and perceive more sexual pressure and coercion. However, there is relatively little research on objectification in romantic relationships. Therefore, the purpose of this research was to explore how partner-objectification might be related to sexual pressure in heterosexual relationships. A sample of 162 women from all over the United States participated in an online study that measured partner-objectification, self-objectification, sexual agency, and sexual pressure and coercion. The data were analyzed using bivariate correlations. Results showed that (a) partner-objectification is positively correlated with women's self-objectification, (b) self-objectification is negatively correlated with less freedom and control, and (c) less freedom and control is related to more sexual pressure. This research adds to the literature on romantic relationships and can inform interventions aimed at reducing sexual coercion.

In the United States, objectification is pervasive (American Psychological Association, 2007) and primarily affects women (McKinley & Hyde, 1996). Objectification is a concern for women in countless aspects of their lives, including their work, school, political, and private environments (Nussbaum, 1999). To sexually objectify a woman is to mentally divide her body and mind in order to focus on her sexual body parts and functions. Her body parts are no longer associated with her personality, but are seen as instruments, and she is treated as a sexual object to be used by others (Bartky, 1990).

While there are many negative consequences to being objectified and objectification is generally considered to have a negative impact on women (Bartky, 1990; Fredrickson & Roberts, 1997; Zurbriggen, Ramsey, & Jaworski, 2011), some theorists have proposed that romantic relationships are one context where objectification is safe and even enjoyable because of the emphasis on physical attractiveness in romantic relationships (Nussbaum, 1999). On the other hand, viewing one's partner as an object or feeling like an object could create inequality in a relationship, as the objectified partner may feel like his/her needs and emotions are not being acknowledged. Furthermore, objectification theory purports that objectifying someone makes it easier to commit violence against that person (Fredrickson & Roberts,

1997), and so an objectified partner may be subjected to more sexual pressure and even sexual coercion. Surprisingly little empirical research has examined objectification in the context of romantic relationships. For this study, we focused on women in heterosexual relationships to determine how much women feel objectified by their romantic partner, if they internalize that objectification, and if that objectification is related to having less control in the relationship and experiencing sexual pressure and coercion in the relationship.

Partner-Objectification

Partner-objectification is thinking of a partner as a sex object instead of an equal partner in the relationship with his or her own feelings and emotions (Zurbriggen et al., 2011). Within a romantic relationship, it is expected that each partner will assess each other's attractiveness and anticipate sexual experiences. However, thinking of one's partner just as an object to be used for one's sexual desires could lead to negative consequences, such as partners feeling unequal in their relationship. The only published study on partner-objectification tested the relationship between media consumption, partner-objectification, and relationship satisfaction (Zurbriggen et al., 2011). The data showed that consuming objectifying media was positively associated with partner-objectification, which in turn predicted lower relationship satisfaction. In other words, the more that a person views their partner as an object, the less satisfied they are in the relationship. The current study seeks to build off of this research by examining and gaining a deeper understanding about how partner-objectification affects the person who is being objectified. For example, we hypothesize a positive correlation between partner- and self-objectification.

Self-Objectification

When women internalize the idea of being viewed as an object, they are engaging in a process known as self-objectification (Fredrickson & Roberts, 1997). Self-objectification has been empirically linked to a number of negative consequences, including constant body monitoring and self-surveillance, body shame, appearance anxiety, eating disorders, negative self-esteem, and poorer academic performance (Sanchez & Broccoli, 2008; Steer & Tiggemann, 2008). Particularly pertinent to romantic relationships, self-objectification is correlated with lower relationship satisfaction (Sanchez & Broccoli, 2008) and sexual dysfunction (Steer & Tiggemann, 2008). The basic nature of sex involves partners focusing on each other's bodies, which can magnify the sense of body shame and appearance anxiety associated with self-objectification and result in poorer sexual functioning (Sanchez & Kiefer, 2007; Steer & Tiggemann, 2008).

We hypothesized, that women who feel objectified by their partner are likely to internalize that objectification and experience self-objectification. Women in relationships could believe that their partner is looking at them like an object for sex, and therefore they would want to make sure their bodies are pleasing to their partner. Instead of concentrating on what their body can do and how it functions, women focus on how their body looks to others, especially if their partner reinforces this idea. Even women who claim to enjoy being sexualized by men experience self-objectification and actually feel more shame about their bodies than women who do not report enjoying sexualization (Liss, Erchull, & Ramsey, 2011). The present study assesses whether feeling objectified by one's partner is related to experiencing self-objectification.

If a woman self-objectifies, she may concentrate on her body as a physical object that needs to be desired by men, and consequently focus much less on her own wants and needs. Indeed, previous research has shown a negative correlation between body image, self-consciousness, and sexual agency (Curtin, Ward, Merriwether, & Caruthers, 2011). In the current study, it is hypothesized that more self-objectification is correlated with less agency in a relationship.

Agency

Previous research has linked objectification with the denial of agency, or the restriction of one's freedom to make decisions (Gray, Knobe, Sheskin, Bloom, & Barrett, 2011). Lowered sexual agency has been linked to a host of negative outcomes, including decreased sexual risk knowledge, difficulty in engaging in safe sex practices (such as requiring a partner to wear a condom during intercourse), and the inability to refuse unwanted sex (Curtin et al., 2011; Rostosky, Dekhtyar, Cupp, & Anderman, 2008).

Using assessments of condom use and sexual assertiveness, research has shown a direct link between self-objectification and diminished sexual health among adolescent girls (Impett, Schooler, & Tolman, 2006). Women who do not feel comfortable making sexual decisions in a relationship have difficulty advocating safe sex behaviors, such as condom use, which can negatively impact their sexual health. One specific study of condom use found support for the idea that women who have a lack of agency in a relationship and feel less power to make sexual decisions also feel sexual pressure (Gakumo, Moneyham, Enah, & Childs, 2011). The ability to negotiate condom use requires agency from both partners in a relationship; women who feel objectified and lack agency may also feel pressure from her partner and be unable to properly negotiate sexual behaviors.

Sexual Pressure & Coercion

Feeling objectified by one's partner, self-objectification, and sexual agency are particularly important variables to study because of their logical connection to sexual pressure and coercion. Sexual pressure is defined as feeling the need to conform to expectations to have sex due to a fear of consequences that may include losing benefits, being abandoned by one's partner, and physical or emotional threats (Jones & Gulick, 2009). Sexual coercion, on the other hand, is sexual pressure that involves threats of violence, actual physical force, or emotional manipulation (Shackelford & Goetz, 2004). By definition, an object has no agency, and so viewing a relationship partner as an object could interfere with one's ability to consider their partner's needs and desires, making it easier to pressure or coerce that partner into participating in particular sexual behaviors. Due to the internalization of that objectification (i.e., self-objectification) and lowered sexual agency, the objectified partner might feel pressure to perform more sexual activities and might be less inclined to act on their own feelings and emotions. The result of this pressure would be the objectified partner consenting to sexual behaviors that she otherwise would not consent to in an effort to please her partner.

This logic is reflected in the cultural expectations that men should be more aggressive and women should be more submissive (Fredrickson & Roberts, 1997). Additionally, previous research demonstrates that sexual pressure is positively correlated with sexual victimization, and women who feel more sexual pressure are more likely to have unprotected sex (Jones & Gulick, 2009). This study tested whether objectification and agency are related to experiencing sexual pressure and coercion.

Hypotheses

The following hypotheses were tested in the present study: 1) partner-objectification will be correlated with increased self-objectification, lowered agency, and increased sexual pressure and coercion; 2) self-objectification will be correlated with lowered agency in romantic relationships; 3) lower agency in romantic relationships will be correlated with increased pressure and coercion to perform sexual behaviors.

METHODS

Participants

Two hundred sixty-seven female participants were recruited using the web service Amazon Mechanical Turk (AMT) that distributes task requests to a population of workers throughout the United States who can volunteer to complete a task (such as a survey) for a nominal amount of money. Previous research has demonstrated that AMT can produce reliable data appropriate

for social science research by providing samples that are more diverse and more representative of the U.S. population than typical samples gathered in college settings or typical internet samples (Buhrmester, Kwang, & Gosling, 2011).

Three attention questions were randomly placed throughout the survey in order to evaluate whether the respondent was responding in a valid fashion. An example of an attention question used is: "If you have been reading the questions in this survey, click never;" those people who did not select "never" were marked as incorrectly answering one of the attention questions. Participants who did not answer at least two of the attention questions correctly or did not complete the majority of the survey items ($n=45$) were excluded from the analyses. Also, because the present study aimed to focus on heterosexual relationships, those who did not respond as being heterosexual ($n=45$) were eliminated from the data. The sample size for non-heterosexual participants was too small to permit thorough data analysis, and so analyses of those data are not included in the present study. Those women who have never been in a romantic relationship ($n=11$) were also eliminated from the data. Finally, women who answered the questions about their best opposite sex friend, as opposed to their current or previous partner, were eliminated from the data ($n=2$). This resulted in a final total of 162 participants.

The participants ranged in age from 18 to 69 ($M=29.53$, $SD=11.90$). The majority of the sample was working class (48.1%) or middle class (37.7%). A majority of the women who responded identified as White/Caucasian (78.4%). About 85% of the participants reported that they are currently in relationships. Out of the 164 women, 14.8% responded that they are single, 9.9% dating, 24.1% have a steady partner, 7.4% are engaged, 14.2% are living with their partner, and 29.6% are married.

Measures

Partner-objectification. A modified version of the partner-objectification scale (Zurbriggen et al., 2011) was used to assess how much each participant felt objectified by her partner. The scale was originally designed to measure how much a person objectified their partner, but it was modified to measure how much a person feels their partner objectifies them. For example, "I rarely think about how my partner looks" in the original scale was modified as "My partner rarely thinks about how I look" for the present study (this item was reverse scored). Participants used a 7-point scale from *disagree strongly* to *agree strongly* to respond to the 8 items in the measure. The reliability of a scale is calculated and shown with the symbol alpha (α). An alpha level of .7 or better shows that all of the items in the scale are measuring the same

construct. For this particular scale, $\alpha = .76$.

Self-objectification. Self-objectification was measured using the surveillance subscale of the Objectified Body Consciousness Scale (McKinley & Hyde, 1996). Participants responded to the 8 items using a 6-point scale ranging from *disagree strongly* to *agree strongly* to measure how much she views her body from an observer's perspective ($\alpha = .88$). An example of a reverse-scored item is "I think more about how my body feels than how my body looks."

Sexual agency. To measure sexual agency, participants completed four subscales of the Sexual Self-Efficacy Scale for Females (SSES-F; Bailes et al., 1989). Each subscale lists activities related to sexual agency and asks participants to respond with a 0 if they are unable to do any of the sexual activities. If they can do the sexual activities, they are asked to rate their confidence in their ability to do each of them from 1 (*quite uncertain*) to 10 (*quite certain*). The four subscales used were body acceptance (2 items, $\alpha = .77$, e.g., "Feel comfortable being nude with the partner"), refusal (2 items, $\alpha = .63$, e.g., "Refuse an advance by a partner"), communication (5 items, $\alpha = .81$, e.g., "Ask the partner to provide the type and amount of sexual stimulation needed"), and interpersonal interest/desire (6 items, $\alpha = .89$, e.g., "Be interested in sex").

Sexual pressure. The Sexual Pressure Scale for Women-Revised (Jones & Gulick, 2009) was modified to be about a partner, instead of a generic person, to measure how much a person feels victimized or forced into unwanted sexual acts by their partner. An example of one of the 18 modified questions is: "How often have you had someone misinterpret the level of sexual intimacy you desired," changing "someone" to "your partner." Respondents answer on a 5-point scale ranging from *never* to *always*. The alpha coefficient for this scale was .82.

Coercion. The Sexual Coercion in Intimate Relationships Scale (SCIRS) was used to measure the frequency and severity of sexual coercion in a romantic relationship (Shackelford & Goetz, 2004). Items were answered on a 6-point scale, where respondents chose from a range of *act did not occur in the past month* to *act occurred 11 or more times in the past month*. The two subscales used were: Resource Manipulation/Violence (15 items, $\alpha = .93$, e.g., "My partner threatened violence against me if I did not have sex with him" and Commitment Manipulation (10 items, $\alpha = .94$, e.g., "My partner hinted that if I loved him I would have sex with him").

RESULTS

The means and standard deviations of each of the measured variables are presented in Table 1. Bivariate correlations were conducted to test each of the hypotheses. Table 2 shows the correlations between each variable.

Table 1. Survey Scales with Means (M) and Standard Deviations (SD)

Survey Item	M	SD
Partner-Objectification	3.42	1.02
Self-Objectification Self-Surveillance Subscale	3.94	.97
Agency Body Acceptance Subscale	7.96	2.65
Agency Body Refusal Subscale	8.06	2.47
Agency Communication Subscale	9.07	1.88
Agency Interpersonal Interest/Desire Subscale	9.03	2.03
Coercion Resource Manipulation/ Violence Subscale	1.11	0.38
Coercion Commitment Manipulation Subscale	1.33	0.74
Pressure	1.90	0.49

DISCUSSION

The data for this study supported the hypotheses proposed for women in heterosexual relationships. The results showed that, for heterosexual women, 1) feeling objectified by a romantic partner is related to women objectifying themselves, feeling lowered agency, and perceiving more sexual pressure and coercion; 2) self-objectifying is related to feeling lowered agency in their romantic relationship; 3) feeling lowered agency in their romantic relationship is related to feeling sexual pressure and coercion from their romantic partner.

Limitations and Future Research

This study is important for relationships and has the potential to allow men and women to improve how they treat one another sexually. Being mindful of how and when one thinks of their partner as an object, sexually or otherwise, can help relationship partners become more purposeful in respecting one another and increasing their satisfaction with their relationship. In addition, acknowledging objectification can help women realize when they lack agency and allow them to resist and avoid sexual pressure.

Because this was a correlational study, no causal relationships can be determined, so caution is needed in interpreting these

Table 2. Non-zero Correlation for Each Variable

	1	2	3	4	5	6	7	8	9
1. Partner-objectification	-								
2. Self-objectification Self-Surveillance Subscale	.203**	-							
3. Agency Body Acceptance Subscale	-.232**	-.276***	-						
4. Agency Body Refusal Subscale	-.172*	-.317***	.142†	-					
5. Agency Communication Subscale	-.262***	-.180*	.437***	.316***	-				
6. Agency Interpersonal Interest/ Desire Subscale	-.278***	-.283***	.637***	.226**	.743***	-			
7. Coercion Resource Manipulation/ Violence Subscale	.132†	-.081	-.017	-.073	-.185*	-.170*	-		
8. Coercion Commitment Manipulation Subscale	.221**	-.040	-.108	-.154†	-.316***	-.298***	.698***	-	
9. Pressure	.288***	.121	-.075	-.286***	-.197**	-.234**	.521***	.588***	-

†p < .10, *p<.05, **p<.01, ***p<.001

findings. For example, the correlation between partner-objectification and self-objectification shows that women who feel that their partner objectifies them are more likely to also objectify themselves. However, these data do not reveal if partner-objectification causes women to objectify themselves, if women's self-objectification causes her partner to further objectify her, or if a third variable causes both self- and partner-objectification, producing a spurious correlation. The same logic follows for the other correlations reported. It is important that future research test these relationships experimentally to confirm whether self-objectification, partner-objectification, sexual agency, and sexual pressure and coercion are causally related, though this could be difficult given the ethical and logistical barriers to manipulating these variables. In particular, it would be beneficial to test for a causal relationship between partner-objectification and sexual pressure and coercion, as that would suggest that interventions aimed at reducing sexual violence in intimate relationships should include efforts to reduce objectification. A longitudinal study measuring these variables over time would also help gauge the direction of the relationship between partner-objectification and sexual pressure and coercion.

An additional limitation to this study includes the reality that we were unable to include both partners of a couple in a present relationship. While the data from Amazon Mechanical Turk is diverse and reliable, it does not give the option to find people who are in a romantic relationship together. Therefore, the data from the present study is all based on one individual's perception of the relationship. This affects how some variables

are interpreted; for example, it is not possible to determine whether women who perceive that their partner objectifies them have a partner who *actually does* objectify them. To some extent, this may be a moot point because a person's construal of their partner's behavior can have stronger consequences for the relationship than their actual behavior (e.g., Murray, 1999). However, it would be interesting for future research to recruit both members of couples to further test and explore how objectification is related to agency and sexual pressure and coercion in romantic relationships.

Finally, future research could examine a sample beyond heterosexual women. Looking at data from men to see what happens when they feel objectified by women could also be enlightening to objectification research. It would be interesting and more inclusive to tailor a similar survey for same-sex couples to see if they experience the same connection between objectification and sexual pressure within their relationships.

Conclusions

This study is important for understanding and improving dynamics within heterosexual relationships. The findings in this study add to the literature on self-objectification and partner-objectification by showing a relationship between objectification and sexual pressure. The acknowledgement of these associations can help both men and women become more aware of how they are thinking about and treating their partner, as well as possibly lessen sexual pressure and coercion in romantic relationships. Future research should continue to investigate objectification in romantic relationships.

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Amygdalae Enlargement and Activation are Associated with Social Network Complexity in Individuals with Human Immunodeficiency Virus (HIV)

CHRISTINA JASPER



At the time of submission, Christina Jasper was a senior majoring in Psychology and English. This

research, which was conducted at Brown University's MRI Research Facility, began as an Adrian Tinsley Program (ATP) semester grant in the spring of 2012, and was further supported by an ATP Summer Research Grant. She is grateful for the opportunities made possible by ATP and would like to thank The Office of Undergraduate Research. She is especially grateful to Dr. Sandra Neargarder and Dr. Uraina Clark for their endless enthusiasm, encouragement, and mentorship.

Brain volumetric studies reveal that human immunodeficiency virus (HIV) infection is associated with significant changes in several neural regions, including enlargements in the amygdalae, which are small sub-cortical structures located deep within the left and right temporal lobes that contribute to social behavior. Research on healthy individuals has shown a positive correlation exists between amygdalae volumes and social network size. However, there is evidence that larger amygdalae volumes are associated with increased psychiatric difficulties. The present study investigated the relation of amygdalae volumes and activation to social network size in HIV patients. It was predicted that HIV participants would demonstrate amygdalae enlargement and hyperactivity, and that this would correlate with reduced social interactions. The Social Network Index (SNI), a self-report measure that assesses involvement in eight social domains, was administered to 14 HIV positive (HIV) and 7 healthy control (HC) individuals. The psychological profiles of the groups were characterized using several self-report questionnaires, measuring current stress levels, mood, rates of interpersonal difficulties, and alexithymia. High resolution anatomical magnetic resonance images (MRI), obtained using a 3-Tesla scanner, were used to quantify amygdalae volumes. Participants viewed black and white images of angry and fearful faces, stimuli known to elicit robust amygdalae activation, as part of a functional MRI paradigm. The HIV and HC groups did not significantly differ on measures of social functions, amygdalae volumes, or amygdalae activation. In both groups, trend level correlations were observed between increased left amygdala volume and social network size. We also observed a significant correlation between right amygdala activation and social network complexity in the HIV group; however, these correlations were not significant in the HC group. Taken together, our results indicate that in HIV patients, greater amygdalae volumes and activation in response to highly potent social stimuli were associated with a higher degree of social interaction. These data have high clinical significance in that they provide preliminary evidence that individuals with HIV demonstrate a similar relation between social functions and amygdalae structure/function, as has been previously shown in HC samples. Studies with larger samples are needed in order to investigate these preliminary findings further.

Human immunodeficiency virus (HIV) is a disease that attacks specific blood cells, CD4 T cells, which protect the body against diseases (Centers for Disease Control [CDC], 2006). The CDC estimates that approximately 1.1 million people are living with HIV in the United States (CDC, 2011).

Second to the lungs, the brain is the most frequently affected organ in HIV patients (Masliah, DeTeresa, Mallory, & Hansen, 2000) and frontal-subcortical regions are particularly susceptible to the disease (Becker, J. T. et al., 2011; Wiley et al., 1999). Volumetric studies reveal significant brain changes in individuals with HIV, particularly in the amygdalae, which are small subcortical structures that lie deep within the temporal lobes (Clark et al., 2012). An extensive body of literature suggests that the amygdalae play a crucial role in social behavior (Cremers et al., 2011), as well as emotion recognition, particularly negative emotions, such as fear, anxiety, and aggression (Becker, B. et al., 2012; Garrett, 2011). The amygdalae are also active in recognizing emotional facial expressions – a role that is essential to normal social judgment. In a study by Adolphs, Tranel, & Damasio (1998), three individuals with complete bilateral (i.e., both sides of the brain) amygdalar damage were asked to judge faces of unfamiliar people on the basis of two attributes that are relevant to real-world social interactions: trustworthiness and approachability. All three participants judged the faces as more trustworthy and more approachable than control participants. Patients with bilateral amygdalae damage due to Urbach-Wiethe syndrome, a rare recessive autosomal disease which results in calcification (i.e., hardening of soft tissue due to the build-up of calcium salts) of anterior medial temporal lobe structures (Hamada et al., 2002; Hofer, 1973) also demonstrate deficits in the recognition of fearful faces and decreased social network size and complexity when compared to control participants (Becker, B. et al., 2012). Taken together, these findings suggest that damage to the amygdalae negatively impacts our ability to judge facial expressions, which could potentially further interfere with social interactions.

Some researchers have suggested that the amygdalae are most sensitive to ambiguity. Lloyd and Kling (1991) found that stimuli that predicted threat some of the time, as in a partial reinforcement schedule, produced greater amygdalae responses in squirrel monkeys than those stimuli that consistently predicted threat. Our day-to-day lives tend to have some level of ambiguity. As a result, researchers have suggested that there is a strong relationship between amygdalae function and activation and successful navigation of our social environments (Buchanan, Tranel, & Adolphs, 2009).

Volumetric research on the amygdalae has deepened our understanding of the active role these structures play in mediating social behavior, although findings vary across populations. Increased amygdalae volumes have been observed in children with autistic spectrum disorder (ASD) and have been implicated as a contributing factor in the social and communication deficits displayed by this population (Kim et al., 2010; Schumann, Barnes, Lord, & Courchesne, 2009). Cremers et

al. (2011) found that the volume of the right amygdala positively correlated to healthy participants' levels of extraversion. Other research in healthy individuals has indicated that a positive correlation exists between amygdalae volumes and neuropsychiatric function, as indexed by measures of social network size (Bickart et al., 2010). Here, social network refers, for example, to an individual's friends, family members, neighbors, colleagues, peers. Individuals with larger amygdalae volumes had larger, more complex social networks. Kanai, Bahrami, Roylance, and Rees (2012) found that the grey matter density of the amygdalae positively correlated with the size of individuals' real-world social networks and their online social networks.

The present study was conducted to investigate whether there is an association between amygdalae volume and activation and social network size in individuals with HIV. In the present study, social network is defined as a social construct. The term refers to the collection of relationships maintained by an individual. Since individuals with HIV tend to demonstrate larger amygdalae volumes, it is of interest to determine if this volumetric abnormality correlates with social network size. Gaining a better understanding of the relationship between amygdalae volume and social network size could have important implications for the rehabilitation of individuals with HIV. This current project precedes a more involved study that will assess these effects in a larger population. Based on Bickart's (2010) findings, we predicted a positive correlation between amygdalae volume and social network size in the healthy groups. Based on data indicating that in patient populations enlarged, hyperactive amygdalae are associated with a greater degree of neuropsychiatric difficulty (Clark et al., 2012; Malykhin et al., 2012) we also hypothesized that HIV participants would demonstrate increased amygdalae enlargements and hyperactivity, and that these changes would correlate with reduced social functions.

METHODOLOGY

Participants. The study included 14 HIV-positive (HIV; 5 women, 9 men, $M_{age} = 48.43$ years, $SD_{age} = 9.53$ years) and 7 HIV-negative healthy control (HC; 2 women, 5 men, $M_{age} = 55.14$ years, $SD_{age} = 8.51$ years) individuals. HIV participants were recruited from a pool of participants currently enrolled in an ongoing longitudinal HIV aging study at Brown University. HIV participants did not have any comorbid psychiatric disorders known to alter amygdalar volume and function. HC participants were acquaintances of HIV participants and individuals recruited from the community. All participants scored within the normal range on the Mini-Mental State Exam (MMSE; Folstein, Folstein, & McHugh, 1975), indicating the absence of dementia and were fluent in English. The major-

ity of the participants had already been recruited and screened based on a variety of criteria prior to the start of data collection for this study. The participants were well-matched on basic demographic variables and significantly differed only on number of years of education ($p < .05$). A variety of measures were administered to assess mood and perceived stress in the two participant groups. All participants completed the Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988), the Center for Epidemiologic Studies-Depression Scale (CES-D; Radloff, 1977), the Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983), the Inventory of Interpersonal Problems (IIP; Horowitz, Alden, Wiggins, & Pincus, 2000), and the Toronto Alexithymia Scale (TAS; Bagby, Parker, & Taylor, 1994). These measures assessed anxiety, depression, perceptions of current stress in the month before testing, interpersonal difficulties and maladaptive relationship behavior, and alexithymia (i.e., difficulty identifying and describing one's own feelings) respectively. The HIV and HC groups did not differ on these measures (all p -values $> .05$).

Potential participants were excluded based on the following criteria: 1) history of significant pre-existing brain disease or injury; 2) previous and/or current central nervous system (CNS) infections; 3) current post-traumatic stress disorder (PTSD) diagnosis; 4) history of chronic psychiatric illness involving psychosis (e.g., schizophrenia); 5) mental retardation; 6) drug and alcohol dependence within the past six months; 7) positive urine drug screen at time of testing; 8) MRI contraindications (e.g., pregnancy, claustrophobia, MR non-compatible implants). Approval for using these assessment tools had been obtained from the Miriam Hospital's Institutional Review Board. All participants gave informed consent and were financially compensated for their time.

Measures and Procedures

All participants completed several psychological questionnaires that measure social network size, perceived stress levels, and mood. After answering the questionnaires, all participants completed an fMRI task.

Social Network Assessments. The Social Network Index (SNI; Cohen et al., 1997) is a 23-item self-report measure that assesses participation in eight social domains (e.g., family, professional, academic, volunteer). The SNI is arranged into a series of coupled questions. The first question asks if the respondent has a particular relationship and the second question asks if they communicate with the people in that particular relationship at least once every two weeks. For example, the second question on the SNI asks about the number of children a person has. Respondents answer by checking a line next to the correct number ranging from zero to seven or more. Question

2a asks about the number of children the participant communicates with in person or by phone at least once every two weeks. The same response key used in the previous question is supplied. If a respondent indicates that he/she have no children on question 2, he/she would skip question 2a and answer question three. The majority of the questionnaire is arranged in this format.

The SNI provides three sub-scales: (1) Number of High Contact Roles, (2) Social Network Size, (3) Number of High Social Domains. Each measures separate aspects of sociability. A high contact role is a social role in which the respondent has regular contact (i.e., at least once every 2 weeks) with at least one person. For example, if a participant is a parent who has regular contact with his/her children, they would qualify for that high contact role. Social network size is determined by calculating the total number of people with whom the respondent has regular contact. The number of high social domains is meant to reflect the complexity of the respondent's social network, and measures the number of different network domains in which a respondent is active.

Brain Imaging

Magnetic Resonance Imaging (MRI) – Amygdalae Volumetrics:

Structural images of the brain were obtained using a 3-Tesla scanner (Siemens TIM Trio; Siemens, New York, NY). High-resolution T1-weighted MPRAGE images were acquired in the sagittal view.

Measures of whole-brain and amygdalae volumes (both on the left and right sides of the brain) were acquired via the Individual Brain Atlases using Statistical Parametric Mapping Software (IBASPM). Individual brain volumes were segmented into gray matter, white matter, and cerebrospinal fluid and normalized via nonlinear registration to the MNI 152 template. Volume estimates were calculated for each parcellation as well as for total intracranial volume. Participants' amygdalae volumes were determined in cm^3 . Brabec et al. (2010) estimate that the anatomical volume of the amygdalae in normal healthy adults ranges from 1.24 cm^3 ($SD = 0.14$) to 1.63 cm^3 ($SD = 0.2$).

Functional MRI (fMRI) Task – Amygdalae Activation

We administered an emotional paradigm known to elicit a robust response in the amygdalae. Participants viewed black and white images of angry and fearful faces and completed the five task conditions shown in Figure 1. While in the scanner, the participant gave their answer to the task by pressing the corresponding button on a button box. Our analyses focused on the Observe condition, as it is known to produce the most robust amygdalae response. Analyses of Functional NeuroImages (AFNI) software was utilized to conduct fMRI analyses.

Examples of fMRI Task Conditions

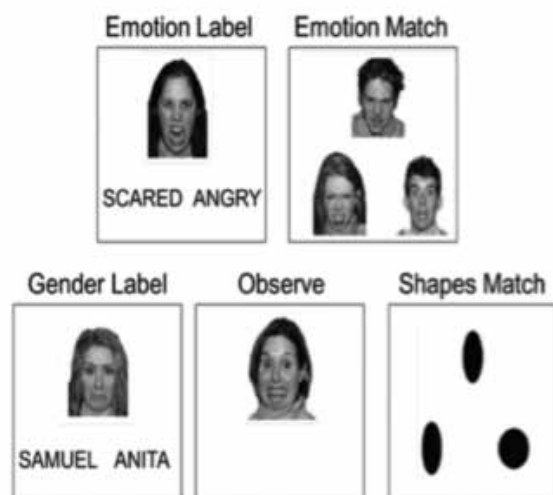


Figure 1. This figure displays the conditions of the fMRI faces task. All of the faces shown in the various conditions displayed anger or fear because these two emotions are known to illicit the most robust amygdala response. With the exception of the label headings, this is what the participant would have seen.

Results

Social Network Assessments

The HIV and HC groups did not differ on the three subscales of social functioning as assessed by the SNI. These subscales included number of high contact roles, $t(19)=0.79$, $p=0.44$, social network size, $t(19)=0.95$, $p=0.35$, and number of high social domains, $t(19)=1.04$, $p=0.31$.

Amygdalae Volumetrics:

Amygdalae volumes in the HIV and HC groups did not significantly differ (left: $t(19)=.29$, $p=.77$; right: $t(19)=.27$, $p=.79$).

fMRI – Amygdalae Activation

We observed a significant activation of the left and right amygdalae during the Observe condition across groups (left: $t(19)=3.38$, $p<.01$; right: $t(19)=2.60$, $p<.02$); however, we did not find significant differences in amygdalae activation between groups in this condition (left: $t(18)=.66$, $p=.52$; right: $t(18)=.71$, $p=.48$; Figure 2).

SNI Correlations with Amygdalae Volumes

Across the HIV and HC groups, we observed a trend level correlation between left amygdala volumes and high contact roles ($r(21)=.33$, $p=.07$; one-tailed) as well as social network size ($r(21)=.33$, $p=.07$; one-tailed; Figure 3). No significant correlations were found between the HIV and HC groups on these measures (high contact roles: $z=.20$, $p=.84$; network size: $z=.15$, $p=.88$).

Amygdalae Activation Across Conditions

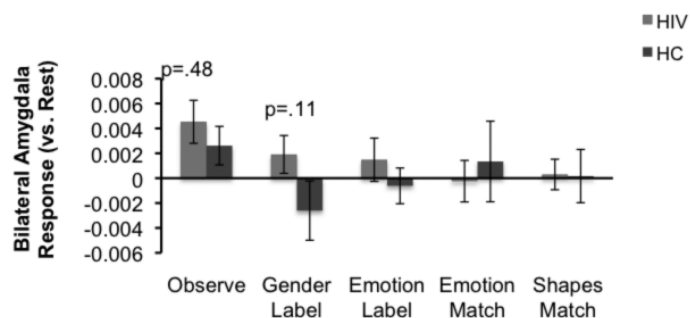


Figure 2. The graph presents the levels of bilateral amygdalae response in both groups according to the conditions in the fMRI task. We observed significant activation of the left and right amygdalae during the Observe condition across groups; however, there were no significant differences in amygdalae activation between groups in this condition. In both the HIV and HC groups, the right and left amygdala were most active when observing angry and fearful faces.

SNI Correlations with Amygdalae Activation

We observed a significant correlation between right amygdala activation and number of high social domains in the HIV group ($r(13)=.69$, $p<.01$; Figure 4). This correlation was at a

Correlations between Left Amygdala Volume and SNI Subscales Across Groups

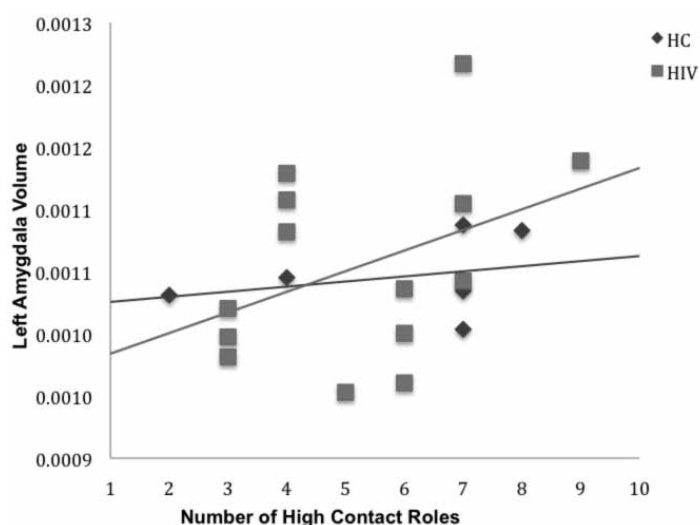


Figure 3. The graph shows that across groups there was a trend level correlation between left amygdala volumes and number of high contact roles as measured by the SNI. The correlation is not significant, but an increase in left amygdala volume is associated with an increase in participants' numbers of high contact roles.

Correlations between Left Amygdala Volume and SNI Subscales Across Groups

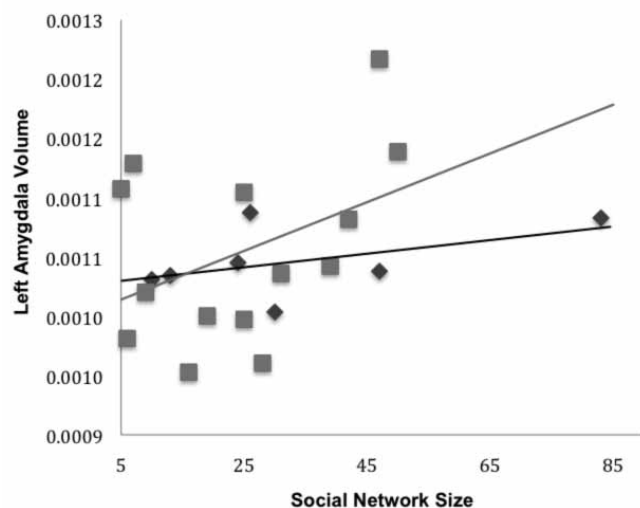


Figure 3b. The graph shows that across the groups there was a trend level correlation between left amygdala volumes and social network size as measured by the SNI. The correlation is not significant, but an increase in left amygdala volume is associated with an increase in the size of participants' social networks.

trend level for the left amygdala ($r[13]=.50$, $p=.08$). These correlations were not significant in the HC group (right: $r[7]=.42$, $p=.35$; left: $r[7]=.22$, $p=.63$). To validate our findings of a relationship between right amygdala activation and social function, we examined the relation between amygdalae activation

Correlations between Right Amygdala Activation and Number of High Social Domains in HIV Group

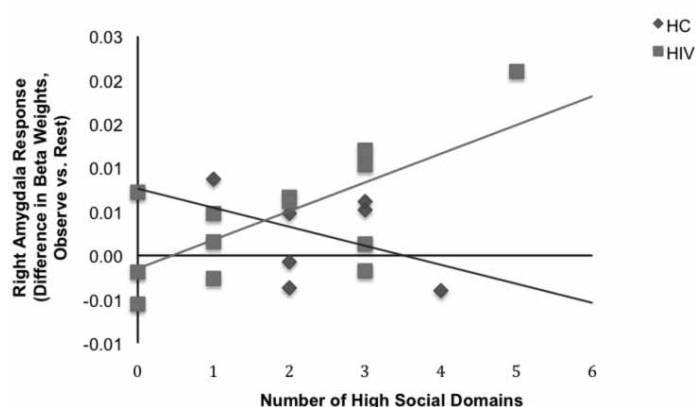


Figure 4. FMRI data analysis presented a significant correlation between right amygdala activation and number of high social domains in the HIV group. This correlation was at a trend level for the left amygdale. These correlations were not significant in the HC group.

and interpersonal problems as measured by the IIP, and found that across both groups, greater activation was associated with reduced levels of interpersonal problems ($r[20]=.63$, $p<.01$).

Discussion

Based on Bickart's (2010) findings, we anticipated that we would see a positive correlation between amygdalae volume and social function in the HC participants. We also predicted that the HIV group would display larger, hyperactive amygdalae and that these factors would correlate with reduced social function. Our hypothesis regarding the HIV group was not supported by the results. In HIV patients, greater amygdalae volumes and activation in response to highly potent social stimuli were associated with a higher degree of social interaction. These data provide preliminary evidence that individuals with HIV demonstrate a relationship between social functions and amygdalae structure and function, consistent with previous findings in HC samples. This suggests that enlarged amygdalae volumes do not negatively impact HIV patients' social functioning and this in itself can be a message of hope to this clinical population. The results suggest that HIV patients' abilities to form relationships and maintain social networks are not necessarily adversely impacted by the disease. Our findings also suggest that amygdalae enlargement and increased activation may potentially be associated with positive neuropsychiatric outcomes (i.e., complex social networks).

The results of the study also indicate that the HIV participants were similar to HC participants on the various measures that were given to assess mood and perceived stress. In the present study, the HIV participants did not display neuropsychiatric difficulties. Our findings conflict with previous research that suggests there is a strong link between HIV infection and neuropsychiatric difficulties. The disease is associated with higher rates of multiple psychiatric disorders when compared to the general population rates (Hinkin, Castellon, Atkinson, & Goodkin, 2001). A study conducted by Bing et al. (2001) involving 2864 individuals with HIV reported that nearly 50% of the participants screened positive for at least one of the following psychiatric disorders - major depression, dysthymia, generalized anxiety disorders, and panic attacks. More than a third of the participants screened positive for major depression (Bing et al., 2001). We expected the HIV participants to display neuropsychiatric difficulties given the body of literature that indicates there is a relationship between the infection and psychiatric dysfunction. One reason the HIV participants in the present study did not display neuropsychiatric difficulties may be due to our small sample size. The HIV group had higher means than the HC groups on all of the mood and perceived stress measures; however, these differences did not reach significance. We believe that adding more participants to the

study would have resolved this issue, and the two groups would show significant differences on these measures.

The HIV group and the HC group differed only on number of years of education, but we do not feel as though this impacted our results, as the fMRI task that we administered was not a cognitively demanding or complex task. The participants viewed angry and fearful faces and were asked to make a judgment about which emotion was being displayed. The conclusion that participants' levels of education had no influence on the results is supported by Kirouac and Dore's (1985) finding that there is no significant link between participants' levels of education and emotion recognition.

There are several issues with the present study that warrant further consideration. One of the limitations of this study is its small sample size, which reduced the chances of observing significant group differences between the HIV and HC groups in terms of the neuropsychiatric and volumetric analyses. The independence of the participant samples presents another limitation of the present study. HC participants were recruited from the surrounding community, but they were also acquaintances of the HIV participants. The recruitment strategies suggest that these participants could share some common or overlapping social networks. A possible confounding variable is that numerous studies have suggested that social networking may play a protective role in both physical and mental health in individuals with HIV and healthy individuals (Bassuk, Glass, & Berkman, 1999; Pinquart & Duberstein, 2010; Robbins et al., 2003).

Future studies utilizing larger samples are needed to further investigate these preliminary findings. These studies might also want to consider including stress as a covariate in the analyses since it has been shown to be a factor in increased amygdalae size and hyperactivity in HIV patients as well as otherwise healthy individuals (Clark et al., 2012; Tottenham et al., 2010).

The present study was conducted to investigate the relationship between amygdalae volume and activation and social network size in individuals with HIV. The HIV and HC groups did not significantly differ on measures of social functions, amygdalae volumes, or amygdalae activation. In both participant groups, trend level correlations were observed between increased left amygdala volume and social network size. A significant correlation between right amygdala activation and social network complexity was observed in the HIV group; however, these correlations were not significant in the HC group. Taken together, these findings indicate that in HIV patients, greater amygdalae volumes and activation were associated with a higher degree of social interaction. These data have high clinical significance in

that they provide preliminary evidence that individuals with HIV demonstrate a similar relation between social functions and amygdalae structure/function, as has been previously shown in HC samples. Studies with larger samples are needed in order to investigate these preliminary findings further.

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Ancients, Moderns, and Americans: The Case of Tyranny

ALEXANDRIA LAROSE



Alexandria LaRose is a senior majoring in Communication Studies and Political Science. She

completed this research with Dr. Barkalow of the Political Science department as part of the Summer ATP research grant. In the fall of 2013, Alexandria will begin a master's program in Mass Communications.

American political thought's reliance on modern, liberal thinking raises questions about its ability to fully and properly understand tyranny. According to Leo Strauss (2000), this lack of understanding, or total misunderstanding, stems from America's failure to return to the political thought of the ancients. Ancient philosophy provides one with the normative criteria by which it becomes possible to distinguish between healthy and unhealthy regimes. This project assesses the argument of Strauss through a textual analysis of Locke's Second Treatise and The Declaration of Independence. The analysis conducted finds no evidence to suggest that American political thought provides an understanding of tyranny substantive enough to allow us to identify tyranny when confronted by it. Instead, we must look outside of the American political tradition, to Tocqueville's Democracy in America, for an understanding of tyranny that is characterized by both substantive and procedural components.

Central to American political discourse is the concept of tyranny. From the Pilgrims' desire to escape religious persecution in England to President George W. Bush's use of tyranny to describe the attacks of 11 September 2001, tyranny continues to occupy a central place in America's political vocabulary. In 2005 Democratic Senator Russell Feingold used the term to describe President Bush's decision to have the NSA listen to international calls placed within the United States. He states, "I tell you, he's President George Bush, not King George Bush. This is not the system of government we have and that we fought for" (ABC, 2005). More recently, Representative Joe Walsh called President Obama a tyrant. He argues that Obama's decision to change the immigration policy in order to prevent the deportation of undocumented immigrants brought to the United States as children was a tyrannical act. Walsh said, "I was on one radio station and I said, 'My god he's a tyrant.' I don't know what else you call him. I don't want to give him that credit because I don't think he's smart enough" (Siddiqui, 2012).

Despite the continued use of the word, there is reason to believe that there is a basic misunderstanding, or total lack of understanding, of tyranny. Leo Strauss (2000, 22-23) writes:

The analysis of tyranny that was made by the first political scientists was so clear, so comprehensive, and so unforgettably expressed that it was remembered and understood by generations, which did not have

any direct experience of actual tyranny. On the other hand, when we are brought face-to-face with tyranny—with a kind of tyranny that surpasses the boldest imagination of the most powerful thinkers of the past—our political science failed to recognize it.

The reason for this, according to Strauss, lies in a fundamental distinction between ancient and modern understandings of tyranny. Aristotle treats tyranny as a deviation from monarchy, and from this one may infer that a tyrant is little more than a monarch who rules with an eye to his private advantage instead of the public good (*Politics* 1259a 15-18). In contrast, modern tyranny rejects the distinction between king and tyrant and the normative evaluation that informs this distinction. In rejecting the ancient distinction, philosophers remove from political theory the distinction between healthy and unhealthy regimes. In other words, they remove the normative foundation that allows one to comprehensively speak to why tyranny is bad. If Strauss is correct, we can only fully understand tyranny by returning to modern political thought the politics of the ancients due to the lack of a comprehensive understanding of tyranny provided by moderns. To the extent that Strauss is correct, his argument presents a problem for American political thinking on tyranny given the centrality of the political ideas shaping our founding documents to .

This essay begins by examining the nature of the ancient and modern tyranny distinction drawn by Strauss. The next section provides an analysis of tyranny as defined by Locke in *Second Treatise of Government*. This and the third section, focusing on *The Declaration of Independence*, shows how the American Revolutionaries drew on Locke in developing their understanding of tyranny. The final section examines Tocqueville's depiction of majority tyranny in America, as well as his solution to the problem. The American Founders rely on a modern understanding of tyranny. Therefore, American political thought does not provide a response to Strauss' (2000) charge that modern political thought fails to provide a comprehensive understanding of tyranny. However, Tocqueville offers a response to Strauss' charge. Tocqueville's emphasis on mores helps to provide standards of political morality that inform his understanding of majority tyranny; therefore, Tocqueville offers a definition of tyranny that is simultaneously ancient and modern.

Strauss on Tyranny and Natural Right

Strauss draws a distinction between ancient and modern tyranny. The key to this distinction, according to Strauss, is that ancient tyranny is grounded on a political morality absent in the modern understanding of politics. Consequently, modern political theory has difficulty determining which governments

are tyrannical and which are not (Strauss 2000). The key to understanding the difference between ancient and modern tyranny can be found in Strauss' distinction between ancient and modern natural right.

The ancient understanding of natural right is grounded on a teleological viewpoint.¹ Strauss states, "all natural beings have an natural end, a natural destiny, which determines what kind of operation is good for them. In the case of man, reason is required for discerning these operations: reason determines what is by natural right with ultimate regard to man's natural end" (Strauss 1953, 7). Individuals are guided by natural standards in order to live their lives virtuously and complete virtuous acts. Similarly, ancient governments are founded on the same natural standards that facilitate the habituation of citizens into working for the betterment of the city. Aristotle emphasizes the importance of habituating citizens into virtuous behaviors at an early age as early habituation instills in individuals a sense of obligation, or duty, to their city as well as predisposes them to the right action (*Ethics*, 1103a 20). Ancient republican views of virtue put the good of the city above the good of the individuals, the early habituation into these values allows for individuals to act for the betterment of the city.

Moderns view the city as an artificial construct; therefore there is no natural political morality, which can be used to evaluate the regime. Strauss (1999, 111) argues, "The city is a multitude of human beings who are united not by nature but by convention" who come together to protect their common interests. While ancient natural right focuses on virtue and good citizenship, modern natural right is concerned with securing and enjoying natural rights. Despite the commonality between ancient and modern thought on natural right, moderns view the common good in fundamentally different terms than ancients. Without the strong attachment to common good, moderns have no sense of duty to the city; instead they argue that natural standards are located within the individual. The good comes to be determined by each individual, consequently, the good too becomes a relative term that is the polar opposite of a single, natural standard. Individuals no longer need to look to natural standards for guidance and morality, instead the good can be determined by each individual. This is contrary to the ancient belief that decisions are set by natural standards. Moderns argue that government should work towards the protection and enjoyment rights for the individual. By placing the natural standards within the individuals, natural rights become based on the individuals' rights, instead of the common good.

According to Strauss, Locke is emblematic of the modern change in how natural right is understood. While Locke initially appears to provide a traditional account, closer inspection

shows how radical Locke's teaching really is. The shift from emphasizing duties to securing and enjoying a revised understanding of natural right causes individual egos to "become the center and origin of the moral world," according to Strauss (2000, 248). Strauss shows the change by looking into Locke's teaching on property. Locke argues that the work a man puts into objects is what gives the object value (§37).² Strauss reads Locke's teaching with regard to property as resulting in hedonism. This happens because individuals stop looking to natural standards of virtue for pleasure and start collecting items as the source of their happiness. Happiness is no longer found in adhering to natural standards, but in the indulgence of our physical desires. For moderns, there is no longer a place for a morality that is not self-authored. The change in where value lies causes a change in philosophy, into a world of convention instead of a world of nature, meaning that conventional things such as money have become more important than natural standards of morality.

Locke on Tyranny

Locke creates a clear distinction between usurpation and a tyrannical government. He writes, "[a] usurpation is the exercise of power which another hath a right to, so tyranny is the exercise of power beyond right, which nobody can have a right to" (§199). To understand the nature of this distinction, it is useful to consider Locke's thoughts on slavery. Locke defines slavery as, "... nothing else but the state of war continued, between a lawful conqueror and a captive" (§23).³ In slavery, individuals are given arbitrary power over the lives of other people. A slave is no longer able to act as an agent for their own lives, he/she no longer possesses the freedom to direct their own lives, due to the giving up arbitrary power of their lives to another person. Governments become tyrannical when they execute arbitrary power over its citizen while working with an eye to private interests instead of the common good. Locke states, "[if the government is beyond its limits, the government becomes tyrannical]" (§199). Natural rights limit governmental political power. When government goes beyond these set limits the political power it acquires power that they have no right to. No one has the right or power to use the power they acquire for their private good instead of for the common good; when this happens, tyranny occurs (§199).

Tyranny occurs when a ruler goes above and beyond the laws. Locke states, "[w]here law ends, tyranny begins" (§202). He argues that no one can strip citizens of their rights: "whosoever in authority exceeds the power given him by the law, and makes use of the force he has under his command to compass that upon the subject which the law allows not, ceases in that to be a magistrate, and acting without authority may be opposed, as any other man who by force invades the right of

another" (§202). Laws are one of the ways that governments protect rights, particularly the right to own and enjoy property. Locke states, "for in governments, the laws regulate the right of property, and the possession of land is determined by positive constitutions" (§50). Laws are also created as a way to limit the power of government and create stability. Stability is needed, "... to preserve his property, that is, his life, liberty and estate, against the injuries and attempts of other men; but to judge of, and punish the breaches of that law in others" (§87). Consequently, when these laws are breached by the government it acts arbitrarily. In the state of nature, stability is not provided causing the problem of uncertainty. The laws provide agreed upon rules as to what one can and cannot do, which is not a characteristic of the state of nature.

When individuals enter into a political society they restrict their own rights and the power to punish others, in return the government protects them. Individuals entering into society are looking to gain security. In the state of nature there are no impartial judges or established laws by which society is governed by (§125-126). For Locke, governments are created to secure the natural rights of individuals. Men are willing to give up freedoms that they possess in the state of nature to secure and enjoy their natural rights, specifically their rights to life, liberty and property (§87, §131). A good government, according to Locke provides stability. The uncertainty felt in the state of nature is caused by the right for a party to take from another just because they can in a state of nature until peace is found between the two parties (§20). An impartial judge, government, establishes laws to protect and allow for the enjoyment of rights. Another way that governments secure rights is through laws. Having laws created which prevent injury and destruction also creates rules that are followed by citizens. These laws create stability by making rules to be followed by all citizens as well as providing an independent body to solve disputes.

When government no longer protects the rights of the people it governs and allows for their enjoyment of these rights, then the majority has a right to dissolve the government. Locke writes, "the people have a right to act as supreme, and continue the legislative in themselves; or erect a new form, or under the old form place it in new hands, as they think good" (§243). The importance of majority rule can be found in Locke's depiction of the legislative body. Where Locke speaks of legislative power he explicitly mentions that it is governed by majority rule.

He states that changes can only be made with the support of a majority of the governed. This consent needs to be given by either the people themselves or by representatives that the governed have chosen to give consent for them (§140). Locke

believes that if a law inflicts harm upon another citizen it is an unjust law (§ 202). The citizens then have the right to try and alter the government. If the acts of tyranny are perpetrated against the majority of citizens and the majority decides to alter the government, this will happen because “in such cases as the precedent and consequences seem to threaten all, and they are persuaded in their consciences that their laws, and with them, their estates, liberties, and lives are in danger” (§ 209). The majority of the people have to give consent to any changes made in order for the dissolution of government to happen.

American Revolutionaries on Tyranny

The Declaration of Independence was written by Jefferson in order to prevent tyranny in America. He states, “The history of the present King of Great Britain is a history of repeated injuries and usurpations, all having in direct object the establishment of an absolute Tyranny over these States” (*Declaration*). Jefferson argues throughout the document that, because of the presence of tyranny in America, there is a justification for politically breaking away from England and becoming the United States. In doing so, Jefferson must show that the King’s rule in America is illegitimate. On both counts, Jefferson follows the example of Locke.

Jefferson follows Locke’s emphasis on the purpose of legitimate government is to secure natural rights. Jefferson argues in *The Declaration of Independence* that men are all born with inalienable rights: “[w]e hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the pursuit of Happiness” (*Declaration*). The idea of rights to life, liberty, and happiness can be found in other documents.⁴ The Virginia Bill of Rights of 1776 states, “That all men are by nature equally free and independent, and have certain inherent rights, of which, when they enter into a state of society . . . namely, the enjoyment of life and liberty, with the means of acquiring and possessing property, and pursuing and obtaining happiness and safety.” Jefferson and the revolutionaries argue for the enjoyment of rights, the same as Locke. Similar to Locke, Jefferson argues that legitimate government becomes tyrannical when it abuses and usurps power. Jefferson more explicitly adds an injury component to tyranny which Locke does not explicitly depict. Jefferson writes, “. . . when a long train of abuses and usurpations, pursuing invariably the same Object evinces a design to reduce them under absolute Despotism” (*Declaration*). *The Declaration* also states, “[t]he history of the present King of Great Britain is a history of repeated injuries and usurpations, all having in direct object the establishment of an absolute Tyranny over these States” (*Declaration*). Thus, according to Jefferson, tyranny is a function

of the abuse of power, the usurpation of political power, and injury.

An abuse of power occurs when a leader uses their political power to benefit their private interests instead of the common good. This King abuses the power he has been given by undermining the rule of law. According to Jefferson, the King, “. . . has forbidden his Governors to pass Laws of immediate and pressing importance, unless suspended in their operation till his Assent should be obtained; and when so suspended, he has utterly neglected to attend to them” (*Declaration*). The King only passed laws which were beneficial to himself, instead of passing laws which were for the common good. He managed this by stopping the legislative body from passing laws. Not only did the King refuse laws but he also undermines the consent of citizens. Jefferson argues in *The Declaration* for a Lockean understanding of consent from the citizens. Gathering the legislative body in places “unusual, uncomfortable, and distant from the depository of their public Records” in order to prevent the legislative body being able to consent to laws (*Declaration*). Consenting to the government is a requirement for legitimate government according to Locke. He also dissolves the legislative bodies when they disagree with his abuse of the rights of citizens. This means that Americans were not able to give the consent needed to make the government legitimate. Nowhere is this more important than in they cry “no taxation without representation.” Jefferson and other revolutionaries argue for the governed to be able to give express consent to their government. They required government to gain consent from the governed in order to be legitimate.

Jefferson also argues that British control over the colonies is illegitimate because the monarch usurps political power. Jefferson has the same understanding of usurpation as Locke; they argue that usurpation is when an individual uses power they do not have a right to (§199). In *The Declaration*, Jefferson states that the King takes power from other branches of government that he has no political right to. An example of this is when the King assumes the legislative powers of regulating trade with different parts of the world, as well as imposing taxes (*Declaration*). Both of these are powers of parliament that the King has no right to. The King of England also usurps natural rights from the people. He denies citizens their right to a jury trial of his/her peers. Instead, he transports people overseas to be tried on false charges (*Declaration*).

American Revolutionaries petitioned the King of Britain to try and stop the oppression of America; however, they were still faced with repeated injuries even after petitioning for change (*Declaration*). The King of England hindered America’s ability to provide by plundering “our seas, ravaged our coasts, burnt

our towns, and destroyed the lives of our people” (*Declaration*). By damaging property and taking the lives of citizens, the King is no longer protecting the natural rights that American revolutionaries argued for, the rights to life, liberty, and the pursuit of happiness. The King also put an undue burden upon Americans to keep rebuilding their lives in order to pursue happiness. Destroying property and slaughtering individuals causes the governed to no longer receive enjoyment from their rights, thus removing their tacit consent.⁵ Another injury perpetrated by the King was declaring war against American citizens. After declaring war, mercenaries were sent to carry out atrocities on Americans. *The Declaration* reads: “He is at this time transporting large Armies of foreign Mercenaries to complete the works of death, desolation, and tyranny, already begun with circumstances of Cruelty & Perfidy scarcely paralleled in the most barbarous ages, and totally unworthy the Head of a civilized nation” (*Declaration*). Through these acts the king has endangered the peace, tranquility, property, and the common good of the United States. Which wasn’t yet established.

When presented with tyranny, the *Declaration* states, “That whenever any Form of Government becomes destructive of these ends, it is the Right of the People to alter or to abolish it, and to institute new Government, laying its foundation on such principles and organizing its powers in such form, as to them shall seem most likely to effect their Safety and Happiness” (*Declaration*). Upon close analysis one can see that the revolutionaries’ desire to overthrow governments which are not working for the good of the people is built on Locke’s understanding of when to governments should be dissolved. For both Locke, and the American Revolutionaries, government can be overthrown but a majority consensus has to occur before this can happen. When withdrawing from government, the governed have the right to state the problems, they are having with the government (*Declaration*). If the majority of the citizens agree, stating problems can lead to the changing or removal of the governmental structure they are currently living under. Jefferson writes, “it is their right, it is their duty, to throw off such Government, and to provide new Guards for their future security” (*Declaration*).

The similarity between the American Revolutionaries and Locke suggest that the American Revolutionaries’ understanding of tyranny is modern and not ancient, in their common emphasis on the nature and purpose of legitimate government. America draws on its own political tradition in order to employ the standards of political morality needed to create the substantive understanding of tyranny. Having a modern understanding raises questions about America’s ability to recognize tyranny when it occurs (Strauss 1953, 200). Strauss argues that the normative quality lacking in modern politics is what allows

tyranny to be recognized. Tocqueville provides for this normative evaluation through his understanding of majority tyranny. If America wants to find the principals of political morality needed, then we need to look to Tocqueville for answers instead of our founding documents.

Tocqueville on Tyranny

Tocqueville argues that the threat of tyranny and despotism are damaging to governments with one ruler but are even more damaging to governments that are ruled by majority. He writes, “Under the absolute government of one alone, despotism struck the body crudely, so as to reach the soul; and the soul, escaping from those blows, rose gloriously above it; but in democratic republics, tyranny does not proceed in this way; it leaves the body and goes straight for the soul” (*Democracy*, 244).⁶ For Locke and the American Revolutionaries tyranny affects the body, individuals are restricted from basic needs, such as food and material items. Tyranny of the soul debars the soul, causing the dehumanizing aspects of tyranny, such as isolation from society. In majority tyranny one is still able to keep their freedoms and their own opinions. However, when an individual disagrees with the majority opinion they lose connections with society. Majority tyranny is especially damaging due to its psychological effects on individuals. According to Tocqueville, when majority opinion is still being formulated the lines of communication are open and individuals can speak their thoughts freely. However, when majority decision is formulated, individuals no longer have the ability to speak their minds when it goes against majority opinion” (*Democracy*, 244). Tocqueville argues that this is because, “In America the majority draws a formidable circle around thought. Inside those limits, the writer is free; but unhappiness awaits him if he dares to leave them” (*Democracy*, 244). These boundaries drawn around ideas create a negative psychological effect on individuals. Under a majority tyranny, thoughts become restricted due to a need to conform: “You are not free to think as I do; your life, good goods, everything remains to you; but from this day on, you are a stranger to us. You shall keep your privileges in the city, but they will become useless to you” (*Democracy*, 244). People become less willing to speak out against the majority due as doing so has consequences. Speaking out against the majority also has political implications: “A political career is closed to him: he has offended the only power that has the capacity to open it up. Everything is refused him, even glory” (*Democracy*, 244). Due to the need to conform one can no longer be who they are or who they want to be. Tocqueville argues that the conformity required by majority tyranny is what makes it more dangerous than the tyranny of a single individual. Tocqueville provides a depiction and understanding of tyranny that goes beyond the rights centered understandings by Locke and *The Declaration*. Tocqueville provides for norma-

tive understanding of good versus bad governments, which can also be found in the ancient understanding of politics.

Tocqueville's solution to majority tyranny is twofold, and consists of an institutional and a non-institutional component. Institutionally, Tocqueville follows the recommendation of the authors of *The Federalist* while placing special importance on the role of an independent judiciary. Tocqueville follows Publius' argument for the separation of powers and a system of checks and balances as well as the benefits of the extended republic (*Democracy*, 260). A major difference between Tocqueville and Publius is Tocqueville explicitly argues for trial by jury (*Democracy*, 260). Tocqueville argues that the jury is a political institution that possesses a great deal of influence on the public: "it would narrow one's thought singularly to limit oneself to viewing the jury as a judicial institution; for, it exerts a greater influence on the fate of cases, it exerts a much greater one still on the destinies of society" (*Democracy*, 260). With a jury, a set number of citizens are temporarily given the right to judge. Tocqueville writes that the trial by jury works to combat tyranny because it teaches people equity and serves to enlighten the public (*Democracy*, 260).

Non-institutionally, Tocqueville believes that freedom of religion, self-interest well understood, and mores will prevent majority tyranny from forming in the United States. Freedom of religion combats majority tyranny by providing a bonding experience, causing people to become close with members of the community (*Democracy*, 280). Further religious lessons teach followers moral boundaries. "... At the same time that the law permits the American people to do something, religion prevents them from conceiving everything and forbids them to dare everything" (*Democracy*, 280). Religion does not grant individuals freedoms, the government does. However, religion helps to facilitate how individuals use their freedoms.

Tocqueville's understanding of mores provides for an understanding of political morality missing in Locke and the thought of the American Revolutionaries. Mores cause people to become more sensitive to other's needs in a democracy. In situations where equality has more of a presence, compassion increases because individuals are better able to imagine themselves having similar problems. According to Tocqueville, Americans are selfish individuals but are open to being compassionate to others (*Democracy*, 538). When equality is present, "one does not see them inflict useless evils, and when they can relieve the sorrows of another without denying themselves much, they take pleasure in doing it..." (*Democracy*, 538). Mores are also important in shaping society through the promotion of proper values. Similarly to Aristotle, education is greatly important to Tocqueville.

Tocqueville argues that self-interest well understood is grounded on mores. The doctrine of self-interest well understood suggests "little sacrifices each day; by itself it cannot make a man virtuous; but if forms a multitude of citizens who are regulated, temperate, moderate, farsighted, masters of themselves" (*Democracy*, 502). Self-interest well understood causes individuals to become more virtuous through habituation. Doing small acts to help others will become a habit if done frequently enough. The doctrine works to even out the virtue in a society. It causes less extraordinary acts of virtue to happen but it raises the virtue of individuals who are lacking it. Self-interest well understood combats the egoism that characterizes Locke's political thinking. According to Tocqueville, self-interest well understood is "[m]arvelously accommodating to the weaknesses of men, it obtains a great empire with ease, and preserves it with out difficulty because it turns personal interest against itself..." (*Democracy*, 502).

Conclusion

While Tocqueville's analysis of majority tyranny offers a response to the challenge of Strauss, the same cannot be said for the political thought of the American Revolution. One does not find in *The Declaration* a standard of political morality that matches those that characterizes ancient political thinking and allow it to distinguish between healthy and unhealthy regimes. Nor is there any evidence indicating that Americans share Tocqueville's concerns with self-interest well understood.

The lack of political morality in American political thought not only raises concerns about our ability to recognize tyranny when confronted with it, it raises concerns about the prospects for successful democratic government in our future.

However, Tocqueville offers a response to Strauss. Tocqueville's emphasis on mores begins to provide standards of political morality that inform his understanding of majority tyranny. Tocqueville argues for the protection of natural rights in *Democracy in America*, but he also focuses on the psychological effects majority tyranny can cause. His concern with majority tyranny allows for a substantive and normative definition of tyranny.

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Footnotes

1 Aristotle focuses on teleology, which translates to wholeness or completeness. He argues that individuals gain completion by purposefully acting after deliberately choosing actions to take. In order

to achieve the highest form of good, the act must be complete. All things have a natural end or teleological purpose (see Aristotle’s *Ethics* footnote twelve at 1097a 20).

2 All references to Locke’s *Second Treatise* are to section number(s).

3 The state of war is characterized by force. Locke describes the state of war as happening when someone “. . . has exposed his life to the other’s power to be taken away by him, or any one that joins with him in his defense, and espouses his quarrel” (§16). When one tries to gain absolute power or threatens force over another man, they enter into a state of war.

4 The Massachusetts Bill of Rights and the Virginia Bill of Rights were two documents looked at.

5 According to Locke, tacit consent is “only as he dwells upon and enjoys that: the obligation any one is under, by virtue of such employment, to submit to the government, begins and ends with the enjoyment: so that whenever the owner, who has given nothing but such a tacit consent” (§ 120). If an individual is enjoying anything acquired in civil society, he is tacitly consenting to the acts of the government.

The Examination of Ankle Joint Motion between Barefoot and Minimalist Running Shoes on Various Inclines

STEPHANIE LLOYD



Stephanie Lloyd is a senior studying Physical Education with a concentration in Exercise Science.

Her research was funded by the Adrian Tinsley Program summer 2012 grant under the mentorship of Dr. Tom Wu from the Movement Arts, Health Promotion and Leisure Studies department. Stephanie plans on presenting her research at the International Society of Biomechanics in Sports Conference in Taiwan this summer.

Recently various sports footwear companies have produced different types of minimalist running shoes to mimic barefoot walking or running such as Vibram FiveFingers and Nike Free Run shoes. The purpose of this study was to examine the range of dorsiflexion and plantarflexion movements at the foot in barefoot conditions in comparison to Vibram FiveFingers and Nike Free Run minimalist shoes to evaluate if the minimalist footwear would affect ankle joint motion on both flat and inclined surfaces. Five elite female runners were chosen to run on a treadmill for 30s at the speed of 3 m/s on an incline of 0%, 4%, and 8%. Reflective markers were placed on the shoulder, hip, knee, ankle, and toe. Joint angles during heel strike, mid support, and toe off were then calculated and compared to determine the degree of dorsiflexion and plantarflexion movements while running at various inclines. A standard two-dimensional kinematic analysis was then conducted for foot dorsiflexion and plantarflexion angles at the heel strike, mid support and toe off for each type of footwear in each incline angle. A two-way (3 types of footwear \times 3 treadmill angles) repeated measures ANOVA test was conducted at $\alpha = 0.05$ with Bonferroni adjustment if a significance was found. No statistical significant differences were found between the various types of footwear on three different inclines. These findings indicate that similar ankle joint movements were observed during the 0%, 4%, and 8% inclinations. Barefoot, FiveFingers and Free Run running shoes provide similar joint mobility during heel strike, mid support, and toe off; therefore, they all mimic barefoot running in the ankle joint.

Running shoes have recently been designed to mimic barefoot walking or running, and they are marketed with promises that runners will benefit from the effects of barefoot running. Researchers argue that barefoot running allows the body to optimize shock absorption through natural foot motions (Paquette, Baumgartner, & Songning, 2010). Little research has been completed to identify if these shoes actually enable one to perform better or if they hinder performance. Studying gait analysis with particular running shoes is extremely important because the ankle and foot serve as the foundation of structural balance, support, and propulsion (Utz-Meagher, Nulty & Holt, 2011). Gait is the pattern of movement in animals or humans of the limbs. Running gait is characterized by the fact that at some point, both feet are simultaneously in the air (Swelin-Worobec, 2012). Without an understanding of the basic human movements of both walking and running, the purpose of running shoes cannot be determined.

The gait cycle is the time period between heel strike to heel strike of the same foot (Malanga & DeLisa, 1998). The phases of human gait include the stance phase and the swing phase. The stance phase accounts for 60% of the human gait cycle, and it is generally categorized by the time period when the foot is in contact with the ground (Malanga & DeLisa, 1998). The stance phase in human gait starts from the initial contact of the foot with the ground until the last part of the foot leaves the ground. Generally, it is the time when the forefoot/heel strikes the ground until the toe leaves the ground. The swing phase accounts for the remaining 40% of the human gait cycle, and it is defined as the period of time when the foot is not in contact with the ground (Malanga & DeLisa, 1998). The stance phase can be divided into sub-phases which include forefoot/heel strike, foot flat, mid support, heel off, and toe off. Forefoot/heel strike is the initial contact of the forefoot/heel with the ground. Foot flat is the time frame when the full foot contacts the ground. Mid-support is defined as the body weight being directly over the supporting leg; heel off is the period when the heel lifts off the ground. Finally, toe off is the last remaining contact of the foot being removed from the ground (Swelin-Worobec, 2012). The stance phase is important to research in biomechanics as it comprises the majority of the gait cycle, as well as it is the only time period in which the foot contacts the ground (Levangie & Norkin, 2001). Thus, the purpose of this research study focused on the stance phase of the gait cycle.

Knowledge of the mechanics of running on an incline is important as it examines adaptive gait control mechanisms the body endures while on a slope (Telhan, Franz, Dicharry, Wilder, Riley, & Kerrigan, 2010). Studying sloped running also allows researchers to examine the changes in mechanics of the lower extremity and possibly determine causes of injuries. Sloped running is important in modern society because uphill and downhill gradients are common to competitive races such as cross-country competitions and marathons (Padulo, Annino, Migliaccio, D'Ottavio, & Tihanyi, 2012). If research allows runners to understand how slope affects running mechanics, an athlete may be able to improve their overall performance.

Vibram FiveFingers and Nike Free Run running shoes are significant to the biomechanics of running because they allow the body to imitate barefoot running, while still providing protection from the elements. Vibram FiveFingers shoe is unique because it provides very minimal cushioning and allows individual toe separation, which may improve balance and stability. These characteristics enable FiveFingers to better simulate barefoot running motion due to the likeness of the bare foot. Nike Free Run shoe, one of the most popular minimalist shoes, is flexible and lightweight and yet provides cushioning. Thus, these two types of shoes have their unique features and are the

interest of this research study. There has been limited research evaluating how effective the FiveFingers and Free Run shoes are on the treadmill at 0%, 4%, and 8% incline. Cross country runners often run on different slopes in their training and competitions, so it is important to evaluate if these shoes can provide the same benefits for an inclined surface.

FiveFingers and Free Run shoes can be described as minimalist running shoes, and researchers argue that they decrease the risk of running injuries as compared to traditional running shoes (American Council on Exercise, 2011). These barefoot running shoes allow the runner to land on the balls of their feet which in turn generates less impact. The objective of the FiveFingers and Free Run shoes is to stimulate a forefoot striking pattern using the feeling of being barefoot yet still providing protection of a shoe. The way that the athlete runs, however, is dependent on their own running patterns, and it is questionable if all athletes will switch to this forefoot running pattern. Those who do switch to a forefoot strike style show greater plantarflexion, which helps performance by absorbing the impact forces of running (American Council on Exercise, 2011). This study demonstrated that the FiveFingers shoes allowed greater plantarflexion on a flat 20-metre surface, but it does not provide any insight on if the FiveFingers shoes would allow runners to have the same performance on the inclined surface.

If the research is able to show these shoes can provide a greater degree of dorsiflexion and plantarflexion while running at an incline, the changes in angles can be compared to barefoot conditions. Having a comparison will allow us to conclude if FiveFingers and Free Run shoes are an appropriate choice of footwear for inclined running. Therefore, the purpose of this current study was to investigate the angles of dorsiflexion and plantarflexion while running on the treadmill at respective degrees of incline.

Methods

Five female elite runners of the ages 20 ± 1 years of age, 1.73 ± 0.03 m in height, and 58.29 ± 3.4 kg in weight were recruited to participate in the study. Participants were recruited based on having more than 5 years of running experience and a heel strike running pattern. Institutional research ethics review was approved, and written informed consent was obtained from each participant prior to the study. The participants were fully briefed on what the study would require from them.

All participants arrived at the Exercise Physiology Laboratory. Each participant was allowed to warm up for approximately ten minutes with their regular warm-up routine on a suspended track. After warm-up, each participant was given a chance to warm up in each type of footwear, allowing the participant

to become familiar with the respective footwear. This process enabled participants to feel comfortable with their shoes. Five joint reflective markers were placed on the right side of the body at the shoulder (glenohumeral joint), hip (greater trochanter), knee (lateral epicondyle of the femur), ankle (lateral malleolus of fibula), and toe (base of fifth metatarsal). Each participant wore tight fitting black running clothes to provide better contrast for video analysis and minimize marker movements.

During the testing each participant ran 30 seconds at the speed of 3 m/s on each incline treadmill angle of 0%, 4%, and 8% for the FiveFingers shoe, Free Run shoe, and barefoot condition. The running speed of 3 m/s was selected due to its prevalence in a similar running research study, which allowed for a comparison between both studies (Telhan et al., 2010). Participants had three minutes to rest between each incline treadmill angle and five minutes to rest between each type of footwear, so the influence of the fatigue was minimized in this study. The order of footwear and barefoot conditions and incline angles were randomized to reduce any order effect. Data collection was concluded in one day for an hour in duration per subject.

A JVC (Model: GR-D371V) video camera was positioned to capture the sagittal view of running motion at 60Hz with a 650W artificial light directed toward the participant. A standard two-dimensional kinematic analysis was conducted for foot dorsiflexion and plantarflexion angles at the heel strike, mid support, and toe off for each type of footwear in each incline angle. All video trials were then transferred onto a University computer in the Biomechanics Lab for gait analysis. Digital filter was applied at 5 Hz to filter the data. A two-way (3 types of footwear x 3 treadmill angles) repeated measures ANOVA test was conducted at $\alpha = 0.05$ and followed by post-hoc t-test with Bonferroni adjustment if a significant difference was found. All statistical analyses were conducted with SPSS (version 18) software.

Results

To conclude this research study, SPSS software was used to compare different types of footwear on similar inclines. At a 0%, 4% and 8% incline the foot angles between Barefoot, Vibram, and Nike conditions were compared during the heel strike phase, Table 1.

Similarly at a 0%, 4%, and 8% incline the foot angles between Barefoot, Vibram, and Nike conditions were compared during the mid support phase, Table 2.

Lastly, at a 0%, 4%, and 8% incline the foot angles between Barefoot, Vibram, and Nike conditions were compared during the toe off phase, Table 3.

In the heel strike phase, the barefoot condition showed the greatest angle on a 0% and 4% incline ($106.8^\circ \pm 11.4^\circ$ and $104.2^\circ \pm 6.4^\circ$), but Nike showed the greatest angle on an 8% incline ($103.0^\circ \pm 4.9^\circ$), Table 1. In the mid support phase,

Table 1. Descriptive statistics between different incline angles and types of footwear during the heel strike phase. Data are means (SD).

Incline	0%	4%	8%
Barefoot	106.8° (11.4°)	104.2° (6.4°)	102.2° (4.9°)
Vibram	100.7° (3.6°)	100.8° (8.6°)	101.5° (10.0°)
Nike	104.3° (11.1°)	101.0° (3.5°)	103.0° (4.9°)

Table 2. Descriptive statistics between different incline angles and types of footwear during the mid support phase. Data are means (SD).

Incline	0%	4%	8%
Barefoot	83.1° (3.7°)	81.0° (4.1°)	80.6° (3.8°)
Vibram	81.1° (6.0°)	79.8° (4.0°)	77.9° (6.2°)
Nike	86.0° (2.5°)	86.3° (4.4°)	85.1° (3.3°)

Table 3. Descriptive statistics between different incline angles and types of footwear during the toe off phase. Data are means (SD).

Incline	0%	4%	8%
Barefoot	128.4° (4.9°)	127.1° (5.5°)	128.2° (4.8°)
Vibram	124.5° (5.2°)	126.5° (2.1°)	125.3° (4.5°)
Nike	130.8° (6.4°)	131.8° (6.2°)	132.4° (5.6°)

Nike showed the largest angle in all three inclines on the treadmill ($86.0^\circ \pm 2.5^\circ$, $86.3^\circ \pm 4.4^\circ$, and $85.1^\circ \pm 3.3^\circ$), Table 2. In the toe off phase, Nike also showed the largest angle on all three inclines on the treadmill ($130.8^\circ \pm 6.4^\circ$, $131.8^\circ \pm 6.2^\circ$, and $132.4^\circ \pm 5.6^\circ$), Table 3. Vibram demonstrated the smallest angle in all three phases of the gait cycle on all inclines, Table 1, Table 2, and Table 3.

While there were no significant differences found in the study, some of the comparisons did approach significance. When the Vibram shoe was compared with the barefoot condition at 4% incline during the heel strike, it showed a large difference in the ankle movement ($100.8^\circ \pm 8.6^\circ$ vs. $104.2^\circ \pm 6.4^\circ$), but it was not statistically significant at $p < 0.042$, Table 4.

Table 4. Statistical probability comparisons between different types of footwear in each incline angle at the heel strike.

Incline	0%	4%	8%
Barefoot vs. Vibram	0.184	0.042	0.821
Barefoot vs. Nike	0.302	0.222	0.526
Vibram vs. Nike	0.412	0.958	0.695

*Statistical significance at $p < 0.006$ with Bonferroni adjustment

In addition, when Nike was compared with barefoot condition during the mid support phase, the statistical probability results showed a gradual approach to significance from incline angle of 0% ($p < 0.166$) to 8% ($p < 0.007$), Table 5.

Table 5. Statistical probability comparisons between different types of footwear in each incline angle at the mid support phase.

Incline	0%	4%	8%
Barefoot vs. Vibram	0.395	0.445	0.171
Barefoot vs. Nike	0.166	0.013	0.007
Vibram vs. Nike	0.185	0.058	0.026

*Statistical significance at $p < 0.006$ with Bonferroni adjustment

Further, when both shoes were compared to one another during the toe off, Vibram and Nike showed an approach to statistical significance at $p < 0.071$, Table 6.

Table 6. Statistical probability comparisons between different types of footwear in each incline angle at the toe off.

Incline	0%	4%	8%
Barefoot vs. Vibram	0.268	0.810	0.453
Barefoot vs. Nike	0.194	0.191	0.083
Vibram vs. Nike	0.165	0.129	0.071

*Statistical significance at $p < 0.006$ with Bonferroni adjustment

There were no statistically significant differences found when analyzed with SPSS software. Because both types of minimalist footwear are constructed with similar materials and display lightweight characteristics, the slight differences in their construction had no impact on ankle joint motion. Both types of minimalist shoes allow the ankle joint to move unrestricted.

Discussion

The purpose of this study was to examine the range of dorsiflexion and plantarflexion movements at the foot joint in barefoot conditions in comparison to Vibram FiveFingers and Nike Free Run minimalist shoes to evaluate if these minimalist footwear types would affect ankle joint motion on the flat condition or on an incline. According to Rothschild (2012) barefoot runners are able to change from a rearfoot heel striking pattern to a forefoot or midfoot striking pattern because of an increased plantarflexion range of motion through the ankle joint. When transitioning from shod to barefoot, there was no increase in plantarflexion range of motion in the ankle joint seen in the five female elite runners in this research study. Rothschild (2012) also noted there was an overall greater joint movement through the ankle joint in the barefoot condition. During this study, there was no statistically significant difference in the ankle joint between shod and unshod. Some possible reasons why there was no difference between shod and unshod in the ankle joint while running is because minimalist shoes were worn, and it is possible Rothschild (2012) had used traditional running shoes. The agreeable points between this study and the research of Rothschild (2012) are that minimalist shoes are a good transition from running shod to running barefoot, as minimalist shoes effectively mimic barefoot conditions.

Although there is little research completed on barefoot and minimalist shoe running on an incline, there are some studies that investigated barefoot running on flat condition. According to Utz-Meagher et al. (2011) there was a significant change in the foot angle while running barefoot. It was noted that the ankle joint angles were significantly decreased when the par-

ticipants ran barefoot. The decrease in the ankle joint range of motion allowed the participants to change to a midfoot or forefoot strike (Utz-Meagher et al., 2011). There was no change in striking pattern or a decrease in foot angle when the five female elite runners were studied. Although a significant decrease in foot angle was observed, Utz-Meagher et al. (2011) only tested participants on a flat surface, and it is unknown what type of footwear they were using as a comparison. In this study no statistically significant increase or decrease in foot angle was seen on a flat condition, 4% incline, or 8% incline in the Nike Free Run or Vibram FiveFingers. However, the author recognizes this research study had a small sample size, yet it provides an important preliminary understanding in the evolution of gait.

Conclusion

The results of this research study conclude that minimalist running shoes do in fact mimic barefoot running. A similar range of motion at the ankle joint between footwear conditions was seen throughout all types of footwear in all three phases of running gait. These similar ranges of motion were also similar with different incline levels on the treadmill. Overall, when five female elite runners performed in Vibram FiveFingers shoes, Nike Free Run shoes, and barefoot there was a similar range of motion in the ankle joint while running. These types of footwear did not hinder the performance in the ankle joint while running; therefore, any of these shoes would be an appropriate choice when looking to select footwear for inclined treadmill running. It is important to note that only the joint angle was examined while there are many conditions that affect performance. Further research is needed to evaluate other factors such as angular velocity, acceleration, force and torque. From the results of this study, the author suggests that all three types of footwear both do not hinder one's range of motion in the ankle joint while running. Future studies are warranted to study the kinetic chain of joints that are linked while running, such as the hip and knee joints. Also, it would be critical to examine the pronation and supination of the ankle joint movement with these types of footwear. These studies will provide a comprehensive understanding about barefoot running and minimalist shoes.

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<Terrorism> in the Age of Obama: The Rhetorical Evolution of President Obama's Discourse on the <War on Terror>

KELLY LONG



Kelly Long ('13)
is a dual major in
Communication
Studies and English.

This project began
as part of the 2012 Adrian Tinsley
Summer Research Grant Program
under the direction of Dr. Jason
Edwards. Kelly has accepted a
graduate teaching assistantship at
North Carolina State University to
pursue a Master of Science degree
in Communication to continue her
studies in the field, with hopes to
focus on media and visual culture as
well as political rhetoric.

Since the events that transpired on the morning of September 11th, 2001, <terrorism> has become a part of the vocabulary of modern American culture. The word <terrorism> has become a powerful ideograph--a word or phrase that is abstract in nature, but has a great deal of ideological power--in American culture. This commonly used abstract word can be heard almost daily in the media and within the larger lexicon of American political discourse. Rhetoricians use the word to describe their motives and persuade audiences to align their ideological principles with those of the larger cause. This study examines how during President Barack Obama's first year in office, he utilizes <terrorism> in opposition to the <rule of law> and <democratic values> in order to create a hybrid identity which combines the Democratic and Republican understanding of the issue that ultimately contributes to a sense of <exceptionalism>.

Since September 11th, 2001, the word <terrorism> has helped to shape and has been shaped by the culture of the American people who have come into contact with this concept on a daily basis in the media for over a decade. Because of this powerful ideograph, soldiers have fought and died in wars against a new breed of enemy in a battle against an idea; policies have shifted and changed along with protocols of collecting intelligence; lines have been drawn, crossed, and altogether erased in the metaphorical sands of alliance. History offers itself as proof that word wielded in the correct way can be more powerful than any superpower's arsenal of military weaponry. <Terrorism> is one such word.

<Terrorism> is an example of what rhetorical scholars call an ideograph, which is a high order abstraction found in everyday language used in political discourse which warrants the use of military, legislative, or financial power, excuses behavior and belief that might otherwise be considered eccentric or anti-social, and guides behavior and belief. An ideograph is also transcendent in nature – “having as much power and influence over the ruler as it has on the ruled” (McGee 1980). In order for the call to collective commitment to be successful, the individual using the ideograph is equally as invested in its definition as the general public who chooses to align their ideologies with it.

Carol Winkler (2006) has explored how <terrorism> has been used by presidents since World War II. Winkler concluded that in the post-World War Era, two distinct and separate ideologies had formed in the ways that

Democratic and Republican presidents used <terrorism>. Democrats understand the issue of combating <terrorism> in the context of the justice system: <terrorism> is a criminal act that should be dealt with through means of police enforcement and punishable by judicial trial. Republicans see the <War on Terror> as a battle of good versus evil governed by morality. George W. Bush used <terrorism> to unite the nation and the world against a common ideological enemy, ushering in a new paradigm of foreign policy, marvelously Republican in nature. America's new era, the <War on Terror>, would mean that the United States would have to tackle a new, diabolical enemy. Facing this foe would mean two of the longest and most expensive conflicts in the history of mankind.

President Barrack Obama, during his first year in office, inherited this new era, as well as a foreign policy badly damaged by President Bush's prosecution of the <War on Terror>. How did President Obama use <terrorism> as he put forth his foreign policy agenda?

Literature Review

Across contexts, the meanings of words and power wielded by them changes and shifts dramatically. This is especially true in the case of high order abstractions, known as ideographs, which are terms, phrases, and images central to political ideology. According to McGee (1980) an ideograph is "an ordinary language term found in political discourse...representing collective commitment to a particular but equivocal and ill-defined normative goal that warrants the use of power, excuses behavior and belief that might otherwise be seen as eccentric or anti-social, and also guides behavior and belief" (p. 15). In other words, ideographs have different functions and meanings for different demographic groups – racial, regional, religious, financial, gender, or generation – at different times in history. Those functions and meanings hold unique symbolic qualities that summarize prevailing attitudes and characteristics of a particular community.

For example, <equality> is an ideograph that may hold different meanings for different groups over time and space. In 1896, the Supreme Court of the United States (SCOTUS) ruled in *Plessy vs. Ferguson* that separate spaces were equal in terms of resources and quality of schooling (Hasian & Condit, 1996). Although the term separate but equal was coined from *Plessy vs. Ferguson*, the reality was that African-American children had far less access to <equal> educational opportunities. *Plessy vs. Ferguson*. In 1954, SCOTUS reversed the separate but equal doctrine in *Brown vs. the Board of Education*. The Court argued the only possible way to achieve the goal of <equality> was to fully integrate the public school systems. <Equality> as defined in *Brown vs. Board of Education*, was the first action in the

larger movement to desegregate public institutions within the United States. The ideograph of <equality> demonstrates how ideographs can provide different understandings of political precepts over time, while also offering intellectual support for specific policies and ideologies that can fundamentally alter a political culture.

Ideographs can be analyzed in either a synchronic or diachronic fashion. Synchronic analysis is analogous to a snapshot or "vertical" approach because rhetorician is attempting to capture how that specific instance of an ideograph is being used at a singular point in time. For example, Amernic and Craig (2004) explored a Southwest Airlines (SWA) letter to shareholders following the terrorist attacks on September 11th, 2001. Their analysis produced "an example, in the extreme case of...cultural ideographs being appropriated to serve corporate ends" (p. 327). Specifically, Amernic and Craig asserted SWA utilized the <Let's Roll> allegory of Todd Beamer of United Airlines' Flight 93 to imply that "SWA is an American (in the same manner as Todd Beamer) with 'iron character', 'unquenchable spirit', and 'inspiring altruism'" (p. 332). In other words, <Let's Roll> symbolized the character of Southwest Airlines in that moment and time.

Analyzing ideographs diachronically works by sampling how a specific ideograph is used over a range of time, assessing its potential evolution within contemporary culture (e.g. the equality example from earlier). For instance, Towner (2010) examined the top selling country music group the Dixie Chicks. In 2004, the Dixie Chicks caused a media firestorm by criticizing President Bush's prosecution of the <War on Terror>. Towner analyzed how the Dixie Chicks used the ideograph <patriotic>. He concluded that over time the use of <patriotic> by the Dixie Chicks came to mean multiple ideas, including the "exercise of <free speech>, <patriotic> as questioning/dialogue, <patriotic> as a voice of dissent, and <patriotic> as love for America" (p. 302). While their use of the ideograph <patriotic> divorced the band from their hardcore country fans, it introduced them to the larger American and global public, skyrocketing them to greater success than before.

Ultimately, ideographs have proven to be an effective means of examining a number of different rhetorical subjects. Pertinent to this study is how political leaders have used ideographs to advance their causes. For example, Althouse and Kuypers (2009) assert that John Pym, a member of the English House of Parliament during the reign of King Charles I, was able to enact legislation that would restrict the powers of both the royal throne and the church influence over Parliament. His appropriation of the ideographs <law>, <religion>, <justice>, and <Parliamentary Privilege> led the way to

reviving democracy in the House of Commons. These ideas would later prove influential in underwriting Anglo-American liberalism that would emerge in the American colonies over one hundred years later. Fast forward three hundred years later to contemporary England where British Prime Minister Margaret Thatcher used the ideograph <terrorism> as a key factor in casting the situation within Northern Ireland as an <epic tragedy>. The juxtaposition of these ideographs allowed her to finagle an excuse to the media coverage of her campaign against Irish Republican Army (IRA), while also creating the symbolic groundwork to allow severe restrictions be put upon other civil liberties (Parry-Giles, 1995). By providing a state of necessity, she was able to get the public to accept her actions, even get them to ideologically align themselves with her prosecution of Britain's terror fight against the IRA in the 1980s, demonstrating their collective commitment in a situation where normally her policies would have been viewed as dictatorial and tyrannical.

The <terrorism> ideograph has also been a fundamental topic in presidential rhetoric. Winkler (2006) examined how American presidents since World War II have used this pejorative term in U.S. public discourse, and that Democrats and Republicans used it differently, which help serve and frame their overall foreign policy principles and specific foreign policy decisions. Valenzano (2006) extended Winkler's findings by focusing on how President George W. Bush juxtaposed the ideographs <freedom> and <terror> together. He found that although Bush probably did not intend to juxtapose the two terms, he did manage to rally the nation against a common, universal enemy via his ambiguous use of the term <freedom> and manipulate the definition of <terror> to include "the threat of action, not just action itself" (p. 161). Understanding how presidents use the ideograph of <terrorism> can provide insight into the specific policies they will enact in U.S. foreign policy and how that might impact America's role in the world. This is because their actions must continue the ideological current circuiting through their rhetoric, or else the call for collective commitment will be unsuccessful.

From these various studies we can draw some important conclusions. First, analyzing ideographs can be an important way of creating and understanding a particular vocabulary of a specific organization, social movement, and/or political party. Understanding these ideographs can determine specific motives, precepts, and policies rhetors to provide. Second, for the purpose of this study, analyzing ideographs within presidential rhetoric, particularly <terrorism> can assist us as United States citizens in understanding what, why, and how power is attained, maintained, and exercised across different contexts and circumstances. Ideographs are a powerful way

to ascertain the motives, movements, and policies of various rhetors. In the following section, I extend the work of Winkler (2006) and Valenzano (2006) by examining how President Obama used the ideograph <terrorism> during his first year in office.

Methodology

In order to conduct an analysis of how President Obama used the ideograph <terrorism> I conducted a textual analysis of various speeches made by President Obama during his first term. I was able to locate these speeches from the American Presidency Project database run by the University of Southern California. It is a database that has every public pronouncement of American presidents since the founding of the Republic. Initially, I conducted a term search for the word "terrorism". That led to over hundreds of different public documents using the term. I then narrowed my data set even further by eliminating public pronouncements that were not speeches and only mentioned <terrorism> in passing. I focused my analysis only on speeches that were dedicated to the specific discussion of <terrorism> and U.S. foreign policy, save for President Obama's State of the Union Address. I included the State of the Union because it is arguably the most important policy speech a president will offer during any given year (Campbell & Jamieson, 2008). After narrowing my search I was left with over a dozen speeches to analyze. From there I began to read and take extensive notes, concluding that the most suitable approach to this subject would be a diachronic evaluation, assessing common patterns and dominant themes arising over time. This finally culminated in the development of several undeniably independent yet unmistakably interwoven themes that work together to highlight certain attributes each other and enhance their importance. In the discussion that follows, I do not use passages from each speech, but the textual fragments cited are representative samples of President Obama's use of <terrorism>.

President Obama's First Year of <Terrorism>

When President Obama entered office in January of 2009, the Iraq War had been underway for six years, and the conflict would not be resolved for another three. To this day, the United States remains in Afghanistan after beginning the military expedition back in 2001, less than a month following the September 11th terrorist attacks. At the time Obama took office, public opinion of the two conflicts was extremely negative and had been on the decline for quite some time. On top of that, the nations of the world had borne witness to the previous administration's disastrous foreign policy dealings, and Obama had to devote time and energy to repairing relationships and restoring the country's reputation. Most importantly, he inherited an ideological responsibility to transition the public

from <terrorism> as Bush defined it to his own, understanding and execution of the term in his own rhetoric.

<Terrorism> as Threat to Democratic Values

President Obama's primary concern with the <terrorist> threat to democratic values was the undermining of them by <terrorist> groups, which are lawless organizations that do not operate under a constitution, in which anarchy reigns and chaos is king. Our sense of American identity is built upon our democratic values, specifically our unique understanding of the <rule of law>. Obama believed that the best offense is a good defense, and in preserving and maintaining the rule of law, we were to effectively combating terrorism by foiling it. Otherwise, the United States would fall into a similar state of lawlessness, madness, and turmoil.

In order to demonstrate a necessity for engaging in combat with <terrorist> forces, Obama made their strikes against us personal rather than political. This is reminiscent of George W. Bush's famous statement following the terrorist attacks of September 11th, 2001: "if you're not with us, you're for <terrorism>." By striking at the heart of American ideals, the lone <terrorist> and the organization they represent strike at American identity. This sense of a collective self stems from the democratic values which our Declaration of Independence is based on: life, liberty, and the pursuit of happiness. Obama (2009g) emphasized that: "The main goal of <terrorists> is not only to spread fear and sow the seeds of instability, but also to undermine the basic values of our societies." Obama reasoned that by spreading fear and sowing the seeds of instability, the <terrorist(s)> would have undermined our basic societal values and that by doing so, they would shake the foundation of our nation. It is a self-sustaining, dependent relationship between the two variables. His usage of the term "fear" as a weapon used by <terrorist> to accomplish their goals is highly sentimental of President Franklin D. Roosevelt inaugural address: "we have nothing to fear but fear itself".

This idea of combating fear as a method of weakening the <terrorist> opposition is simple and effective for the reason that it gives power back to the people. By specifically juxtaposing the <rule of law> against <terrorism>, Obama implied that one of the direct results from letting the "bad guys" win would be injustice and anarchy, a process of spiraling out of control. It puts a stopper in the plan to spread fear and sow the seeds of instability, and therefore the basic values of our society are not in jeopardy. This is why Obama used the <rule of law> specifically rather than grouping it in a general matter with the rest of our democratic values – its existence is critical in order for the others to be available, let alone successful.

The physical acts of <terror> committed are a means to achieve the end – a thriving culture of fear and panic. The United States is a symbol of freedom, hope, and prosperity in the modern world; through intimidation, destruction, and murder, <terrorists> wish to extinguish the beacon of light that is America. Obama (2009e) stated that, "I believe that our Nation is stronger and more secure when we deploy the full measure of both our power and the power of our values, including the rule of law." By encouraging the nation to rally around the core values of the American way of life, this further makes bullet-proof the ideas that strengthen feelings of patriotism that ultimately foils the terrorist plot. He juxtaposed the power of foreign policy, implicitly militaristically speaking, with the power of our values which soldiers fight to defend, therefore justifying the expenditure of troops overseas to fight the common enemy: <terrorism>.

President Obama illustrated that <rule of law> is the foundation upon which our <democratic values> are built, hence why he so specifically isolated the former in his foreign policy rhetoric. However, he spent a good deal of time emphasizing that, "... the most effective response to their criminal strategy remains the promotion of democracy, human rights, the rule of law and equitable social conditions" (2009g). Obama had thrust the focus not on the opposition, but on the American team working together under the banner of the American dream. This exemplified the fact that <terrorists>, although clever and cunning of wit in the execution of their wicked deeds, do not have an over-arching goal to be achieved. Should their agenda ever be fulfilled, the organization would implode upon itself, for their identity stems only from their opposition and determination to destroy American identity. This is because the rhetoric of <terrorist> organizations does not have such strong values underlining their causes – meanwhile, American democratic values carry with them centuries of idealistic ideological baggage, and that, according to President Obama's rhetoric, is worth its weight in the fight for freedom.

By developing an ideological justification for the conflicts that the United States was involved in at the time, Obama remedied much of the damage done by the Bush administration. Simultaneously, he was improving the nation's image of self as well as its global reputation. The continuation of the wars led many citizens to ask why, and here, Obama provided a series of answers to that very inquiry. What worked to his advantage was the subjective nature of ideographs, in that each person prescribes their own meanings to the abstracts, and as a result they are more likely to support the movement if their definition aligns with the President's, which in the case of protecting the <rule of law> and <democratic values>, it is difficult to disagree with him. This is one way in which he was able to successfully

generate support from the free nations of the world in his call for collective commitment and erase the line drawn between the Democrats and Republicans at home. By basing his rhetoric on universal ideals that make up the premise of the globe's modern understanding of <rule of law> and <democratic values>, there was very little room for opposition or disagreement regarding the necessity to combat <terrorist> advances.

<Terrorism> as Necessity for Collective Commitment

Long has there been conflict and tension building across the globe regarding American measures of national security, both at home and abroad. One inarguable point is that the <rule of law> and the rest of our <democratic values> should and must be defended at all costs, and in order to be victorious in this campaign, President Obama was bestowed the task of rallying not only his own partisan House behind him, but also invoking the allegiances of the free nations of the world. Shortly following the September 11th attacks, former President George W. Bush was the first leader of the free world to call for action on an international scale, by invoking NATO's Article 5, as discussed by President Obama (2009d): "An attack on one is an attack on all." That is a promise for our time and for all time." His choice of pronouns is extremely unified in nature, using inclusive possessive words, portraying <terrorism> as a common enemy, and therefore, the act of fighting back against them as a common cause. Obama (2009d) stated that, "...the choices we make in the coming years will determine whether the future will be shaped by fear or by freedom, by poverty or by prosperity, by strife or by a just, secure, and lasting peace." He called upon emotions, images, and ideographs that the entirety of the free world is familiar with and closely connected to in order to rally them into action against a common enemy. Because Al Qaeda does not identify itself with any one country's government or national constitution, they have already isolated themselves from any potential allies to a certain degree. Obama's explanation of the necessity for collective commitment to secure these common values is based on safety in numbers. Obama emphasized the risk of countries acting independently, implying that they would fall to the agenda of <terrorism> if the nations of the world did not band together as one unit to battle this universal threat. Also, if he was successfully able to persuade NATO to act alongside or at least approve of his desired or selected course of action, Obama would have successfully justified, or at least excused, the United States occupation of the Middle East.

President Obama faces extremely similar challenges on the home front, having to cooperate and often compromise with one of the most partisan House systems the country has seen in its short life of two hundred years. Obama (2009k) recognized this, explaining that "Years of debate over Iraq and terrorism

have left our unity on national security issues in tatters and created a highly polarized and partisan backdrop for this effort." Here, Obama refused to trivialize the issue – the word "tatters", for example, insinuated the violent rhetoric put forth by both parties in their efforts to promote their campaign as to how the <War on Terror> should be handled. In order to bridge the gap between the two parties, President Obama, rather than cater to each individually, decided to forge a middle ground. He conjoined the morality of the Republican Party with the judicial perspective of the Democratic Party – making this an issue of good cop versus evil criminal, a hybridized version of the story. He accomplished this rhetorically by interweaving the two viewpoints: the basis of morality is religion, and the basis of justice is criminality, which are close enough in definition that Obama (2009l, see also 2009b and 2009g) was able to wield them almost synonymously:

Evil does exist in the world. A nonviolent movement could not have halted Hitler's armies. Negotiations cannot convince Al Qaida's leaders to lay down their arms. To say that force may sometimes be necessary is not a call to cynicism; it is a recognition of history, the imperfections of man, and the limits of reason.

This quotation portrays the two visions side by side, not only demonstrating their differences but highlighting their commonalities. He appealed to Republicans by applying pathos – the image of evil and the imperfections of man are rooted in moral understandings. On the other hand, Democrats were brought on board by logos, portrayed by the image of negotiation with a criminal in a hostage situation and alluding to the limits of reason. By juxtaposing these two ideological perspectives, Obama successfully adapted a rhetorical hybridism in order to appeal to both parties simultaneously.

The end result of unifying the Capital is a sense of <American exceptionalism>, a phenomenon socially and academically recognized in the postmodern era, which is the belief held by Americans that our historic reputation precedes us and that we of are greater importance simply because of our citizenship and legacy of overcoming adversity. Much like the life cycle of any living organism, the country itself has experienced major milestones that allow it to grow and mature and nurture its own world view based upon them. There is a certain, inherent type of high-order responsibility bestowed unto the nation as a result of this sensation. Some view this as a form of false authority, of vanity and self-absorption, yet Obama (2009c) qualified that "...pragmatism must serve a common purpose, a higher purpose. That's the legacy that we inherit. And that, in the end, is how government of the people, and by the people, and for the people, will endure in our time." Once

again, Obama provided motivation for the Republicans and the Democrats to work together towards a common goal: eradicating <terrorism> in the modern world. He invokes history, appeals to patriotism, and projects the focus upon protecting the people that the House is supposed to represent, serve, and ultimately, protect.

Conclusion

Despite the difficult challenges of overcoming the damaging foreign policy rhetoric of the Bush Administration in a post-9/11 world, President Barack Obama successfully established his own unique rhetoric regarding the <War on Terror>. By juxtaposing <terrorism> to <democratic values>, specifically the <rule of law> in particular, Obama was able to convey a message that called for collective commitment on a global scale. He simultaneously bridged the split between the partisan two-party system, merging the Republican morality complex with the Democratic judicial perspective, reminding both the politicians and the people of the United States of America of their legacy of exceptionalism. President Barack Obama efficiently developed an ideology and successfully launched an ideographic campaign that established the groundwork for his next three years in office in dealing with foreign policy affairs.

Today, the <War on Terror> is considered over, but not yet done with. In order to understand what lies ahead, we must continue to look back into an exploration of President Obama's handlings of <terrorism> during its final years of legislative debate and how the ideograph is handled in the post-<War on Terror> era. From there, we can develop a contemporary and working understanding of how <terrorism> is evolving at this moment in politics, media, and foreign policy. This way, we will be able to comprehend the impact and efficacy of President Barack Obama's ideographic campaign, and be able to appreciate the rhetorical legacy that the next Commander-in-Chief will inherit.

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Preliminary Findings: Speed-Accuracy Tradeoff in Windmill Fastball and Change-up Pitching

KEVIN McELWEE



At the time of submission, Kevin McElwee was a senior majoring in Physics at BSU. This research

began as an Adrian Tinsley Program (ATP) Semester Research Grant in the Fall of 2010 under the mentorship of Dr. Pamela Russell. His work was presented at the 2012 National Conference on Undergraduate Research in Ogden, Utah. Kevin currently works as an R&D Engineer in the Oncology Department at Angiodynamics.

Little data have been collected that compare the linear velocity of the ball at release versus the accuracy of the pitch in fast-pitch windmill softball pitching. Previous research suggests that accuracy of a task may decrease as the speed of the task increases. Little research exists that previously compares the speed and accuracy of fastball and change-up pitches in windmill softball pitching. These data may assist the batter in decoding the type of pitch being thrown before the ball is released from the pitcher's hand. It was hypothesized that the slower change-up pitch might be more accurate and the faster pitch less accurate. Three female subjects (20 ± 1 years old) volunteered to throw ten fastball and ten change-up pitches. Sagittal plane video data were recorded and analyzed with Dartfish Software (v5.5). The accuracy of the pitch, linear ball velocity, elbow and hip angles of the pitcher at ball release, and mean angular shoulder flexion velocity throughout the pitch were measured. Mean elbow angles at release were significantly different ($t = 0.03$), which suggests that the batter might be able to detect the pitch via elbow mechanics. Mean hip angles were similar and showed no significant difference ($t=0.32$), which suggests that the batter could not use hip mechanics to decode the pitch. Spearman Rho correlations ($n = 30$) between linear ball velocity at release and accuracy were not significant (fastball = .20; change-up = -.21); however, the change-up pitch best resembled the speed-accuracy relationship.

Introduction

Research supports an inverse relationship between the speed and accuracy of a task (Fitts, 1954). Fitts designed three different experiments to observe how the accuracy of a motor task changed as the necessary movement decreased and the target area increased. Fitts defined a motor task to be any movement of a particular limb, particular set of muscles, or a particular motor behavior. His findings indicated that increasing the necessary movement of a task leads to a decrease in the accuracy of the task. In this study, the authors examined the speed-accuracy relationship between the fastball and change-up pitches using the fast-pitch windmill softball pitching motion in an on-the-field scenario. Given Fitts's findings, the slower change-up pitch might be more accurate and the faster pitch less accurate. The author's purpose was to study the relationship between the linear velocity of the ball at release with the accuracy of the pitch upon reaching home plate. Understanding this relationship in softball pitching could help batters decode these pitches by recognizing differences in the speed-accuracy trade-offs of each pitch. Van

Den Tillaar and Ettema (2006) studied the speed-accuracy tradeoff with over-arm throwing in team handball with novice and expert players. Their results suggested that the speed-accuracy tradeoff did not exist in team handball. The authors of this study initially concluded that the training regimen of these players affected their data. After manipulating the goal of the task, the participants yielded similar results and thus determined that the lack of the speed-accuracy relationship in their results was not due to the players' training regimen. Additionally, Van Den Tillaar and Ettema (2003) examined how instruction specifically affected the speed and accuracy of over-arm throwing in team handball when both skills were emphasized at different magnitudes. The authors instructed the participants to focus on varying levels of concern to both the speed and accuracy of the throw. The authors noted that when they stressed accuracy, the velocity of the throw decreased. However, as the emphasis on accuracy increased, the accuracy of the throw did not continue to rise; though the velocity of the throw did continue to decrease. These findings suggest that the levels of instruction provided to the participants could severely affect data if the purpose of the study were to replicate an in-game scenario. Since this current study does attempt to replicate an in-game scenario, these findings are relevant. During this current study, the authors did not instruct the pitcher to focus more on the ball velocity at release rather than the accuracy or vice versa. Rather, the participants were instructed to throw as if they were participating in a live inning. Amongst this previous research, little data have been collected that studied the speed-accuracy trade-off in softball pitching. Thus, the purpose of this study was to examine how the linear velocity of the ball at release would affect the accuracy of the pitch in fast-pitch windmill softball pitching.

Methods

Participants. Three females (20.00 ± 1.00 yrs; 1.69 ± 0.02 m) volunteered to participate in this study. Our participants had a mean pitching experience of 11.00 ± 3.10 years and each participant provided University-approved informed consent to participate. Each subject listed high school or college pitching experience as highest level of play.

Experimental Setup. The pitching mound was set up 13.11m (NCAA regulation) from a regulation-size softball home plate (Abrahamson, 2010). The target, representing the strike zone, was taped onto the wall. The distance between the floor and the center of the target was 0.86m. The center of the strike zone was centered with the pitcher's mound. Sagittal plane video data were recorded at 60 Hz with a Sony Handycam DCR DVD650 positioned perpendicular to the plane of movement at a height of 1.07m to maximize the image of the pitching motion.

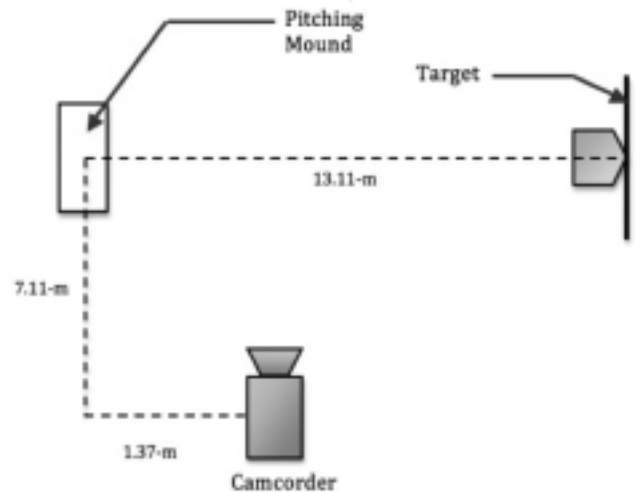


Figure 1. Experimental Setup. Aerial view of our experimental setup. McElwee photo.

The target, used to measure accuracy, was composed of carbon paper overlaid on white paper (0.91m by 0.91m each). Five concentric circles were drawn on the white sheet of paper. The first circle was 7.62 cm in radius.

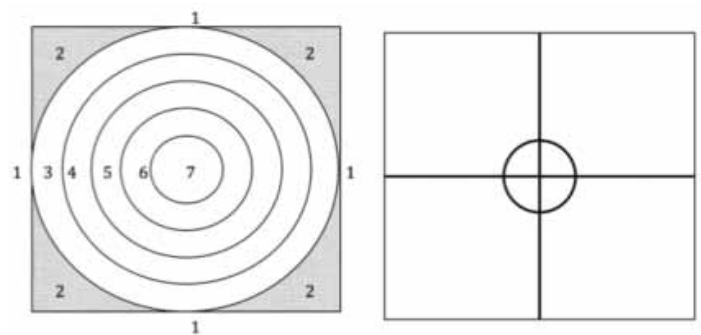


Figure 2a (left). Strike Zone Bull's Eye. Target with point values for each area, ranging from 7 (most accurate) to 1 (least accurate). (McElwee photo).

Figure 2b (right). Strike Zone Target. The pitcher saw this as they threw at the target. (McElwee photo).

Each successive circle increased by 7.62 cm in radius. A final sheet of white paper was overlaid on the carbon paper with a cross hair (the cross hair in Figure 2b was the same size as accuracy zone 7 in Figure 2a). Each pitcher was given ten minutes to warm up as if she were preparing for a game. Once ready to pitch, the authors placed joint markers on several bony landmarks: acromion process, lateral epicondyle of the humerus, greater trochanter of the femur, proximal fibular head, and the distal radio-ulnar joint (all on the same side of the pitching arm).



Figure 3. Joint Markers. Joint marker placement: (1) acromion process, (2) lateral epicondyle of the humerus, (3) greater trochanter of the femur, (4) proximal fibular head, (5) distal radioulnar joint. McElwee photo.

Each pitcher threw ten fastball pitches and ten change-up pitches. The pitcher was told to aim for the center circle of the target. Twenty pitches per pitcher created a fair balance between a realistic number of pitches thrown by a pitcher in one inning and a high number of data points, which was ideal for analysis. The type of pitch thrown first (i.e., fastball or change-up) was randomized to reduce order effect. After each pitch, the researchers recorded the accuracy score by observing the mark left by the softball on our target. The authors chose the accuracy score based on the location of the central mark left by the ball.

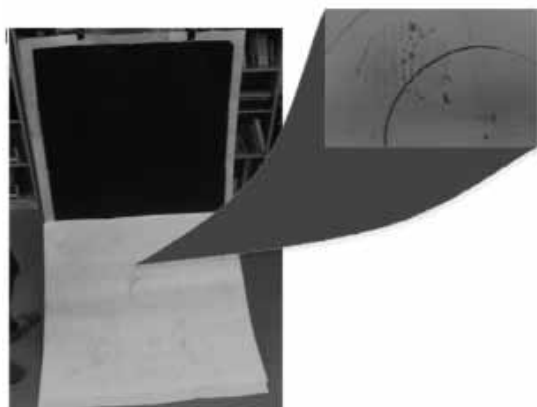


Figure 4. Ball Marking. Actual target with a magnified view of the mark left by the softball. McElwee photo.

Data Analysis. Using Dartfish Software (v 5.5), shoulder angles were measured by finding the angle between the lateral epicondyle of the humerus, acromion process, and the greater trochanter of the femur. Elbow angles were measured between the acromion process, lateral epicondyle of the humerus, and the distal radio-ulnar joint. Hip angles at release were measured between the acromion process, greater trochanter of the femur, and the proximal fibular head. Angular shoulder flexion velocities were calculated between each frame (1/60 sec.) from the twelve o'clock stage of the pitch until release using the measured shoulder angles. These individual angular shoulder flexion velocities were averaged throughout the entire pitching motion to create an average angular shoulder flexion velocity for each pitch. The average shoulder flexion velocities were compared to find potential differences between fastball and changeup pitches. These data might help indicate any variations in the pitching motion, which may tip the batter with knowledge of which pitch type was being thrown before the softball left the pitcher's hand. Furthermore, linear ball velocities at release were calculated by measuring ball displacement from the point of release until one frame afterwards. Linear ball velocity data were correlated (Spearman rho) with the accuracy scores to assess the relationship between speed and accuracy. A paired two-tailed t-test ($p < .05$) was used to find significances between elbow angles and hip angles during the fastball and change-up pitches.



Figure 5a (left). Elbow Angle at Release. Elbow angle of each pitcher's throwing arm at release. (McElwee photo).



Figure 5b (right). Shoulder Angle at 12 O'clock. Shoulder angle near the 12 o'clock position. (McElwee photo).

Results & Discussion

The elbow angle of the throwing arm at release was $156.87 \pm 8.94^\circ$ (fastball) and $152.20 \pm 11.25^\circ$ (change-up). A t-test comparing the elbow angle between the two pitches showed a significantly strong difference ($t = 0.03$). This indicates that there is a significant difference between the elbow angles at

release for fastball versus the change-up pitch. The batter might be able to detect which pitch type was about to be thrown based on the detection of elbow mechanics. Whether or not the batter is capable of detecting these mechanics in the time it takes the ball to travel from the pitcher's hand to home plate is not covered in this study. This study attempts to show that the elbow mechanics are different, which demonstrates that there is an opportunity for the batter to detect the type of pitch being thrown based on the elbow mechanics. The hip angle at release was $167.79 \pm 5.93^\circ$ (fastball) and $166.86 \pm 6.58^\circ$ (change-up). A t-test between these two measurements showed no significant difference ($t = 0.32$), suggesting that the batter would not have the opportunity to decode fastball versus change-up pitch type by looking for a difference in the pitchers' hip angle.

Table 1. Accuracy and Linear Kinematics

	Fastball Mean + SD	Change-up Mean + SD	p
Elbow Angle ($^\circ$)	156.87 ± 8.94	152.20 ± 11.25	0.03
Hip Angle ($^\circ$)	167.79 ± 5.93	166.86 ± 6.58	0.32
Release Velocity (m/s)	23.87 ± 3.67	17.14 ± 1.25	0.00
Accuracy (points)	3.50 ± 1.94	1.73 ± 1.23	0.00

Mean shoulder flexion velocities were $886.89 \pm 371.21 \text{ }^\circ\text{s}^{-1}$ (fastball) and $810.06 \pm 321.12 \text{ }^\circ\text{s}^{-1}$ (change-up). Use of a mean value over the entire delivery and variability in skill level may account for such large standard deviations in angular velocity. Mean shoulder flexion velocities were calculated in order to observe if there was a quantitative difference in the shoulder flexion velocities between the fastball and change-up pitches. This could prove to be an advantage to the batter if the batter could determine the pitch type during the pitching motion. Mean linear ball velocities at release were significantly different between the fastball ($23.87 \pm 3.67 \text{ m/s}$) and change-up ($17.14 \pm 1.25 \text{ m/s}$) pitches. Since little research exists that is similar to this study, no data can be compared to the author's data. Furthermore, mean accuracy scores were also significantly different between the fastball (3.50 ± 1.94 points) and change-up (1.73 ± 1.23 points) pitches. Spearman Rho correlations ($n = 30$) between linear ball velocity at release and accuracy were not significant (fastball = .20; change-up = -.21). The change-up tended to resemble the speed-accuracy relationship more than the fastball. This could be due to the fact that a successful fastball pitch is designed to be thrown at a faster linear velocity. Therefore, throwing a fastball pitch at a slower linear velocity could make it more difficult to throw, thus less accurate. As a

result, the linear ball velocity and its accuracy are proportionally related, which contradicts the speed-accuracy relationship. Likewise, the change-up pitch is designed to be thrown at a slower linear velocity. Therefore, throwing a change-up pitch at a faster linear velocity could make it more difficult to throw, and thus less accurate. The relationship between the linear ball velocity and the accuracy of the pitch shows that the two measurements are inversely proportional, which matches the speed-accuracy relationship.

This research study encountered three limitations. One, while the strike zone target successfully measured for accuracy, it was not realistic to a game scenario. The pitchers preferred to aim at the corners of the target since they were accustomed to this while playing in a game. They tended to feel uncomfortable throwing at the center bull's eye of the author's target, which would be located at the center of a batter's strike zone when pitching in a game scenario. A different strike zone should be used when measuring accuracy. This strike zone should not only measure for accuracy, but it should also better resemble a strike zone used in a game scenario. Perhaps four bull's eyes could be placed in the four corners of a square strike zone and the pitcher could aim for a specific bull's eye on each pitch. Furthermore, the frame rate capture of the video camera used for recording video of the pitcher's throwing motion was mediocre. While 60Hz was sufficient, 120Hz would be a much better frame rate for measuring the linear ball displacement at release in order to calculate the linear ball velocity at release. Finally, two subjects listed college experience as their highest level of play and one listed high school experience as her highest level of play. This disparity in experience could affect data if the data are different between college and high school pitchers. If continued further, additional studies should choose high school or college pitchers instead of using subjects from both groups. In doing so, comparisons can be drawn between the velocity and linear kinematics between different levels of skill or age groups. If there are differences, then combining subjects from multiple skill levels or age groups into one study could lead to higher standard deviations in data. Data were similar between the two skill levels in this study, which minimized the effect of this limitation on this study.

Conclusion

This study set out to determine if the speed-accuracy tradeoff existed in fast-pitch windmill softball pitching. Three subjects threw ten fastballs and ten change-up pitches. By comparing the linear velocities of the softball at release with the accuracies of each pitch based on a point system with our target, it was determined that the change-up pitch best resembled the speed accuracy tradeoff. The accuracy of the fastball pitch tended to increase as the linear velocity of the ball increased at release.

This could be due to the fact that a fastball pitch is intended to be thrown at a faster linear velocity rather than a slower one. Thus, throwing a fastball pitch at a slower linear velocity could result in a decrease in accuracy, which disagrees with the speed-accuracy relationship. The change-up pitch, however, did follow the speed-accuracy relationship. Since a change-up pitch is intended to be thrown at a slower linear velocity, throwing it faster may decrease the pitch's accuracy. Thus, the change-up pitch would follow the speed-accuracy relationship. Both correlations, however, were weak. While statistically similar mean hip angles at release suggest that the pitcher's mechanics during the fastball and change-up pitches do not appear to be different to the batter, statistically different mean elbow angles suggest that the batter might be able to detect the pitch type before it leaves the pitcher's hand.

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Defending Your DNA: Combating Threats both Foreign and Domestic

JAMES MCISAAC



James McIsaac is a senior pursuing a B.S. in Biology with a minor in Biochemistry.

This paper originated as an in-class research assignment in Cell Biology, with Dr. Boriana Marintcheva. The subject matter is related to the research he conducts in the Biochemistry Research Lab. James plans to pursue his Ph.D. related to DNA damage tolerance and repair.

We are under constant assault from forces capable of damaging our DNA. The genetic code of DNA is made up of four nucleotides: adenine (A) which bonds with thymine (T) and guanine (G) which bonds with cytosine (C). If something happens to upset this normal pairing or the nucleotides themselves, our body must spring to action and respond to the damage. When damage to nucleotides prevents the normal replication machinery from doing its job, enzymes like the Y-family polymerases are called in. A special mechanism allows them to identify damage and insert the correct nucleotide or bypass the lesion to continue replicating a new strand of DNA. If not bypassed correctly, the result is a mutation in our genetic code that could lead to cancer. Understanding how our body reacts to genetic damage on a molecular level, will aid the development of future anti-cancer therapies.

Introduction:

Every day of your life there are soldiers that stand between you and certain danger. These soldiers are hidden from sight; waiting, watching, and always ready to protect you. They have abilities that set them apart from their peers and allow them to do the jobs that no one else could, but they do so with little to no oversight. What if, one day these soldiers act in a way to protect you, but something goes terribly wrong? What if these defenders make a mistake that puts your life in jeopardy? This is not the latest script for a Hollywood movie, but a scene that plays out every day inside every cell in your body. The stars of this real life action role are a group of enzymes commonly referred to as translesion polymerases. Every day, your DNA is under constant attack from enemies both foreign and domestic, or in biological terms, exogenous and endogenous, respectively. These attacks, when successful, often result in some type of damage. When DNA is copied, this damage, which is often referred to as a lesion, prevents the normal replication machinery from doing its job until the lesion is fixed by the DNA repair machinery of the cell. If the damage is too extensive, it then becomes the responsibility of the Special Forces enzymes that are able to perform a function called translesion synthesis (TLS). When these TLS polymerases step in and do what needs to be done to continue the DNA replication, errors in the code can be created. These errors are known as mutations and can be dangerous depending on which genes are affected. The mutations in DNA may translate into mutations in proteins, which may alter the way a protein functions or prevent it from working completely. The major focuses of this paper are the consequence of mutation,

types of damage to our DNA, and the enzymes responsible for coping with the damage.

Consequences of DNA damage:

The most well known consequence of mutation in DNA is cancer. In the 2012, it was estimated that an American was diagnosed with cancer every 19 seconds (1).

Long before a doctor can see evidence of a tumor, the process of cancerogenesis starts as a single genetic mutation. Our cells have an amazing array of defensive mechanisms to prevent these mutations from leading to cancer (2). Unfortunately, this becomes a numbers game in many cases. For 75 to 80% of cancer patients, their disease is the result of some external factor they came in contact with on a daily basis (3). The protective and repair mechanisms within our bodies can only cope with so much before failing or making a mistake. These genetic mutations can begin in the form of a DNA lesion, which is a structural anomaly in our genetic code caused by exposure to a residue or other harmful event capable of impacting our DNA. Our cells can either remove the lesion or attempt to replicate past it with special enzymes. If this damage is not properly handled a mutation may be present in future copies of the DNA. The impact a mutation will have on the body has more to do with how many are present, the gene possessing the mutation and what its normal function involves. The damage to our DNA comes in many sources and forms.

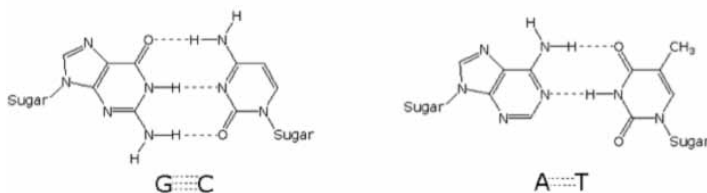


Figure 1 DNA nucleotides base-pairing. DNA is composed of four nucleotides whose order codes specific genetic messages in the double helix G (guanine) with C (cytosine) and A (adenine) with T (thymine). Each nucleotide is composed of a base (depicted with a chemical formula), sugar (depicted with the word sugar) and a Phosphate (omitted for clarity). The G-C and A-T bonding pattern determines the regularity of the DNA shape. Any mispairing or nucleotide chemical modification could cause a distortion of the double helix. This image was generated with ChemBioDraw Ultra.

Types of DNA Damage:

Our genetic code is determined by the sequence of four nucleotides: adenine (A), thymine (T), guanine (G), and cytosine (C) (Fig. 1). Under normal conditions each nucleotide only pairs with one other nucleotide. Adenine bonds with thymine and guanine bonds with cytosine. Each molecule bonds to its complementary pair in a specific way, creating the regular

shape of a double helix. Anything that disrupts this pairing or alters the shape of the nucleotides is known as a lesion. Some of the lesions found in DNA are abasic sites, interstrand & intrastrand crosslinks and adducts (8).

Abasic sites are lesions in which one member of a complementary pair of nucleotides is missing or twisted out of the DNA helix (7). These lesions can occur as the result of internal and external agents. There are several chemical interactions that could result in a nucleotide being excised from the DNA molecule. Enzymes could eject a nucleotide, or it could even happen spontaneously (7). When a nucleotide is missing or twisted out of alignment it causes a local and usually minor shift to the normal helical shape of a DNA molecule (7). This presents a two-fold problem for the normal replicative machinery. The normal enzymes must cope with the geometric distortion in the shape of the DNA molecule and the missing piece in the sequence to be copied.

Interstrand and intrastrand crosslinks are other types of lesions formed when nucleotides develop covalent bonds with another nucleotide instead of the normal pairing with its complementary nucleotide (6). When nucleotides on opposite strands form covalent bonds, they prevent the enzyme DNA helicase from performing its role of splitting the strands for replication (11). When these interstrand crosslinks or ICLs occur the cell will die if this damage is not repaired. Intrastrand crosslinks are formed when nucleotides on the same side form a covalent bond. These bonds can be caused by a variety of endogenous and exogenous agents. Thymine-thymine crosslinks are caused by exposure to ultra-violet radiation and are usually associated with different types of skin cancer (Fig 2). One way to remove this lesion is to eject one or both of the cross-linked nucleotides creating an abasic site (4). Alternatively, TLS polymerases can be used to bypass this lesion and allow replication to continue and prevent cell death (2).

Adducts are lesions in which DNA becomes covalently bonded to a molecule (5). These malicious chemicals can originate from a variety of sources. Given that there are so many potential chemical interactions that could occur, there are a tremendous number of possible adducts; a few examples are shown in Figure 3. Adducts distort the geometric shape of DNA to varying extremes, depending on the size of the adduct itself and where it occurs within the molecule (6). Normal replication enzymes are unable to synthesize new strands of DNA past these adducts, and enzymes like the Y-family of polymerases are called in to do the job (6). Etheno-dA is a lesion that can lead to mutation when cells try to copy DNA containing it (2). When hydroxyl-2-nonenal (or HNE for short) attacks a normal molecule of adenine, it forms a new bond that can

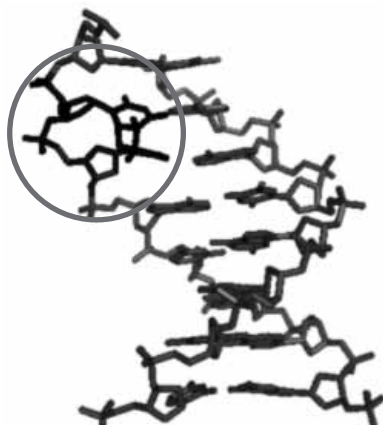


Figure 2 Distortion of a DNA by Thymine-Thymine Dimer. Double-stranded DNA adopts a regular helical shape driven by regular basepairing between complementary DNA bases. Thymine-Thymine dimers (circled in black) arise from crosslinking two adjacent Thymine bases upon UV irradiation and alter the overall shape of the DNA molecule. This image was generated by PyMOL. .

produce the etheno-dA lesion, altering the original structure in a way with which normal replication processes cannot cope (Fig. 3). The external influences that can generate these lesions are wide and varied, from the consumption of alcohol and coffee to cigarettes (9). Because of the change to the molecule of adenine, as shown in Figure 2 it is possible for the TLS polymerase to misread the nucleotide and incorporate a cytosine instead of a thymine leading to mutation (9). In order for cells to survive genetic damage they need special polymerases with their own set of rules.

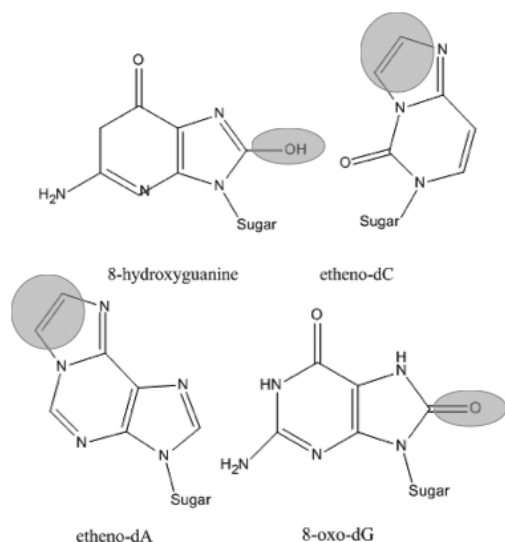
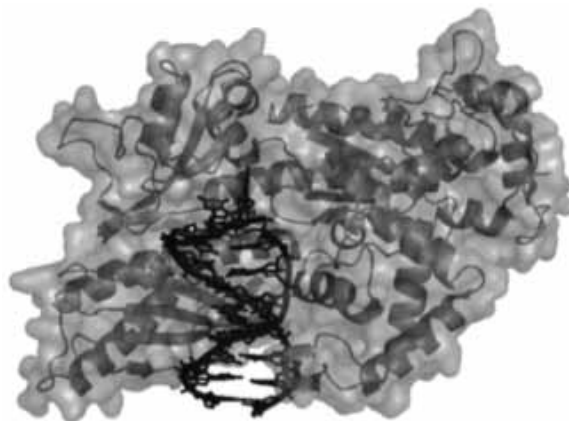


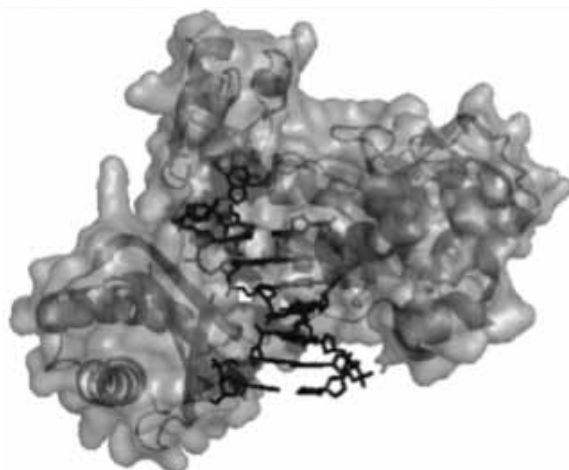
Figure 3 Examples of adducted nucleotides. Adducted nucleotides are chemically modified versions of Adenine, Thymine, Cytosine and Guanine. The chemical modification in each adduct is highlighted with a grey oval. The displayed chemical formulas were generated using ChemBioDraw Ultra.

Translesion Synthesis (TLS) polymerases:

In humans, translesion synthesis is largely attributed to five polymerases. Four of the polymerases are from the Y-family: **Kappa**, **Eta**, **Iota** and **Rev1**. Polymerase **Zeta** is from the B-family (6). Each polymerase has been shown to perform certain roles both individually and while working in tandem. The Y-family polymerases closely resemble each other, though with enough variation to perform different tasks (9). As with all proteins, function is directly related to structure. While these enzymes perform related tasks, the lesions they bypass are structurally different and require their respective bypass enzymes to have sufficient variation in their active sites to accommodate these lesions (Fig 4). These enzymes have been described as resembling an open right hand, and the regions of this enzyme have been labeled according to that analogy (Fig 5). They have a thumb that holds the DNA in a region called the minor groove. The polymerase finger(s) lie over the template nucleotide to be copied. The palm creates a bond with the phosphate backbone of the DNA molecule. There is a section of the enzyme called the N-digit or little finger which has some variation in functionality between the enzymes. The wrist or polymerase associated domain (PAD) contacts the ma-



A



B

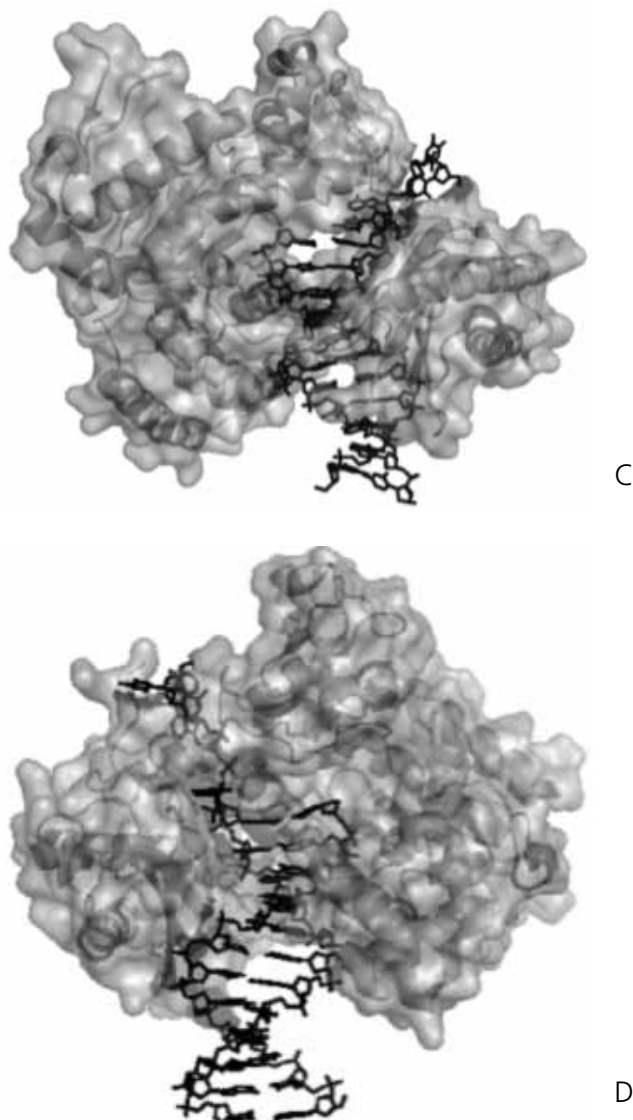


Figure 4 Y-Family DNA polymerases. A) Pol. Eta (PDB 2R8J) B) Pol. Iota (PDB 3GV8) C) Pol. Kappa (PDB 3IN5) D) Rev1(PDB 2AQ4). Each polymerase is visualized interacting with DNA to give a perspective on the size of each enzyme and its active site with respect to the other enzymes in the family. These four polymerases are structurally different as seen by the above images. The variation in structure allows for lesions of various sizes to fit within the active site of the appropriate enzyme. The image was generated using PyMOL Molecular Graphics System using crystal structures obtained from the PDB.

jor groove region on DNA (9). Some obstructions prevent a single enzyme from both bypassing a lesion and restarting the replication process for the rest of the DNA strand to be copied; and therefore must work with a partner (9). If TLS is done correctly, it allows DNA to replicate, despite the initial presence of an anomaly, though this replication is not always error free. The error rate for a TLS polymerase is between 10^{-2} and

10^{-4} , while normal replication polymerases have an error rate between 10^{-5} and 10^{-7} (3). It is important to note that because TLS polymerases do not have any proofreading component, like polymerases involved in normal replication, this can result in mutations that are not corrected.

Pol Eta is capable of working independently or in conjunction with one of its sibling enzymes. This enzyme has proven efficient at dealing with lesions caused by ultra-violet rays (9). Cyclobutane pyrimidine dimers or CPDs are lesions caused by UVB and UVC rays, and Pol eta is the most reliable at bypassing these lesions without mutation (9). It can also perform translesion synthesis past some types of intercross links or ICLs. Bulky adducts like 8-oxoguanine are bypassed by this polymerase also. The thymine-thymine crosslink, like that shown in figure 2 which can lead to skin cancer, is bypassed by this enzyme along with Rev1 (4). Pol eta is able to insert two adenines across from the two thymines, but it requires Rev1 to restart the replication process (4).

Pol Iota is considered the highest fidelity, or most faithful polymerase in the Y-family (9). Pol iota is also capable of bypassing thymine-thymine crosslinks though not as well as Pol eta (9). Incorporation of the correct nucleotide is more efficient with adenine and guanine as the template than cytosine and thymine (9). It has been shown that abasic sites can be bypassed by Pol iota with good efficiency. As well as certain guanine adducts, and a wide variety of adenine adducts. Though capable of bypassing several lesions, it is often inefficient at extending replication past the lesion and must work with a partner to perform both functions (9).

Pol Kappa is considered to be fairly high fidelity for a Y-family polymerase. It has been shown to work with other polymerase enzymes, where it takes on the role of extending replication past the lesion site (9). It has proven effective for certain types of ICS bypass (4). Pol kappa is well known for being able to bypass bulky guanine adducts like Benzo(a)pyrene diol epoxide (BPDE), and adduct associated with cancer caused by cigarette smoke (2). It will also work with other enzymes like Rev1 when bypassing adducts like thymine glycol, where Rev1 is responsible for restarting the replication process past the lesion (2). Pol kappa has also been shown to both bypass abasic sites and cause them (2). When it causes an abasic site by removing a nucleotide it often causes another problem known as a frame-shift error or mutation (9). These frame-shift errors are often the result of an adjustment caused by a misinsertion of a nucleotide. The enzyme tries to force out the incorrect sequence and reinsert it across from the next appropriate nucleotide (9). This can cause slight distortion to the frame of the DNA helix even after replication has restarted.

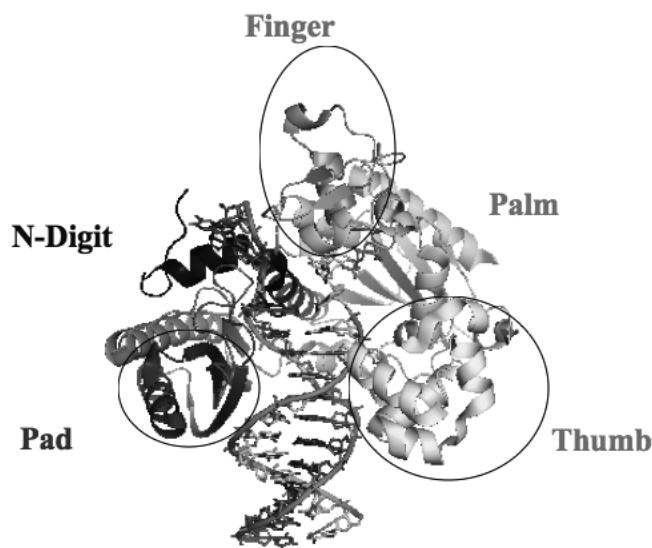


Figure 4 Rev1 Molecular Structure. DNA polymerases 3D structure is often described as an analogy of a Right Hand composed from Thumb, Palm, Fingers, PAD and N-digit as depicted above. The characteristics of the Palm, PAD, Fingers, Thumb and N-Digit vary slightly between the polymerases allowing them to perform their specific tasks. While there is variation, the basic configuration is the same throughout the family. This figure was generated using PyMOL and PDB 2AQ4 molecular coordinates.

The complete role of **Rev1** is still being uncovered. Rev-1 typically binds to a guanine and inserts a cytosine when reading and copying DNA (11). Although Rev1 prefers inserting a cytosine opposite a guanine, it will bind to other sites, although much less efficiency is observed (6). When Rev1 interacts with the DNA helix, the amino acid glycine forms specific interactions on guanine (6). Once bonded to the guanine, Rev1 is then able to insert a cytosine into the new strand of DNA to allow proper coding to continue. If Rev1 does not do its job in this fashion, the new strand will contain a potentially hazardous mutation. Bypassing guanine adducts is what this polymerase is best known for, which is a poor choice because it focuses on one aspect of what this enzyme is capable of. Rev1 has been shown to possess the unique ability of interacting with the rest of the TLS polymerases. The N-digit on Rev1 allows it to interact with other enzymes and accessory proteins (4). With these protein interactions Rev1 makes it possible for lesion bypass to occur with the continuation of the replication process without stalling and putting the DNA strand in more jeopardy.

It is nearly impossible not to talk about **Pol Zeta** when speaking on the subject of translesion synthesis. The other two enzymes in the B-family have a proofreading functionality that, like the Y-family, Pol Zeta lacks. While it may lack proofreading, it is still a higher fidelity polymerase than most of the Y-family (5). It has been experimentally determined that Pol zeta can work

with other enzymes to allow replication to continue past the site of a lesion, or a bypassed lesion. Pol Zeta is structurally different from the Y-family, as it is composed of only two subunits called Rev3 and Rev7 (4). Pol zeta in conjunction with Rev1 is blamed for many of the mutations found in eukaryotes (12). These two enzymes together are able to bypass many lesions and incorporate the wrong nucleotide.

Looking to the future:

According to Sun Tzu, “the highest form of generalship is to balk the enemy’s plans, the next best is to prevent the junction of the enemy’s forces, the next in order is to attack the enemy’s army in the field, and the worst policy of all is to besiege walled cities” (13). Fighting a walled city is exactly what we are doing when we attack cancer that has already formed a tumor. This city has an ever-increasing population, and its own blood vessels supply it with all of the resources it needs to fight back. We are often forced to fight cancer with weapons that attack the entire body, not just the tumor. As we are exposed to chemotherapy drugs, they create the risk of developing new cancerous mutations. In no way is this a wise strategy for winning a war. With more research aimed at understanding the mechanics behind a cell becoming cancerous, we can switch our tactics and focus on balking the enemy’s plans.

Cancer is an enemy that does not confine its damage to the person it attacks, but unleashes its malicious influence in some way upon everyone in the victim’s life. During 2010, American families spent an estimated \$124.57 billion dollars on cancer care (1). This enormous financial burden is the result of doctor visits, clinic treatments, procedures, lab tests, imaging tests, radiation treatment, drug costs, hospital stays, surgeries, and home care (1). The financial breakdown was a lot to fit into a sentence; imagine fitting it into your life. What if there was another way to fight cancer? Without a better understanding of this process we will never learn to ask better questions. As more research is done to understand the role each enzyme plays during lesion bypass, the closer we come to developing targeted treatments and more comprehensive preventative measures.

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A Study in Sherlock

REBECCA MCCLAUGHLIN



Rebecca McLaughlin is a senior, graduating May 2013, with a major in English and a minor in

Communication Studies. This excerpt, taken from her Honors Thesis, began as part of an Adrian Tinsley Summer Research project, under the mentorship of Dr. Kathleen Vejvoda. This work was presented at the 2013 Popular Culture Association Conference in Washington, D.C. Rebecca will begin her graduate studies in English at Northeastern University in Fall 2013.

In 2010, the BBC launched its newest series, *Sherlock*. The show was an instant success in the UK, Europe, and the United States. In early 2012, Season Two aired with even greater success. But we might ask why, nearly 120 years after he was first introduced, the character of Sherlock Holmes, along with his companion Dr. John Watson, still captures the attention of TV audiences? My study examines the representation of this fictional male friendship as a popular culture phenomenon both at the turn of the twentieth century and today. Focusing on the representation of domesticity and unmarried men, homosocial bonding, and professionalism in the television series, I hope to illuminate parallels between late Victorian and contemporary cultural anxieties about masculine identity.

When the BBC first aired *Sherlock* in July of 2010, co-creators Steven Moffat and Mark Gatiss anticipated success but were greatly, and pleasantly, surprised with the show's actual reception. Reflecting on the show's success, Moffat recalls, "We thought it would be like an audience of four million and an obscure award at a Polish festival or something like that. It happened so completely suddenly. We barely finished the show and it's this enormous hit. There seemed to be no intervening moment of escalation" (Moffat, Interview). Neither Moffat nor Gatiss could have predicted the show's success. *Sherlock* reached international acclaim, sparking an internet "#believeinsherlock" campaign and capturing audiences across the globe. Ecstatic with the show's reception, both Moffat and Gatiss claim that the show was really only written with one purpose in mind, to express their love of the Sherlock Holmes canon. Moffat remarks, "We [wrote] *Sherlock* to entertain each other," while Gatiss claims that he [did] it to "please the eight year old version of [himself]" (Moffat, Interview). For these men, writing what they call a "Modern Sherlock" was something they wanted to do for quite sometime, and it was instantly accepted by the BBC. (Note, in relation to the stories, the characters are Holmes and Watson, but, when referring to the series, they are Sherlock and John.) With this passion for the original Holmes canon, and in some ways these "new characters," both Moffat and Gatiss brought a contemporary Sherlock to the screen, with very little change to the original stories and the successful incorporation of the male friendship between Holmes and Watson.

Unlike an original text, *Sherlock*, an adaptation, has the ability to incorporate criticism that has arisen over the decades. And that is precisely what Moffat and Gatiss have done. Unlike in the original texts, where Holmes' behavior

is never questioned, others in *Sherlock* explicitly question Sherlock's involvement with criminal acts and his role as a degenerate. This notion stems from decades of criminality research, including research conducted by Cesare Lombroso and Max Nordau. In many ways, Sherlock fulfills the attributes regarding the idea of a criminal, and the show, unlike the stories, emphasizes his criminal tendencies with the use of characters like Irene Adler and Jim Moriarty. However, unlike Adler and Moriarty, Sherlock never acts on his criminal tendencies. Arguably, what sets Sherlock apart from criminals is his friendship and bond with Dr. John Watson. Likewise, Sherlock gives purpose to John's existence, preventing him from falling into degeneracy.

For Moffat, this is the one aspect of the Holmes' stories that trumps the rest. It's not the detective stories nor is it Holmes' superior intellect. Above all, it is the friendship and bond that Holmes and Watson share that make the stories truly captivating:

Under the surface—the detective stories are the surface—is the story of the greatest friendship ever. Because it's a male friendship, they simply never talk about it...I find joy in writing this, in writing the friendship. It's subtext, but it really is right to the top level of subtext and just in those two men, and the fact that they endure each other ("A Study in Pink" Commentary).

Sharing Moffat's point of view, I agree that the male friendship is by far one of the story's most important aspects. Both Sherlock and John rely on their friendship, albeit for different reasons. For John, the relationship offers rehabilitation, an introduction back into society, adventure, and safety from criminality. For Sherlock, John offers morality and humanity. He is what prevents Sherlock from succumbing to criminal actions and degeneracy.

In the show, Sherlock and John meet much like they do in the original texts. John, having just returned from war in Afghanistan, is introduced to Sherlock via a mutual friend. Sherlock quickly reveals his intellectual genius through an analysis of John himself. Upon viewing the infamous 221b Baker Street, both men agree to be flatmates. This is the beginning of their bond and friendship. Throughout the rest of the series, John accompanies Sherlock on all of the cases he solves, blogging about the happenings consistently and defending Sherlock's honor against those who try to tarnish his name. The loyalty between these two men is carefully crafted throughout the series. It represents the friendship of the original stories, with a much greater emphasis on the reasons why these men need each other.

Dr. John Watson is a man haunted by his past in Afghanistan. "A Study in Pink," the first episode of Series One, opens with a representation of John's war-dream and him waking in a cold sweat. The viewer can see the panic and horror in John's eyes, only to be followed by John locking away a pistol in his drawer. Cutting to the next scene, John is meeting with his psychiatrist. This is where John is defined for the viewer. When questioned about why he hasn't started blogging, John remarks that "Nothing happens to [him]" ("A Study in Pink"). He also witnesses his psychiatrist noting that he "still has trust issues" ("A Study in Pink"). We see that John is a man troubled by his past, trying to reenter society after being away at war. He has no purpose in life and needs to find reasons to carry on. These are the kind of men who were most at risk for degeneracy and were the perfect candidates for adventure stories (i.e. the Holmes cannon), Stephen Arata argues. He writes that these adventure stories were "centrally concerned with the possibility of renewal" and, citing David Trotter, they take "exhausted, purposeless men...whom we expect to degenerate or wither away, and transposes them to a new territory, the frontier, where a more vigorous identity can be created" (Arata 80). John is both exhausted and aimless upon his return from Afghanistan. With no job, little money, and the need for new rooming, John needs a change, an adventure. And for him the adventure, the "frontier," is the city of London, where he is able to create a new identity through his friendship with Sherlock. This opening context also gives John a comparative identity. It shows that he was someone before he met Sherlock, and it isn't until Sherlock's "death" at the end of Series Two that he'll ever be that way again.

In many ways, it is Sherlock who saves John from a purposeless existence, with the most tangible evidence being John's blog. In "A Study in Pink," John's psychiatrist recommends that he keep a blog, recording all of his daily activities. John remarks that nothing happens to him, thus he has no purpose for a blog. However, enter Sherlock, and everything changes. By the beginning of the second series, John's blog is an internet success, reaching 1,895 views overnight. Because of the friendship between these two men, and John's role in accompanying Sherlock, John's life is given purpose. He represents Sherlock to the public, sharing all of the cases and their details. For John, the relationship with Sherlock is rehabilitative. He uses his blog and role in solving cases as a way to reenter society and rehabilitate after returning from war. Using the cases, John finally has a perspective for not only his blog, but for his personal life.

After meeting Sherlock, John also undergoes both physical and psychological changes. Physically, John loses his limp. John was wounded in action while in Afghanistan, a wound

that Sherlock claims is psychosomatic upon first meeting him. For John, though, the wound is very real. However, when the thrill of following Sherlock on an investigative lead takes hold, John forgets about his once physically-restricting limp. From this moment on, John is able to walk on his own, with neither limp nor cane. Along with his physical change, John undergoes a psychological change from the first series of *Sherlock* to the final episode in Series Two. While visiting Sherlock's grave in "The Reichenbach Fall," John remarks in a very emotional apostrophe:

You told me once that you weren't a hero. There were times I didn't even think you were human, but let me tell you this. You were the best man, and the most human human being that I've ever known and no one will ever convince me that you told me a lie. I was so alone, and I owe you so much. Please there's just one more thing, one more miracle, Sherlock, for me. Don't be dead. ("The Reichenbach Fall")

Here we see the depth of John's relationship with Sherlock. He refers to Sherlock as "the best man," and refuses to believe that Sherlock is anything less than that. We also see here the psychological change in John, and his affirmation that his change is in great part a result of his relationship with Sherlock. John states that he was "so alone" and owes so much to Sherlock. It was this relationship and the adventure it offered that kept John from leading a purposeless and idle life. With Sherlock around, John was kept from criminalistic tendencies and was kept in the realm of the professional. He was deterred from falling into degeneracy through his work with Sherlock. Although it was Sherlock who held the title of consulting detective, John was also a crucial part of the business that Sherlock conducted. After all, it was his blog that brought new clients to 221b Baker Street. Also important to note is that after meeting Sherlock at the beginning of Series One, John never again met with his psychiatrist. It isn't until Sherlock "dies" that we see John with his psychiatrist again. She asks the reason for his sudden return and he attributes it to the death of his best friend, Sherlock Holmes. Because of Sherlock's "death," John reverts back to a purposeless existence. He has lost his adventure, his reason for blogging, and his best friend. Essentially, John has lost his identity, an identity that Sherlock helped him create. These are the many reasons for John's homosocial bond with Sherlock. He relies on this friendship for adventure and, more importantly, purpose. With Sherlock, John feels a sense of identity. He has the ability to rehabilitate both his physical and psychological wounds. Because of this relationship, he needs neither cane nor psychiatrist. Sherlock keeps John busy and on track, preventing him from the criminalistic temptations that can occur when one leads an idle life.

Just as Sherlock is the reason for John's well being, John also offers a great deal to Sherlock. In his book, *Degeneration*, German physician Max Nordau explores the characteristics that define a criminal. He writes,

...degenerates are necessarily egotistical and impulsive...His excitability appears to him a mark of superiority; he believes himself to be possessed by a peculiar insight lacking in other mortals, and he is fain to despise the vulgar herd for the dullness and narrowness of their minds. The unhappy creature does not suspect that he is conceited about a disease and boasting of a derangement of the mind. (19)

In all of these ways, Sherlock is the epitome of Nordau's defined degenerate. He is both egotistical and impulsive, often having to be reminded by John the reason for his presence. He shows excitement at the start of a new case, with John reminding him that there has been a murder or that innocent lives are involved. His most defining attribute, however, is his detestation for what he sees as inferior human beings. On many occasions, Sherlock remarks that it must be so boring not being him and wonders what it must be like in other people's heads. One of Sherlock's infamous lines, in both the series and the original texts, is that one "see[s] but do[es] not observe" (Conan Doyle 5). He believes that people can understand certain things, but only to a point. However, they do not observe their surroundings and take in all of the details, as he does. Recalling Nordau's research on criminals, Sherlock does not believe that he is conceited or wrong in his actions. He believes that his superior intellect and deduction skills are worthy of such a personality. He often criticizes the Scotland Yard officers for not having the capacity to live up to his abilities. Thus, Sherlock is a prime candidate for degeneracy, based on the definition put forth by Max Nordau.

Just as Sherlock's qualities meet Nordau's definition of a degenerate, so do they raise suspicions amongst others whom Sherlock encounters. One member of the police force, Sgt. Donovan, says of Sherlock:

You know why he's here? He's not paid or anything. He likes it. He gets off on it. The weirder the crime, the more he gets off. And you know what? One day just showing up won't be enough. One day, we'll be standing around a body and Sherlock Holmes will be the one that put it there...Because he's a psychopath. Psychopaths get bored. ("A Study in Pink")

This is her warning to John to stay away from the likes of Sherlock. His love of crimes and his ability to solve them raises

concerns about his involvement. She questions his actions and his resources when solving crimes around London. However, despite all the evidence against him, Sherlock remains resistant to degeneracy.

Because of his relationship with John, Sherlock is able to remain untainted by criminal actions. John provides a humanizing balance to the sometimes overly-rational mind of Sherlock. When starting a new case, Sherlock often shows excitement over the new distraction. When he has no cases, he often complains of boredom and falls into a type of depression. With John around, Sherlock is reminded that, although he finds new cases stimulating, they are still cases and there are still innocent lives involved. John is also able to assist Sherlock in solving certain aspects of the cases, proving that his knowledge is actually beneficial to Sherlock. In Series One episode three, "The Great Game," John criticizes Sherlock for not knowing anything about the solar system. Sherlock defends himself by describing this type of knowledge as "not important" ("The Great Game"). He remarks that, "Ordinary people fill their heads with all kinds of rubbish. And that makes it hard to get at the stuff that matters...All that matters to me is the work. Without that, my brain rots" ("The Great Game"). Here we see Sherlock's deep rooted connection to his work as a consulting detective. For him, his work is all that matters. This scene is also example of Sherlock's self-imposed superiority. He refers to others as "ordinary people," while placing himself above all the "rubbish" that fill their heads. But, what is most important, here, is that Sherlock is wrong. Later in this same episode, it is knowledge of the solar system that helps Sherlock to solve his case and save a child's life. The only reason for his knowledge of the solar system is because John brought it to his attention. John serves to balance Sherlock's rational mind by offering compassion and companionship.

The best example of Sherlock's need for his relationship with John comes in the form of Sherlock's greatest nemesis, Jim Moriarty. In many ways, Moriarty is an exact replica of Sherlock. Moriarty matches him in terms of intellect and genius and makes his living in a similar fashion. Sherlock is the only consulting detective in the world, while Moriarty is the only consulting criminal. The striking difference between the two men is John; Moriarty does not share a homosocial bond in the way that Sherlock and John do. In "The Reichenbach Fall," Moriarty acknowledges that he and Sherlock are the same, saying, "You need me or you're nothing. Because we're just alike, you and I. Except you're boring. You're on the side of the angels" ("The Reichenbach Fall"). For Moriarty, the difference between Sherlock and himself is the "side" that each chooses to work for. Moriarty has chosen to oppose the "angels" as a consulting criminal. However, what keeps Sherlock on this side

is his relationship with John, a relationship that Moriarty lacks.

Unlike Sherlock, Moriarty has no specific bonds with humanizing and moral beings such as John. Instead, he works a web of criminals, never bonding with any of them. People are merely tools for his business. Moriarty remarks, "Aren't ordinary people adorable? Oh, you know. You've got John. I should get myself a live in one" ("The Reichenbach Fall"). This raises a few points. Moriarty refers to others as "ordinary people." Recall here Sherlock in "The Great Game." Moriarty and Sherlock share the notion of others as ordinary in comparison to their superior selves. This idea also resonates with the ideas posed by Max Nordau concerning degeneracy. Moriarty, like Sherlock, feels he has a "mark of superiority" and believes he is "possessed by a peculiar insight lacking in other mortals" (Nordau 19). Also important here is Moriarty's remark that Sherlock has John, as he goes on to say that he should "get [himself] a live in one" ("The Reichenbach Fall"). Moriarty sees John as a stark difference between Sherlock and himself, viewing John as ordinary and mere entertainment, while Sherlock understands that his bond with John is both beneficial and necessary.

Moriarty represents Sherlock without John. He is an example of what Sherlock has the potential to become without the bond he shares with John. In the original texts, Moriarty is used as a mere tool to lead to Holmes's death. However, the show emphasizes the potential in Moriarty's character. He is used to highlight the importance of the relationship between Sherlock and John. Sherlock plays with ideas of criminality relating to Sherlock himself, and Moriarty highlights all of the suspicions that Sherlock raises. Sherlock has all the potential to end up just like Moriarty, yet his ability to resist this destiny lies in his relationship with John.

Since they were first published in 1887, the Sherlock Holmes stories have sparked a number of adaptations. What is most fascinating about the BBC's adaptation with *Sherlock* is that it incorporates criticism that has arisen regarding the texts. The show explicitly challenges Sherlock's role in criminal activity while still maintaining Sherlock's respectability. Even more important is the way *Sherlock* composes a ternary amongst Sherlock, John, and Moriarty. The relationship between Sherlock and John holds significance for both men, albeit for different reasons. Enter Moriarty, and their relationship's importance is further emphasized. Unlike in the texts where Moriarty is a mere tool to ensure Holmes's downfall, he is used as a foil character in the show. He highlights the qualities in Sherlock that make him ideal for degeneracy and criminality, while further highlighting Sherlock's relationship with John as the reason he is able to resist. These characters,

and the friendship they share, will live on. Sherlock and John are examples of men with the potential to degenerate, while running the risk of falling into the realm of criminality. Yet through their friendship and bond with one another they resist.

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Characterization and Investigation of At2g42005 in *Arabidopsis thaliana*, a Nematode-Induced Transporter

RACHEL MEDINA



Rachel Medina graduated in January 2013 with a Bachelor of Science in Biology. She began this

research in 2012 with a semester grant and a summer grant funded by the Adrian Tinsley Program under the direction of Dr. Heather Marella. This project was presented at the Undergraduate Research Symposium in the summer of 2012 and in La Crosse, Wisconsin in April 2013 for the National Conference on Undergraduate Research. Rachel currently works for a nematology laboratory at Ohio State University and will be pursuing a PhD in the fall of 2013 in plant pathology.

Meloidogyne incognita is an obligate parasitic roundworm that infects the root tips of a wide variety of host plants. This infection directly affects the crop production globally with the loss of crops such as tomatoes, carrots, and potatoes. Nematode infection manipulates the plant root by altering gene expression for nematode benefit. Genes such as At2g42005, a putative amino acid transporter, have been found to be up-regulated by nematode infection. Characterizing the role of the At2g42005 gene in Arabidopsis thaliana is the first step to understanding its function in nematode infection. The role of At2g42005 were explored by creation of a promoter:GUS vector and gene expression investigation by RT-PCR. The GUS vector is a molecular tool that allows for visualization of gene expression within the tissues of the plant. After plasmid cloning and bacterial transformation, a promoter:GUS vector was created for insertion into flowering plants for visual staining of gene expression. RNA was extracted from various plant tissues and RT-PCR performed to determine At2g42005 expression patterns. The gene At2g42005 was found to be expressed in all tissues examined. Further investigation of RNA expression will be done using qPCR to quantify At2g42005 levels.

The ability to grow crop plants without the harmful use of pesticides is an important area of research due to its environmental significance. Pesticides have contaminated the applied areas, and supply water from runoff, and have harmed wildlife habitat. These factors push research to identify mechanisms for a safe alternative that can eliminate nematocide use completely. There is an important correlation between the supply and demand balance in agricultural research and world hunger. It has been estimated that one-eighth of the global population does not have enough food on a daily basis and this desperate percent only increases each day (1). The recent climate-based challenges, such as drought, have weighed heavily on industrial output for food resources (1). With food crops being harvested and used for biofuels, the limited output going towards global hunger is decreasing (1). All of these factors need to be taken into account when focusing research efforts on finding a way to increase global crop production without the use of ecologically harmful pesticides. Roughly half of the damage of these limited crops is due to nematode infection which currently can only be controlled by nematocide spraying unless plants with inhibitory defenses can be created (2). Therefore, the research proposed in this study focuses on bringing clarity to just one of the many problems facing agriculture, nematode infestation.

Arabidopsis thaliana is a small weed in the mustard family that has become an important model organism of plant biology research (3). *Arabidopsis* was the first plant to have its genome fully sequenced which makes it a helpful tool when working in a laboratory setting (3). Scientists now have the ability to examine the over 20,000 genes and their roles in processes throughout the plant (3). This plant is also capable of growing in potted soil or petri dishes with an agar-based media, making it ideal for laboratory research.

The species of root-knot nematode used for this research is *Meloidogyne incognita*. This species is native to the tropics and was found to grow exceptionally well on *Arabidopsis* (4). *Meloidogyne incognita* is an obligate endoparasite, meaning it is completely dependent on the plant host for its nutrition and spends most of its life cycle within the plant. The larvae of these parasites hatch from eggs in the soil but will return to the root when they are in the juvenile stage (4). This parasite is also responsible for roughly half the total crop damage due to infected roots which makes it a critical point of study (5). The damage to the root is caused by the formation of knots within the root systems which subsequently block the uptake and transportation of nutrients and water through the vascular system in the plant, leaving it malnourished.

Plant roots weave through the soil in search of water and nutrients. The nematode begins its infection by secreting proteins and molecules that counteract the plant's defensive mechanisms upon entry of the root. This step allows the nematode into the root cap and further into the vascular tissue of the plant. The nematodes then secrete proteins that have properties to break down or loosen the cell walls in the plant (2). Additionally, these nematode secretions reprogram the xylem parenchyma cells turning them into a "giant cell" or "feeding cell" (2). The giant cells are enlarged cells with multiple nuclei and form a knot along with increased vascular tissues (6). These feeding cells are fundamental to the nematode infection because they hold the nutrients being pulled from different parts of the plant (6). The nematode pulls nutrients towards the feeding sites through the duration of its life cycle and creates plant damage (6).

The plant uses transport proteins to move substances around the cell. The importance of transporters within the parasitic interaction between plants and root-knot nematodes (RKN) during the infection and giant cell growth has been established (5). Analysis of gene expression in the roots of an infected plant has revealed that there are a total of 634 transporters involved, 50 of which changed immediately upon initiation of the infection (5). Of those 50 transporters, 26 were upregulated during the infection which potentially implicates the nematode

directly using these during the infection (5). The nematode may be using these transporters not only in the forming of the giant cells but also in nutrient storage (5).

By studying upregulated transporters, it may be possible to understand how they are important for the nematodes within the physiology of the plant. The transporter gene of interest for this research is the gene At2g42005. This gene was chosen as a focus due to previous research showing upregulation of this transporter by fourteen percent in giant cells (H. Marella, unpublished). This *Arabidopsis* gene is 1200 nucleotide base pairs long and transcribed into a putative amino acid transporter. A mutant *Arabidopsis* lacking At2g42005 expression showed significantly fewer nematode egg masses than the wild-type control plants (H. Marella, unpublished results), indicating that the At2g42005 gene is required for full nematode infectivity. When At2g42005 mutant plants were grown on agar plates and compared to wild-type plants, they showed increased growth in lateral roots as compared with wild-type. This data indicates that the At2g42005 gene is necessary for proper root growth and development and as such provides the first clue to its natural function in the plant (H. Marella, unpublished results). Since this particular *Arabidopsis* gene has not been previously studied, the goal of this study was to determine the function of At2g42005 in the plant and investigate its role in nematode infection. It was expected that At2g42005 would be found to show expression within the roots and that that it will be directly seen to increase expression with the infection of root-knot nematodes. In order to test this hypothesis, a promoter: GUS vector was constructed and qualitative RNA analysis of the At2g42005 gene was performed.

MATERIALS AND METHODS

TOPO Cloning

The initial step was amplifying the promoter region of the gene At2g42005 from wild-type *Arabidopsis* DNA. The primer sequencing were as follows: At2g42005PRO – FWD 5' TGT TTG TTT GTG TTC CTC AAG 3', Atg42005PRO – REV 5' CTC TAT ACC TGA TTA GAG ATG GGC TC 3', At-2g42010UTR – FWD 5' TAA TAA GGA AGG ATC CAG TGG CAC 3'. The UTR region primer was used due to a small promoter region for the gene At2g42005 and possible regulatory elements found within the gene At2g42010 UTR region. The At2g42005 primers created a 248 bp fragment whereas the UTR primers from At2g42010 created a 465 bp fragment. The PCR cycling conditions were 95°C for 30 sec, 51°C for 30 sec and 72°C for 1 min for 30 cycles with Platinum® Taq enzyme. The PCR reactions were examined by gel electrophoresis. Samples were selected for gel extraction performed using a Qiagen Quick Gel Extraction protocol. PCR reactions resulted

in two specific samples of At2g42005BIG3 and At2g42005Small2. The DNA products were then cloned in a pCR8/GW/TOPO TA Cloning Kit to create the promoter vector

The At2g42005 promoter/TOPO vector was transformed into competent One Shot® *E. coli* cells which were grown in SOB (Super Optimal Broth) medium and plated onto LB (Luria-Bertani) spectinomycin (spec) plates for plasmid selection after 24 hours of incubation. The DNA was extracted from these cells using a Wizard Plus SV Minipreps DNA Purification System and protocol. An enzyme digestion was performed on the DNA products from both samples, At2g42005BIG3 and At2g42005Small2 for gel electrophoresis analysis.

Promoter: GUS Gateway Cloning

From samples that showed correct size bands, the corresponding DNA was sent out for sequencing to verify the plasmid contained the At2g42005 promoter/TOPO vector from previous steps. *E. coli* cells containing the pBGWFS7 GUS binary vector were grown on LB-spec plates, cultured, and DNA extracted similarly to the TOPO vector. The two DNA vectors were then incubated in a LR Clonase® (Life Technologies, Carlsbad, CA, USA) reaction with the enzyme XhoI, which is a restriction enzyme used to cut the TOPO vector backbone. This consisted of the vector containing the At2g42005 promoter/TOPO vector, the destination GUS vector, and TE buffer. This process incorporates the two vectors into the final product of the promoter:GUS vector. The mix was vortexed with LR Clonase® II enzyme then incubated before deactivating with Proteinase K solution. Competent cells were grown in SOB medium with the LR Clonase product and put onto LB-spec plates for plasmid selection overnight. Following the bacterial culture, DNA was purified, digested with BamHI, and finally gel electrophoresis was performed for confirmation of vector presence.

RT-PCR

RNA extraction was performed on wild-type plants grown on agar plates in a controlled incubator and within soil. The soil-grown plants were collected at the age of 6 weeks and the plate-grown plants at 2 weeks for RNA extraction. The RNA was extracted using liquid nitrogen to freeze the selected tissues while grinding with a mortar and pestle. This was done for the tissues of stem, shoot, flower, root, whole seedling, rosette leaves, and cauline leaves. The RNA was used for RT-PCR using the Invitrogen SuperScriptIII kit, creating copies of cDNA. Reverse-transcription uses primers created specifically for the gene At2g42005 and target its presence in any of the tissues. The primer sequences were as follows: At2g42005 FWD 5' ATG GGT TTG GAG GAA CAA GG 3', At2g42005 REV 5' CAC AAG ACT GCT CAC CAC TC 3' for the At2g42005 gene

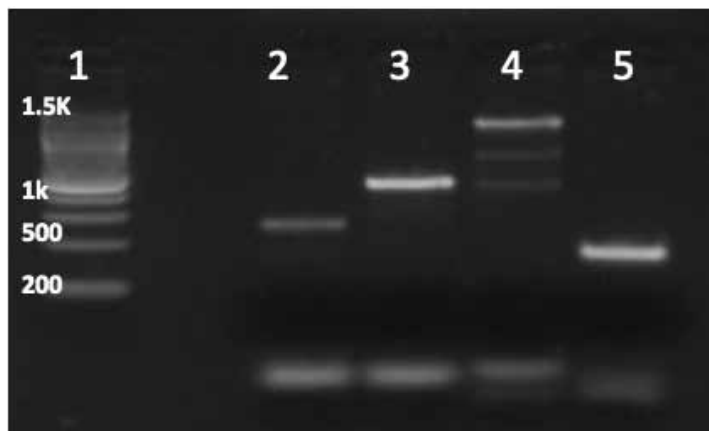
target. This created a 882 bp product. The primer sequence for the control UBP22 gene was as follows: UBP22 FWD 5' TGT TTA GGC GGA ACG GAT AC 3', UBP22REV 5' GCC AAA GCT GTG GAG AAA AG 3'. This created a 158 bp product. The cDNA products were incubated with primers and Life Technologies PCR Supermix in a PCR reaction to give amplified regions where the gene is being expressed. This product was examined by gel electrophoresis beside a UBP22 gene as a control for each sample to show the expression level present.

Results

The original PCR product, which was the promoter region for At2g42005, was amplified and extracted from a successful gel electrophoresis. There were two samples taken one from a larger and smaller band found and both from the gene At2g42005 from wild-type Arabidopsis since two different forward primers were used (Figure 1). Transformation of the bacteria *E. coli* yielded colonies that had the At2g42005 promoter/TOPO vector within them. After an enzyme digest with EcoRI, the gel generated had appropriate bands found in each sample tested (Figure 2). These samples were sent for DNA sequencing to confirm the proper DNA was cloned. Next, the At2g42005 promoter/TOPO DNA was used to create the Promoter:GUS vector using Gateway technology. The expected resulting vector was found in only two of the 12 samples taken from colonies that grew on the LB spectinomycin agar plates (Figure 3). To confirm the results of this vector prior to sequencing, a gel was run following a digest with the restriction enzyme BamHI to verify the results (Figure 4). Both of these clones have the At2g42005 promoter driving the expression of GUS in a binary vector capable of incorporating into the Arabidopsis genome.

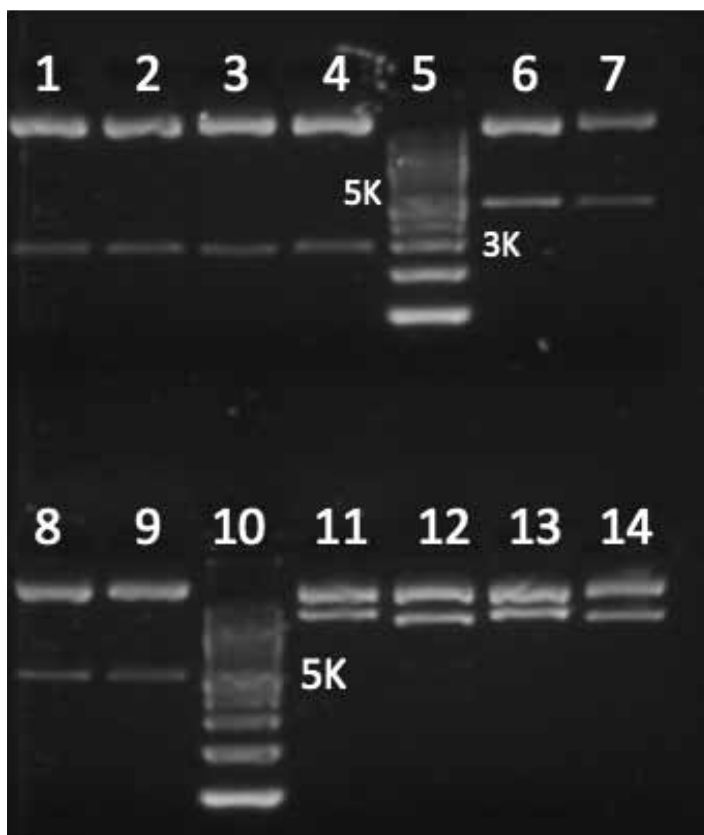
The RNA extraction and RT-PCR yielded evidence for At2g42005 expression in each tissue examined (Figure 5). At2g42005 expression was also detected in samples collected at stages 2 weeks and 6 weeks. The root, shoot, and whole seedling samples were collected from the 2-week-old plate-grown Arabidopsis. The stem, rosette leaf, cauline leaf, and flower samples were collected from the 6-week-old soil-grown Arabidopsis plants.

Figure 1. PCR Amplification of Promoter region of At2g42005.



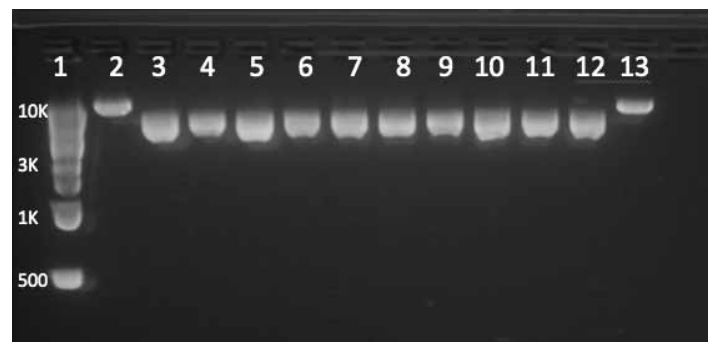
This gel has the following lanes: DNA (100bp) Ladder (1), At2g42005 Pro FWD/REV2 (2), At2g42005 UTR FWD/REV (3), At1g47670 FWD/REV (4), and UPB22 FWD/REV (5). The last two samples were used as positive controls and only the first two bands were cut out for DNA extraction. The UPB22 is an Arabidopsis housekeeping gene and is used as a positive control.

Figure 2. EcoRI Restriction Digest of At2g42005 promoter/TOPO vectors.



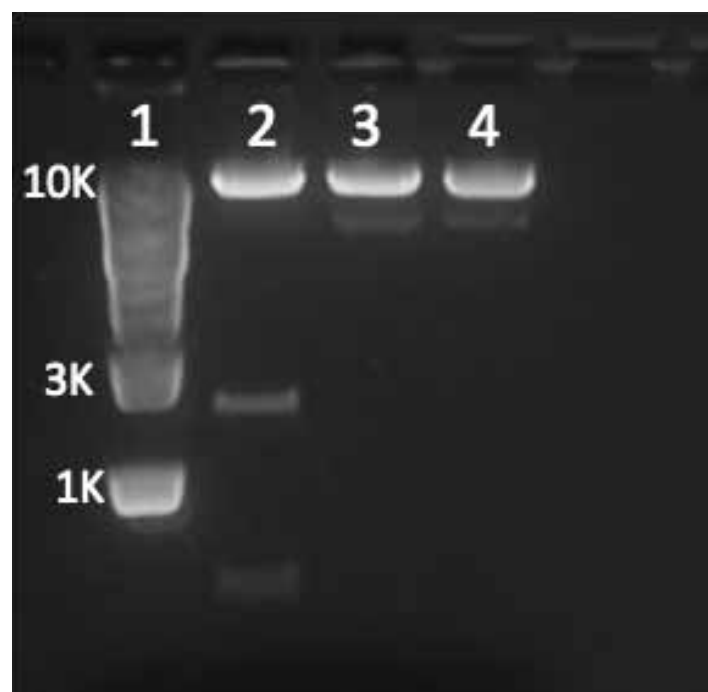
The top bands found on each sample show the TOPO vector present in the DNA samples. The first four lanes show results from cells transfected with At2g42005Small, with a DNA (100kp) ladder in the next lane (1-5). Lanes 6-9 show At2g42005Big cells with a DNA ladder in lane 10. Lanes 11-14 are from LHT8 transfected cells, another gene that is being studied for later uses (11-14).

Figure 3. Promoter:GUS BamHI Digestion Products.



This depicts a DNA (100kp) ladder (1) and multiple samples of At2g42005Big3 samples 1-6 (2-7) followed by At2g42005Big2 samples 1-6 (8-13). Based on the restricted mobility of the plasmid in the gel, the result shows that the only samples with correct Promoter: GUS insert are At2g42005Big3-1 (lane 2) and At2g42005Big2-6 (lane 13).

Figure 4. Restriction Enzyme (BamHI) digest to confirm the promoter: GUS vector.



RNA Expression Analysis

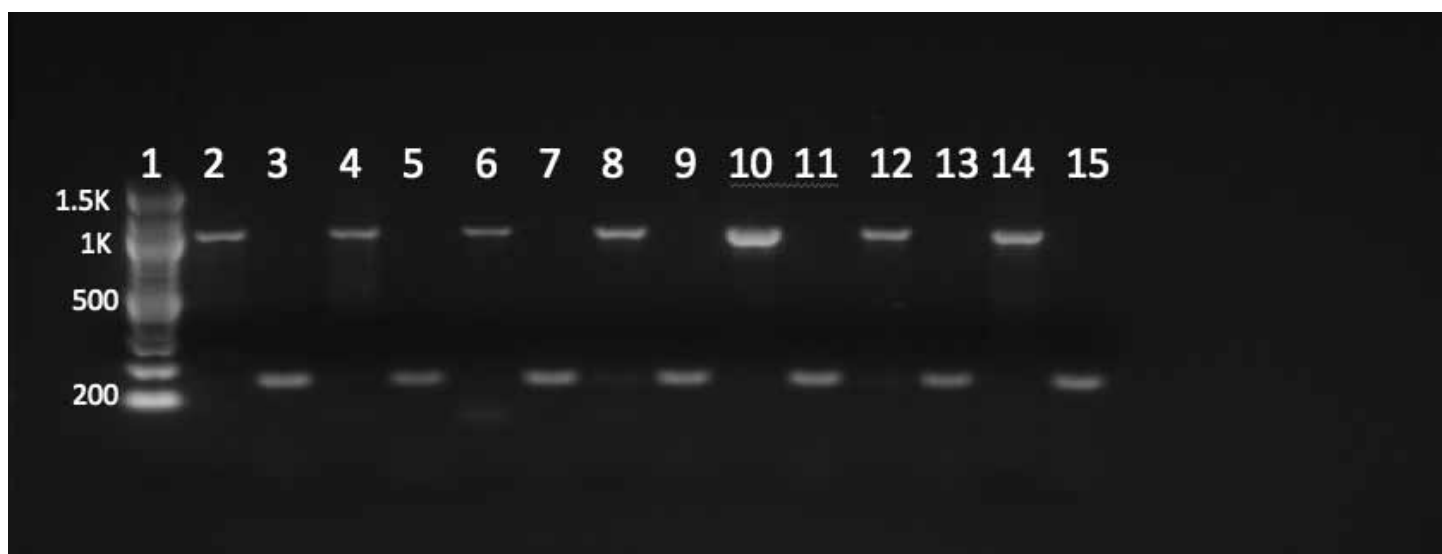


Figure 5. The various tissues collected and tested for expression levels of At2g42005 within them from wild-type Arabidopsis. Each sample has a corresponding UBQ22 control. The first lane is a ladder (1) followed by samples in even-numbered lanes and controls in the odd-numbered lanes. The samples were as follows: seedling (2-3), shoot (4-5), root (6-7), stem (8-9), flowers (10-11), rosette leaves (12-13), and cauline leaves (14-15). All tissues tested demonstrate expression of the At2g42005 gene.

This gel was conducted to verify the data found in Figure 3. The first lane is the DNA ladder (1), followed by: pBGWSF7 GUS binary vector as a positive control (2), At2g42005Big3-1 (3), At2g42005Big2-6 samples (4). The control is found to have multiple bands due to three cuts being made by the restriction enzyme; yet when the promoter is cloned into the vector properly one of those restriction sites is lost resulting in two cuts from the enzyme (lanes 3 and 4).

Discussion

The upregulation of the gene At2g42005 that initiated this study has much larger implications with nematode infection. Amino acids are a requirement for nematode nutrition (7). Since the nematode is unable to synthesize all the amino acids that they need, amino acid transporters are essential for the nematode infection process and a much needed area of study. This is due to the nematode's inability to synthesize all the amino acids that it needs (7). It has been shown with various other amino acid transporters which are similar to At2g42005, such as AAP6, that upregulation is found directly within the feeding cells that the nematodes induce (7). The damage created by nematodes redirecting amino acids for their own benefit is seen in crop plants globally. This is due to the sink effect the nematodes create with their genomic hijacking of the host plant which is defenseless to such infection.

The At2g42005promoter:GUS vector was created to be utilized later in research. This molecular tool will be introduced

into *Agrobacterium* for the transformation of flowering wild-type plants. By performing this next step, the plant can be GUS stained to visualize At2g42005 expression. Difficulties were encountered on the protocol at both the initial promoter amplification as well as the transformation of the final promoter: GUS product vector. The protocols were adapted to the specific gene being worked with and were successful afterwards.

The results for the RNA extraction and RT-PCR indicate that At2g42005 is being expressed throughout the entire plant and at multiple stages within its lifecycle. This was unexpected and causes a need for further investigation for the importance of At2g42005 within the plant. It was hypothesized that At2g42005 would be found expressed in the roots due to this being the site of nematode infection, but its expression elsewhere was unknown. The next stage of research will be to translate the qualitative data reported here and apply a quantitative approach. This will be done using qPCR to measure the various expression levels of At2g42005 within plant tissues. Overall, this study holds promise in the identification of the genes necessary to avert nematode infection without the use of nematicides.

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The Consumption of Children in a Capitalistic Society

JESSICA MELENDY



Jessica Melendy is senior graduating from BSU with a double major in Communication

Studies and English. The research for this project was conducted under the mentorship of Professor John Mulrooney in his Recent American Poetry course. Jessica will attend Emerson College's creative writing M.F.A. program next fall with a concentration in poetry.

Audre Lorde's, "Now that I Am Forever with Child", and Sharon Olds', "The Moment the Two Worlds Meet," juxtapose the natural aspects of childbirth with late capital methods of consumption and reproduction. In "Now that I Am Forever with Child", Audre Lorde describes her fetus as a budding flower but feels detached from it during and after delivery. Sharon Olds also uses the metaphor of an opening flower to demonstrate the climax of delivery in "The Moment the Two Worlds Meet." In both poems, the birth of the child is anticlimactic and disappointing for the mother who feels like an empty vessel. This dehumanizing of self is evident in both poems. These poets share a non-traditional, perhaps radically distorted, view of motherhood. This transformation, in which mothers are cold machines, allows the poets to critique the capitalistic system which necessitated that transformation in the first place. The contrast between nature and industry, presented in these works, illustrates capitalism as a negative effect on society, as far as the value of human life is concerned.

Audre Lorde uses her poem, "Now that I Am Forever with Child," to draw comparisons between natural childbirth and the capitalistic exploitation of fresh ideas. Lorde's speaker views herself as a shell carrying precious cargo rather than as a mother. The child is "blooming within" her (2) like a flower. She "remembers each upon each" (3) day that the baby grows like the development of "each" (3) new blossom. At a particular moment during the pregnancy, she recalls that she "thought" (6) the "fluttering" (5) baby "was [her] heart" (6), establishing the tangibility of life inside of her. Prior to this, the "swelling" (4) of her "body" (4) made her pregnancy obvious, but not "heart" (6) stopping. She credits the "swelling planes of [her] body" (4) with the "blooming" (2) of the baby. As the geometric proportions of her body "swell" (4), like a balloon, the flower grows. The realization that her "heart" (6) is not "fluttering" (5) indicates that she views the baby as having taken over her body. The fetus is valued higher than the vessel as she loses sight of her individuality.

Lorde uses time as a way to fuse nature with industry. She explains that "the days wound down" (7), like a clock, and that "winter" (8) approached, like the "turning" (8) of a page. These harsh depictions of winter and time correlate with her speaker's attitudes alert the baby, who is "growing heavy/ against the wind" (9/10) and sucking the life out of her. This stark visualization

directly relates to her speaker's lack of emotion as the birth approaches. Instead of warm excitement, she robotically lists the developmental progress that the child is making. She says, "now her hands/ are formed" (11/12), "now her teeth are done" (14) and "now she sneezes"(15). As time passes, she starts to depict herself as an oven waiting for the baby to reach the right temperature. The more Lorde's speaker humanizes the child within her womb, the less alive she seems.

The birth of the child separates Lorde's speaker from the baby and establishes a narrative in which the natural is divided from the unnatural. Lorde uses sexual imagery during the birth, as the act of "sneezing" (15) initiates the opening of the "seed" (16). Sex is natural and brings warmth into the poem, establishing the ultimate setting for its climax. The "sneeze" (15) is the orgasm and the "seed" (16) that "opens" (16) is her speaker's cervix. As the child passes through, the umbilical cord functions as the stem and the uncurling baby is the blossoming bud. The child initiates the sexual activity as it transitions from a fetus to a flower. Opposing this verdant illusion that the child is a ripening flower unfolding itself for the first time is the corresponding abrasiveness of the mother as a machine.

Lorde speaks as though it is an obligation and duty to birth the fetus. She unemotionally and methodically states, "I bore you one morning just before spring" (17). The colorful feelings associated with "spring" (17) and "morning" (17) are darkened by the coolness of the word "bore" (17). As the child is "blooming" (2) from her uterus, like a flower in "spring"(17), she turns her attention to the inner workings of her brain. She uses the explosive imagery of a mechanism to recall how her "head rang like a firey piston" (18). Her "legs" (19) become "towers between which/ a new world [passes]" (19/20). These references to machinery and industry reflect Lorde's perspective on childbirth as mechanical productivity.

Lorde, a New Yorker of Caribbean decent, describes a "new world" (20) that passes through the "towers" (19) of her speaker's legs. It is not too far to suggest that this is collinear with tower constructions such as the twin towers of the World Trade Center in New York City. It is the birth of a conscious thought that Lorde is describing in "Now that I Am Forever with Child". As the "new world" travels through the "towers" of her "legs," it is physically being consumed by capitalism. After the thought is formed, birthed, and initiated it is automatically reproduced as a new product to be shared and exploited. This models a capitalistic approach to reproduction. The idea, like the "blooming" (2) flower, will be cut and sold creating the necessity for replenishment. Because she is hanging on by a "thread" at the end of the poem, "flowing through selves/ toward [the thing produced]," it is clear that the speaker is

reliant on the process that validates her existence (24/25). Thus, the mother's value is only sustained through frequent reproduction.

Similarly, in "The Moment the Two Worlds Meet," Sharon Olds establishes a relationship between reproduction and consumption. Like Lorde, Olds's speaker lacks emotion as she describes the fetus as an "it" throughout the poem. Her position during the birth is like that of a machine producing some sort of new product. The baby is "slick" (Olds 2), "glistening" (7), "shining" (7), "with thick liquid on it" (7) and covered with "grease" (23). The people present are like workers on a conveyer belt guiding the new product along. After the "slick whole body comes out" (2), the doctors, like factory workers "pull it" (3) and "steady it" (3) as "it pushes forth, not catch it, but keep their/ hands under it as it pulses out" (4/5). The workers are the "first to touch it" (6) and the "you" (24) is last because Olds is completely separated from the occasion.

As the product is "sliding" (8) along the conveyer belt, Olds's critique of consumption becomes more evident. During this section of the poem she is conveying the image of a grocery store. She describes the "limbs" (8), as they are "compressed close to the body" (9), like a "crab's rosy legs" (10). She continues to make references to food as she describes "the/ thighs closely packed like plums in heavy syrup, [and] the legs folded like the white wings of a chicken" (11/12). She calls the baby a "juiced bluish sphere" (14). She uses the geometric "sphere" (14), like Lorde's "planes" (Lorde 4), to create distance between the child and the mother. As the "baby is/ sliding between the two worlds" (14/15), Olds declares that it is "wet- like sex" (16). The idea that consumption and reproduction unite during sex is "the center of life" (13). The consumption of sex naturally produces a child like the consumption of food always produces the need for more food. This comparison confirms that Olds is suggesting that material production is of the same importance to consumers as human reproduction.

Like Lorde's speaker, Olds's speaker uses the illustration of a blooming flower to naturalize childbirth in a highly sexualized manner. Technically, "it *is* sex" (16) because labor is like the "opening back and back" (17) of the vagina, cervix and birth canal. She refers to the cervix as a "bud" (18), reminiscent of Lorde's, "seed" (Lorde 16). Once the "bud" (Olds 18) is "stripped" (18) it "thrust[s]" (19) and "peels itself" (19) to reveal a "flower" (20). Like the "bent" (10) legs of the "crab" (10), the flower is "severely folded" (20). After it "begins to open and dry" (21), Olds's speaker abruptly changes her attitude towards the blossom because the "the moment is over" (22). The process is anticlimactic. Like a freshly birthed item on a conveyer belt, "they wipe off the grease and wrap the child

in a blanket and/ hand it to *you* entirely in this world” (23/24). Olds finally uses the word “child” (23) in the last sentence of a poem that sounds as if it takes place in a harsh, oily, factory or grocery store. The stuff produced in the factory and sold in the grocery store is valued just as high as a “child” (23). The people are “wip[ing] off the grease” (23) and “wrap[ping] it in a blanket” (23) like they are in a packaging plant rather than at a hospital. When Olds finally states that they “hand it to you entirely in this world” (24), she is speaking to consumers. “The Moment the Two Worlds Meet” is actually the moment in which the consumer purchases the products made by the machine.

Jon Clay, considering modernist poetry, noted that “western poetry is bourgeois to the extent that the society out of which it is produced is a bourgeois society” (38). For these modern poets, the tensions of late capital are even more problematic. Audre Lorde and Sharon Olds relate the reproduction of human life with the reproduction of raw material goods and parallel consumption and reproduction in both natural and industrial settings. In her book, *I Am Your Sister*, Audre Lorde says that the “capitalist structure is a many headed monster” (48). In “Now that I Am Forever with Child,” she explains that she “can only distinguish/ one thread through running hours/ You.... Flowing through selves/ toward you” (22/25). Like a woman in a textile factory reproducing the same sweater, she is holding onto “thread[s]” (23) that will always “flow through selves” (24), or through other “threads” (23), towards the final product. The title, “Now that I Am Forever with Child,” is indicative of this entrapment of self in a capitalistic society.

Sharon Olds’s critique of capitalism is less ambiguous. The word “moment” is substantial in that it transitions the poem from critique to critique. The first time that she uses it, in line one, she is a machine releasing metallic objects for factory workers to guide and sort. The second time it is used, on line 8, the thing produced is described as food being sold at a grocery store. The third time that it is used, on line 13, she is incorporating natural reproduction with sex into the rest of the poem. The fourth time that it is used, on line 22, she pulls the poem together to critique the process as a whole. As the poem progresses, the product becomes more human. At first it is an object, then it is food, then it is a flower, then it is a “child” (23). This progression of importance suggests that children are

the most desirable things to consume. Once the novelty wears off, “the moment is over” (22), and it’s time to make something new.

Audre Lorde and Sharon Olds attack capitalism in these poems. In “Now that I Am Forever with Child,” Lorde criticizes the exploitation of fresh ideas that establish industry. In “The Moment the Two Worlds Meet,” Olds positions herself as a giant machine spitting out products that are born purposely to be devoured by consumers. Both poets use the representations of flowers and babies to contrast the caustic causalities of commerce as it leads to the destruction of such innocence. In the end, however, the concept of reproducing something that is immediately going to be consumed concerns the poet. The difficulty for us, as consumers of these poems, is the anticlimactic feel of a newborn product stemming from the capitalistic approach that more is more. Hence, it is impossible to enjoy the novelty of something because it is automatically old by default. The exploitation, consumption and reproduction of babies, flowers, food, thoughts, objects and sex is making it difficult for us to quench our thirst because overabundance has made it impossible to taste anything. In these poems, Lorde and Olds are expressing their concern for the ethicality of future generations, as they fear that capitalism is creating a world in which society is increasingly incapable of satiating hunger.

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Early to Bed, Early to Rise: How Changing to an Earlier School Start Time Affects Sleep Patterns and Cognitive Functioning in School-Aged Children

LAURA PISTORINO



Laura Pistorino graduated with honors from BSU in May of 2012 with an undergraduate degree

in psychology. This pilot research began in 2011 as part of the Adrian Tinsley Program Summer Grant, mentored by Dr. Sandy Nearing. Laura has presented this pilot study at the 2011 Undergraduate Summer Research Symposium. Since graduating, Laura has completed the follow up study, which was presented at the National Sleep Foundation's Sleep Health & Safety Conference in Washington D.C. in March 2013. Laura is currently working as a research assistant at Boston University's Vision and Cognition Laboratory, with plans to apply to graduate programs in psychology.

The purpose of this project was to elucidate the impact of earlier school start times on elementary school children. Research demonstrates that adolescents are chronically sleep deprived due to shifting biological rhythms and early school start times. As a result, some schools have restructured their schedules to allow for later start times for middle and high school students. This change has inadvertently resulted in earlier start times for the elementary school students. Although studies demonstrate a positive impact of later start times for adolescents, no studies have examined younger children. This project, therefore, examined the effect of an earlier start time on the sleep patterns of elementary school students, as well as assessed correlations between sleep and cognitive functioning. Two groups of second graders (an experimental and control group) were followed for one-year; one experienced an earlier school start time in third grade, and the other did not. Measures of actigraphy and survey data were obtained. Results demonstrated that changing to an earlier school start time may cause school-aged children to obtain less quality of sleep, and experience a higher rate of daytime sleepiness. Because of the limited sample size included in this study, results are dependent on a larger scale experiment which will be completed within the next year.

Sleep is an essential aspect of daily human functioning playing an important role in health and cognition. Psychologists and medical professionals have proposed various theories pertaining to the significance of sleep. The repair and restoration theory and the information consolidation theory are among the most commonly investigated and supported (Magee, 2010; Park, 2010; Stickgold, 2005; Durrant, 2011). These theories suggest that we sleep in order to regain health and consolidate information, respectively. As such, when we experience sleep deprivation, both physiological functioning and cognitive performance suffer (Chee, 2010). This is especially true during the teenage years when a sleep shift takes place (Carskadon, 1993). A shift in sleep may occur as the result of a biological change, which accompanies adolescence, thereby altering circadian rhythms (Wolfson, 1996). As the circadian rhythm is thrown off course, sleeping schedules begin to change.

A number of researchers have examined how this shift affects cognitive functioning in adolescents. For example, Randazzo (1998) assigned adolescents (aged 10-14) to one of two groups: the control group (sleeping 11 hours for one night), or the experimental group (sleeping 5 hours for

one night). Differences between the two groups were found on the Wisconsin Card Sorting Test (WCST), which is a measure of executive function after a single night of restricted sleep. Also, Wolfson's (1998) research demonstrated that a dramatic decrease in total sleep time for adolescents was associated with significant cognitive deficits. Students who described themselves as struggling or failing school (receiving grades of C's, D's, or F's) reported that on school nights they received 25 minutes less sleep and went to bed an average of 40 minutes later than students who received A's or B's for grades.

Because of the abundance of research supporting that a sleep shift occurs in adolescents, keeping these teenagers awake longer into the night (Mindell, 1999; Beebe 2009; Carskadon et al. 1993; Wolfson 1996), many school administrations have pushed an earlier high school start time to a later start time. This change allows the adolescent students to receive a more adequate amount of sleep, which in turn is believed to reduce cognitive deficits apparent in this group due to lack of sleep. One community who decided to make this change was Duxbury, Massachusetts. However, because Duxbury, like many local communities, has a tiered bus system, pushing the high school start time to a later slot inadvertently placed the elementary school in Duxbury (grades 3-5) to the early slot that the high school students once occupied. The elementary school now has an earlier start time than the early education school (grades K-2) and the junior and senior high schools. While 2nd graders in Duxbury begin their school day at 9:10 A.M., 3rd grade students now start school at 7:45 A.M.

As these children in Duxbury enter 3rd grade, their parents are concerned that the earlier school start time in elementary school will alter the sleep and cognitive functioning of the students, similar to the effect seen in adolescents start school early. However, little research has been conducted on the effect of an earlier school start time on school-aged children. Some studies suggest that, similar to general sleep findings, sleep quantity and quality are associated with cognitive performance in children (Lavigne, 1999; Suratt, 2007; Tremaine, 2010). However, there is a gap in the literature on how sleep patterns in school-aged children are affected by changes in school start time.

Students at the elementary school in Duxbury, Massachusetts, grades 3-5, now start school at 7:45 A.M., however the younger students (K-2nd grade) start school at 9:00 A.M. This is a dramatic shift in start times. The present research aimed to elucidate the effects that changing to an earlier school start time has on the sleeping patterns and cognitive functioning of school-aged children. To do this, the sleep and cognitive functioning of a sample of Duxbury students was evaluated as

they transitioned from 2nd to 3rd grade (experimental group), with a sample of students from Pembroke, Massachusetts, where the 2nd grade students started school at 9:00 A.M., and did not experience a shift in start times in 3rd grade (control group). Measures of sleep were gathered through an actigraphy device (a watch-like device that detects movement to gather sleep/wake activity). Cognitive functioning was assessed through tests of executive functioning. Both groups were tested twice, once while in 2nd grade (Time 1), and again while in 3rd grade (Time 2). Although this study primarily focused on measures of sleep and actigraphy data, correlations were examined between these measures and cognitive performance. Because it was unknown whether the shift in school start time would adversely affect the experimental group, this experiment was tested as a two-tailed hypothesis.

METHOD

Participants

Participants included a total of 10 students: four Duxbury 2nd grade students (0 males, 4 females), who served as the experimental group, and six Pembroke 2nd grade students (3 males, 3 females), who served as the control group. The original pilot project contained 11 participants, however one female from Duxbury dropped out of the study due to schedule conflicts. The age range of the participants was 7-10 years old. Participants were tested twice, once in the spring of 2011 (Time 1 – 2nd grade) and once in the spring of 2012 (Time 2 – 3rd grade). They were recruited as a convenience sample, contacted through friends and family, who suggested children that they knew would qualify for the study. The town of Pembroke is very similar in socioeconomic structure to Duxbury, and was also chosen because the school's start time for 2nd grade students is very similar. Duxbury's school start time for 2nd graders is 9:00 A.M., and Pembroke's 2nd grade students start at 9:10 A.M. Once the Duxbury students go on to 3rd grade, they begin school at the now altered start time of 7:45 A.M., while Pembroke students return to school in the 3rd grade with the same school start time as the previous year.

Children were excluded from the study based on parent report of a neurodevelopmental disorder or a psychiatric disorder based on the Child Behavior Checklist, report of sleep disordered breathing based on the Children's Sleep Habits Questionnaire, and/or report of child taking medications that impact sleep (psychostimulants). Informed parental consent and child assent approved by the Boston University Medical Center Campus Institutional Review Board was obtained for this project.

Sleep Measures and Procedures

The primary measures for this study examined sleep using an actigraph and sleep questionnaires.

Actigraph. Ambulatory Actigraphy (AW-64, Respironics, Bend, CO) (Sadeh, 1989) is a watch-like device that is worn on the non-dominant wrist and is used to collect and download continuous, objective, long-term sleep/wake data. The actigraph works by detecting movements. For every 1-minute period, the actigraph sums up the number of movements, the data of which are displayed on a graph. The actigraphy device and software allows researchers to collect data on sleep objectively. This is important for obtaining unaltered results. Many early sleep studies, as well as sleep studies today, have participants sleep in a lab. The participant is taken away from his or her natural sleeping environment, which can make it difficult to obtain reliable and valid results. The sleep measures provided by the actigraphy device and software have been validated against polysomnography (a medical sleep study) with agreement rates for minute-by-minute sleep/wake identification of higher than 90% (Sadeh, 1989). For these reasons, actigraphy devices were used in this study, as it may provide more accurate and realistic sleep data than if participants were instructed to sleep in a lab.

The children and parents who participated in this study were educated briefly on how to wear the watch continuously for the three-day period, and to maintain their regular sleeping schedule as much as possible. The actigraph is completely waterproof, so participants were instructed not to remove it even when showering or bathing. After wearing the device for three days, the actigraph was collected from the participants. Sleep variables obtained from the actigraphy device that were examined in the current project included: Sleep Efficiency, and Sleep Fragmentation. Sleep Efficiency is the percentage of total sleep time divided by actual sleep period. Sleep Fragmentation happens when there are several disturbances in sleep that last a brief duration. Sleep disturbances throughout the night reduces the total amount of time spent in deeper levels of sleep. Sleep Fragmentation as seen on an actigraphy data graph appear as random spikes of movement among periods of very few spikes, or sleeping periods. These measures of sleep were chosen because of their relevance to quality of sleep and measure of sleep patterns, as shown through previous research (Banks, 2007; Sadeh, 2002).

Child Sleep Habits Questionnaire. To obtain subjective sleep data, the participants' parents completed the Children's Sleep Habits Questionnaire (or CSHQ) (Owens, 2000). Variables provided by the CSHQ include: Sleep Duration, Night Wakings, and Daytime Sleepiness. Sleep Duration was assessed

using the parent's responses (scaled as "usually," "sometimes," or "rarely") to several prompts, including: child sleeps too little, child sleeps the right amount, and child sleeps the same amount each day. Night Wakings were scored the same way in response to the following prompts: child moves to other's bed at night, child awakes once during the night, and child awakes more than once during the night. Similarly, Daytime Sleepiness was assessed based on parent's responses ("usually," "sometimes," or "rarely") to the following: child wakes by himself, child wakes up in a negative mood, others wake child, child has a hard time getting out of bed, child takes a long time to be alert, child seems tired, during the past week child appears tired or falls asleep watching television, and during the past week child appears tired or falls asleep while riding in the car. The parent also reports if each item is a problem for the child. Responses were scored, allowing for the assessment of children's sleep on six measures (three from the actigraphy device and three from the CSHQ).

The children also received the Child Behavior Checklist (Achenbach, 2001) to screen for any neurodevelopmental or psychiatric conditions. The parents completed the questionnaires as their children were fitted with the actigraphy devices. All children performed normally on this measure so no children were excluded based on their responses.

Cognitive Measures and Procedures

After wearing the actigraph for three days, each child was met by a laboratory staff member for the neuropsychological testing. The battery was 15-20 minutes in order to minimize participant burden and contained standard tests of executive functioning and sustained attention. Measures of executive function and sustained attention were used in this study as they have been shown to be cognitive measures that are sensitive to sleep (Beebe et al., 2009; Zerouali, 2010). Two tests were used for the current study, the Conner's Continuous Performance Test (CPT-II) and the Digit Symbol Coding subtest from the Wechsler Intelligence Scale for Children, 4th edition. Although results of the cognitive measures are not discussed in this paper, descriptions of the measures are given below as the results include the correlation analysis between the sleep measures and cognitive performance.

CPT II. The CPT-II is a computerized test of sustained attention and response inhibition. The children are instructed to press the spacebar every time a letter is shown on the screen, except for the letter "X." They are told to work as quickly as possible while still being as accurate as possible. The test lasts about 15 minutes. Participants complete a practice test beforehand to ensure that they understand what they are being asked to do. The CPT-II measures assessed in this study include: *Omission*

Errors, i.e. responding to the “X” (test-retest reliability .84), *Commission Errors*, i.e. not responding to letters other than “X” (test-retest reliability .65), and *Hit Reaction Time* (test-retest reliability .55; Corkum, 1993).

Digit Symbol Coding Test. The Digit Symbol Coding Test is a test of attention and speed of processing. The present study used a written version of this test. The children were given a paper, the top of which has boxes with the numbers 1-9. Below the row of numbers are boxes with symbols that are paired with each number. The children are taught that each number corresponds to a unique symbol. At the bottom of the paper are more rows of boxes with numbers in random order, but below them the boxes are blank. The children are instructed to fill in the blank boxes with the corresponding symbol. Once the participants understand the test, they complete a practice section. Again, participants are told to work as fast and accurately as possible. Once ready, they begin the real test, and keep working for a total of 120 seconds, when they are told to stop. After, they are asked to write down as many of the symbols as they can remember. The Digit Symbol Coding Test measures average response latency (in seconds). For this study, performance on the Digit Symbol Coding subtest was measured using two variables: *Total Correct Responses* and *Total Incorrect Responses*.

RESULTS

Between-Group Comparisons

Because this was a pilot study with a small number of participants, nonparametric tests were used to analyze the data. The control and experimental groups were compared across all measures of sleep using the Mann-Whitney U test. They were compared on three measures of the CSHQ and three measures of the Actigraph at two different times: when both groups were in 2nd grade and when both groups were in third grade. Given that school times were equivalent in 2nd grade, one would not expect to see any group differences between the control and experimental participants. If school start times do affect measures of sleep, differences between groups should be observed when both are in 3rd grade, given the different school start times for each group. See the top half of Table 1 for a summary of the following results.

Comparisons on the CSHQ. While in 2nd grade, Sleep Duration in control participants ($Mdn= 3.00$) did not differ significantly from participants in the experimental group ($Mdn= 3.00$), $U= 12.00$, $z = .00$, $p = 1.00$. When in 3rd grade, Sleep Duration in the control group ($Mdn= 3.00$) did not differ significantly from the experimental group ($Mdn= 4.00$), $U= 4.50$, $z = -1.83$, $p = .07$. While not significant, the experimental

Table 1. Summary of Results

	Control vs Experimental Time 1	Control vs Experimental Time 2
CSHQ		
Sleep Duration	n.s.	$p= .067$ (lower in controls)
Night Wakings	n.s.	n.s.
Daytime Sleepiness	n.s.	$p < .05$ (lower in controls)
Actigraph		
Sleep Efficiency	n.s.	n.s.
Sleep Fragmentation	n.s.	n.s.
	Time 1 vs Time 2 Control	Time 1 vs Time 2 Experimental
CSHQ		
Sleep Duration	n.s.	n.s.
Night Wakings	n.s.	n.s.
Daytime Sleepiness	n.s.	n.s.
Actigraph		
Sleep Efficiency	$p < .05$ (higher in Time 2)	n.s.
Sleep Fragmentation	$p < .05$ (lower in Time 2)	n.s.

participants were sleeping slightly longer than controls ($p = .07$). See Figure 1.

Night Wakings in control participants ($Mdn= 3.00$) did not differ significantly from the experimental group ($Mdn= 3.50$) during 2nd grade, $U= 7.50$, $z = -1.19$, $p = .24$. Night Wakings in 3rd grade were not significantly different between control ($Mdn= 3.00$) and experimental ($Mdn= 3.00$) groups, $U=9.00$, $z = -1.23$, $p = .22$. See Figure 2.

During 2nd grade, the experimental group ($Mdn= 9.50$) did not differ significantly from the control group ($Mdn= 8.00$) on measures of Daytime Sleepiness, $U= 5.00$, $z = -1.61$, $p = .11$. However, Daytime Sleepiness in the control group ($Mdn= 8.50$) was significantly lower than the experimental group ($Mdn= 11.00$) while in 3rd grade, $U= 1.00$, $z = -2.41$, $p < .05$, $r = -.76$. See Figure 3.

Comparisons on the Actigraph. While in 2nd grade, Sleep Efficiency did not differ significantly between control ($Mdn=$

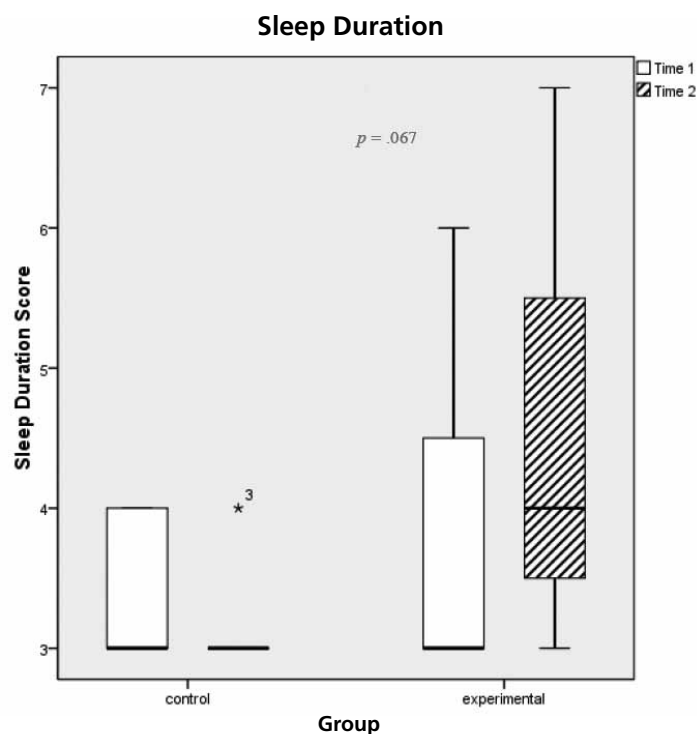


Figure 1. Here a boxplot graph is used to graph the nonparametric distribution of our sample. The thick line inside of the box represents the median. The lines above and below the colored boxes show the maximum and minimum scores, respectively. Sleep Duration was scored using the parent reported answers on several questions of the Child Sleep Habits Questionnaire. A higher score represents longer sleep duration. During Time 2, all of the control participants scored a 3, except for one participant who scored a 4 (as shown by the black asterisks). No significant differences were found in Sleep Duration, however a trend ($p = .067$) was found between control and experimental groups during Time 2 (as marked by the red connecting line).

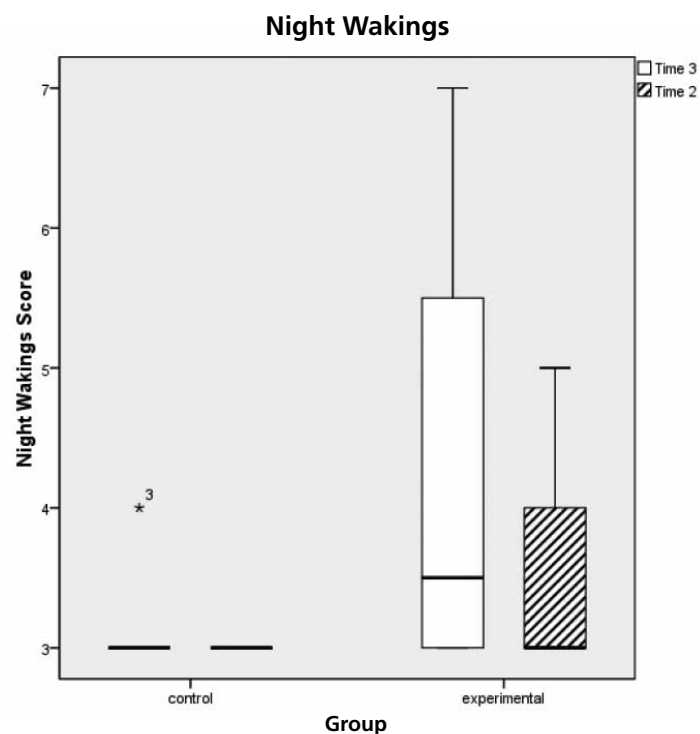


Figure 2. Night Wakings was scored using the parent reported answers on several questions of the Child Sleep Habits Questionnaire. A higher score represents a higher frequency of waking during a night of sleep. All of the control participants scored a 3 during both Time 1 and Time 2, except for one participant who scored a 4 (as shown by the black asterisks). No significant differences were found in Night Wakings.

changed in their sleep performance from 2nd grade to 3rd grade, a series of nonparametric tests were performed for each sleep variable. Because school-start times remained the same for the control group from 2nd to 3rd grade, no significant differences should be found. For the experimental group, if changes in school-start times adversely affected the children, poorer sleep performance should be noted in 3rd grade compared to 2nd grade. The Wilcoxin Signed-Rank Tests was used to compute these comparisons. See the bottom half of Table 1 for a summary of the following results.

Comparisons on the CSHQ. Sleep Duration for the control group did not significantly differ between 2nd grade ($Mdn= 3.00$) and 3rd grade ($Mdn= 3.00$), $z = -.58$, $p = .56$. The experimental group did not have any significant differences in Sleep Duration from 2nd grade ($Mdn= 3.00$) to 3rd grade ($Mdn= 4.00$), $z = -.74$, $p = .46$. See Figure 1.

The control group also did not differ significantly on measures of Night Wakings between 2nd grade ($Mdn= 3.00$) and 3rd grade ($Mdn= 3.00$), $z = -1.00$, $p = .32$. Night Wakings were also not significantly different from 2nd grade ($Mdn= 3.50$) to

75.04) and experimental ($Mdn= 66.56$) groups, $U= 7.00$, $z = -1.07$, $p= .29$. On measures of Sleep Efficiency, control participants ($Mdn= 83.08$) were not significantly different from experimental participants ($Mdn= 80.96$) during 3rd grade, $U= 4.00$, $z = -1.29$, $p = .20$. (See Figure 4). Note that each figure consists of the between groups results reported here and the within group results reported in a later section.

Sleep Fragmentation in control participants ($Mdn= 20.30$) was not significantly different from experimental participants ($Mdn= 23.78$) during 2nd grade), $U= 7.00$, $z = -1.07$, $p = .29$. During 3rd grade, control participants ($Mdn= 16.77$) did not differ significantly from experimental participants ($Mdn= 14.90$) on measures of Sleep Fragmentation, $U=6.00$, $z = -.78$, $p = .44$. (See Figure 5).

Within-Group Comparisons

To examine how each group (control and experimental)

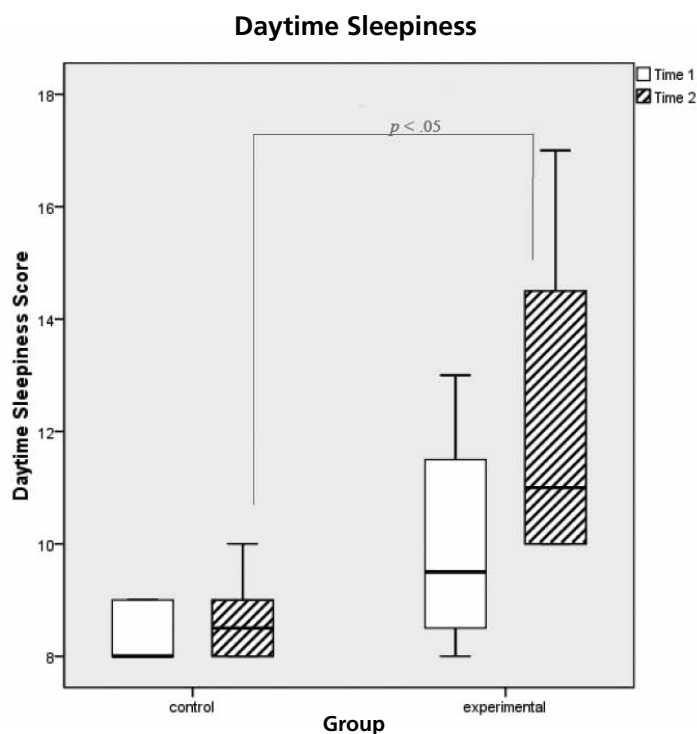


Figure 3. Daytime Sleepiness was also scored using the parent reported answers on several questions of the Child Sleep Habits Questionnaire. A higher score represents more sleepiness during the daytime hours. The only significant difference found was between control and experimental groups during Time 2 (as marked by the red connecting line), where controls were experiencing less Daytime Sleepiness.

3rd grade ($Mdn = 3.00$) in the experimental group, $z = -1.34$, $p = .18$. (See Figure 2).

Daytime Sleepiness did not differ significantly from 2nd grade ($Mdn = 8.00$) and 3rd grade ($Mdn = 8.50$) for the control participants, $z = -1.00$, $p = .32$. Experimental participants did not significantly differ on measures of Daytime Sleepiness between 2nd grade ($Mdn = 9.50$) and 3rd grade ($Mdn = 11.00$), $z = -1.07$, $p = .29$. (See Figure 3).

Comparisons on the Actigraph. Control participants had significantly higher Sleep Efficiency during 3rd grade ($Mdn = 83.08$) than during 2nd grade ($Mdn = 75.04$), $z = -1.99$, $p < .05$, $r = -.63$. In the experimental group, Sleep Efficiency was not significantly different between 2nd grade ($Mdn = 66.56$), and 3rd grade ($Mdn = 80.96$), $z = -1.60$, $p = .11$. (See Figure 4).

Sleep Fragmentation was significantly lower in 3rd grade ($Mdn = 16.77$) than in 2nd grade ($Mdn = 20.30$) for control participants, $z = -2.20$, $p < .05$, $r = -.70$. Sleep Fragmentation was not significantly different between 2nd grade ($Mdn =$

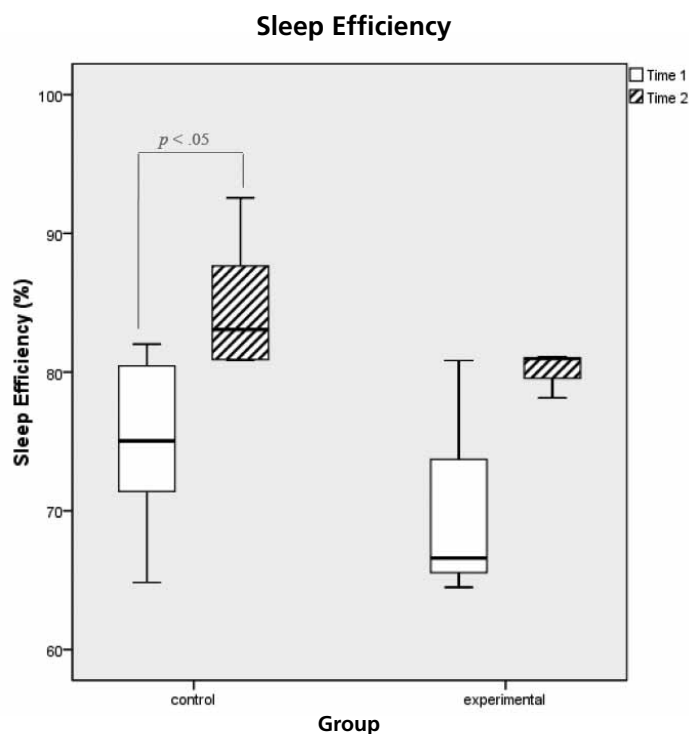


Figure 4. Sleep Efficiency was calculated using the actigraphy device, and is the percentage of total sleep time divided by actual sleep period. A higher percent represents more time asleep during a sleeping period. The only significant difference found was between Time 1 and Time 2 for the control participants, where controls in Time 2 had a higher Sleep Efficiency.

23.78) and 3rd grade ($Mdn = 14.90$) in the experimental group, $z = -1.60$, $p = .11$. (See Figure 5).

Correlations Between Sleep and Cognition

To compare the sleep variables in the present project with the cognitive variables, a series of Spearman Rho correlations for each group was performed: experimental 2nd grade, experimental 3rd grade, control 2nd grade, and control 3rd grade. It was expected that some significant correlations would be noted between sleep and cognition.

No significant correlations using Spearman's Rho were found between sleep and cognition in the experimental group in either 2nd or 3rd grade. However, while in 2nd grade, the experimental participants showed a trend in the correlation between Night Wakings and scores on the CPT-II: *Hit Reaction Time* ($p = .051$; $r = .95$), *Omission Errors* ($p = .051$; $r = .95$) and *Commission Errors* ($p = .051$; $r = -.95$). While in 3rd grade, the experimental group showed another trend between Sleep Duration and *Commission Errors* ($p = .051$), and between Sleep Duration and *Hit Reaction Time* ($p = .051$).

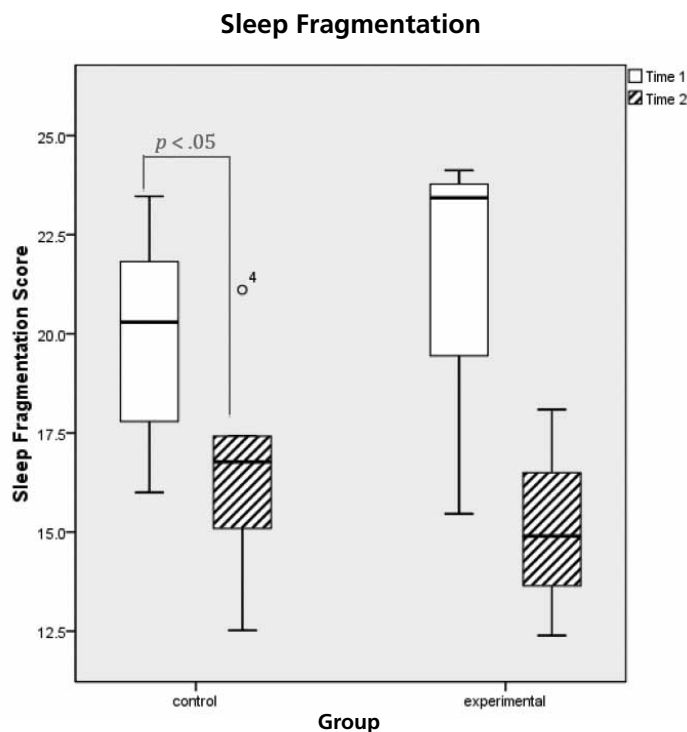


Figure 5. Sleep Fragmentation happens when there are several disturbances in sleep that last a brief duration. Sleep disturbances throughout the night reduce the total amount of time spent in deeper levels of sleep, and is measured using the actigraphy device. There was one outlier in the control group during Time 2 (marked by the circle). There was a significant difference between Time 1 and Time 2 for the control group, where controls had less Sleep Fragmentation during Time 2.

No significant correlations were found between sleep and cognitive performance in the control group during 2nd grade. However, during 3rd grade, the *Hit Reaction Time* of control participants was positively significantly correlated with Daytime Sleepiness ($p < .04$).

Discussion

Despite the small sample included in this pilot study, some interesting results were found that need to be further examined. The analysis showed no significant results between control and experimental groups during Time 1 (2nd grade). This implies that the two groups were equal on measures of sleep before the manipulation of school start times during Time 2. This is important because if the two groups were not equally matched it would not be possible to compare them after changing school start times.

During Time 2, sleep in the experimental group differed significantly from the control group. The experimental participants, after experiencing a change to an earlier start time, displayed a significantly higher rate of Daytime Sleepiness, and,

though not significant, a trend ($p = .07$) toward a longer Sleep Duration than the control participants. While the experimental group may have been sleeping longer to compensate for the earlier start time, they demonstrated poorer quality sleep, leading to a higher rate of Daytime Sleepiness. These results indicate that starting school at an earlier time decreases the quality of sleep obtained by school-aged children. It may be that because there is a change in their daytime schedule, the experimental participants are not able to reach a deeper level of sleep during the night. Sadeh et al. (2002) suggests that, in adults, Daytime Sleepiness may be an adverse factor resulting not from less quantity of sleep, but rather from a decrease in deeper and more restorative sleep stages. This may explain why the experimental group is trending toward a longer Sleep Duration, but has significantly increased Daytime Sleepiness; however this has never been fully examined in children this age. Future studies should examine the underlying sleep stages during a night of “poor quality” sleep in children, and its effect on daytime functioning.

Epstein’s (1998) results further support this finding. He evaluated the sleep and daytime functioning of 811 fifth grade students using actigraphy devices, as well as self-report questionnaires. Those children who were considered “early risers” (starting school at 7:10 A.M.) reported a higher rate of daytime fatigue, and sleepiness than those children who were “regular risers” (starting school at 8:00 A.M.). This finding is particularly interesting and may be vital information for parents, caregivers, and school faculty to be aware of. People may assume that because their child is sleeping an appropriate amount, they are obtaining adequate sleep. However, these preliminary results suggest that this may be false – sufficient quantity of sleep may not always indicate sufficient quality of sleep.

Results also provided some evidence that the control group experienced an improvement in sleep between Time 1 and Time 2, as Sleep Efficiency increased, and Sleep Fragmentation decreased. However, the experimental group did not show any significant changes in sleep between Time 1 and Time 2 (see Table 1). Instead of a decrease in quantity or quality of sleep, a lack of improvement (like the one seen in the control group) was observed in the experimental group between 2nd and 3rd grade. While this finding is not addressed in the literature on children’s sleep habits, it has been shown that children do not experience a major biological shift, such as puberty at adolescence, their circadian rhythms are not altered, and their sleep is unaltered. This finding may implicate that this age group should be obtaining improved quality and quantity of sleep as they develop before adolescence. Literature shows that children can begin altering their sleep patterns as early

as 11 years of age (Wolfson et al., 1996; Paavonen, 2010). School-aged children may compensate for the sleep phase shift that they will soon experience as they near adolescence with improvements in sleep, such as the ones experienced by the control participants.

Although many researchers have found correlations linking sleep with cognition (Stickgold, 2005; Durrant, 2011; Wolfson, 1998; Carskadon, 1981), very few significant associations were found among our sample. The control group experienced a significant correlation during Time 2. An increase in Daytime Sleepiness was associated with a slower *Hit Reaction Time* on the CPTII.

The experimental group also experienced correlations between sleep and reaction time and other factors of cognition. During Time 1, increased Night Wakings was associated with an increase in *Omission Errors*, and a decrease in *Hit Reaction Time* on the CPT II. Accordingly, during Time 2, the experimental group showed a correlation between increased Sleep Duration and faster *Hit Reaction Time*. This is consistent with Kribbs' (2002) research, which implies that sleep loss may accelerate the degradation of a vigilance task. When a participant was sleep deprived, he or she did not seem to be able to sustain attention enough to maintain peak performance speeds. Interestingly, however, increased Night Wakings was also associated with a decrease in *Commission Errors* during Time 1, and an increase in Sleep Duration trended toward an increase in *Commission Errors* during Time 2. These findings go against many research findings and may be a result of a very small sample size.

The results of this project will be further examined in the upcoming year with the completion of the full experiment. The full experiment follows a similar protocol to the present pilot study, however, there are several differences. The number of participants used for the full study includes 11 Duxbury, MA participants, and 15 Norwell, MA participants. Norwell was chosen to be the control group for the full study because it is a town that is better matched on socioeconomic status, and we were able to obtain a high rate of participant involvement. In the full study, participants wear the actigraphy devices over a period of one week, allowing the device to collect more accurate measures of sleep/wake activity. With a higher number of participants and more sleep data collected, one is better able to examine the sleep habits across a wider variety of variables, including sleep onset latency, wake after sleep onset, bedtime resistance, sleep anxiety, and parasomnias. The full experiment will be improving on the limitations of this pilot study.

One of the major limitations of this pilot study was the sample size of the population collected. Originally we planned to

recruit participants through the school systems; however, we encountered various obstacles. The solution was to recruit the students as part of a convenience sample, making it much more difficult to obtain a preferred number of participants. Problems also arose with participants dropping out of the study, wearing the actigraphy watches incorrectly, or taking the device completely off. Because of a mix of all of these factors, our sample size was cut down to ten total participants. While it would be preferred to have a larger sample, having ten participants was enough to run a pilot study and obtain preliminary results. While recruitment in general was challenging for this pilot, obtaining a gender-balanced sample was also difficult. While this pilot study has provided some preliminary evidence, the full experiment will further elucidate any effect that this change in school start time has on the sleep habits and cognitive functioning of a much larger sample of school-aged children. If the full study supports the results from this pilot study, and provide evidence that changing to an early school start time negatively affects the sleep and cognition of these children, many communities will have to rethink the scheduling of their schools' start times. It is important for parents and education professionals to understand the consequences that daytime schedules have on sleep functioning in this age group, and even more important, how poor sleep can affect children's health, cognition, and academic performance at this age in development. With this knowledge, parents and school administrators can work together to find a school schedule that helps each age group – children and adolescents – obtain the best possible sleep, improving their health and ability to perform well in school.

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What was that again, Congenital Disorder of Glycosylation?

JANELLE ROBERTS



Janelle Roberts is a junior in the Dual License Program studying Elementary Education, English, and Special Education. The research was conducted in Fall 2011 as part of an Adrian Tinsley Semester Grant under the guidance of Dr. Edward Carter from the Special Education department and BSU's Children's Physical Development Clinic (CPDC) administrative staff. Janelle has presented at the 2012 BSU Undergraduate Research Symposium as well as the 2012 National Conference on Undergraduate Research in Ogden, Utah. She looks forward to her career as a teacher and impacting the lives of children.

New technology and research are continuously changing our understanding of the human body, and newly emerging diseases are continuously being discovered, such as Congenital Disorder of Glycosylation (CDG). This disease creates challenges for Special Education teachers and others who work with children affected by CDG. The purpose of this project was to increase Special Education teachers' understanding of the rare congenital disease CDG. Specifically, this project examined the augmentative communication strategies used with persons with CDG who are nonspeaking. There are approximately 1,000 diagnosed cases of CDG worldwide, and these figures are low estimates given that CDG presents like many other syndromes and disorders such as those along the autism spectrum. This project included a literature review of CDG research and a case study of a child with CDG. Using my hands-on experience with a 7-year-old boy with Congenital Disorder of Glycosylation, I tested with Talkables IV, a direct-selection communication device designed to assist individuals with speech or communication disabilities. The case study indicated that the 7-year-old, non-speaking child with CDG was able to use Talkables IV to communicate his essential needs. For example, the child could select what physical activity he wanted to do, given four different choices. Each choice on the Talkables device was programmed with a picture and voice output that says the activity chosen. Data collected during the research study showed that communication strategies used with children with other neurodevelopmental disorders, including autism, can also be effective for non-speaking children who have CDG. This research contributes to a better understanding and awareness of children diagnosed with CDG and assists Special Education teachers to develop strategies for communicating with such students.

Although a special educator needs to understand each child on a clinical level, it is important to understand each child on a personal one as well. The teacher needs to use the knowledge that they have gained over many years to apply to the situation and help the child to achieve what they are capable of. It's not just about academics, but helping the child accomplish goals that others never thought they could achieve. It is about the child knowing he did well and learning how to acknowledge that. But more important, it is about helping the child feel like any other student in his school. Although my personal experience was not based in a classroom, it achieved the same outcomes as one may see in a classroom; we set goals for a boy with special

needs, we worked hard to achieve them while having the support of his family, and we helped him feel like any other child his age.

Personal Tie

I came to Bridgewater State University not knowing much about the Special Education field. I was hoping that the Introduction to Special Education class I was attending would provide new experiences and information. During the semester we were assigned a research paper to learn more about one disorder. The assignment required that I write about what I had learned and how, as a teacher, I might adapt it to classrooms. I did not know where to begin or what I would study for the paper. Simultaneously, I participated in an extracurricular activity called Children's Physical Developmental Clinic (CPDC) that allows undergraduate students at Bridgewater to interact with children with special needs from the surrounding community for eight Saturday morning sessions of the semester. As a clinician for one of the children at PDC, I set up three goals to complete by the end of the eighth Saturday. Two goals were focused on gym activities ranging from balancing on a balance beam to shooting baskets from the free throw line. The third goal was to swim in the prone position while controlling and coordinating arms and legs in the pool. All of these goals had to be within the child's capabilities while also pushing him a bit beyond his limits. This "hands-on" experience was just what I needed to develop the confidence to work with children with special needs.

Before the first session where we meet the assigned child, my co-clinician and I looked through the child's folder to understand what to expect before we actually met the child. We found ourselves saying, "CDG? What is that? Oh, Congenital Disorder of Glycosylation?" All the information in the folder was too detailed for me to even comprehend. We flipped to the back of the folder to his picture. He looked so cute and eager to interact and have fun. My co-clinician and I were excited to get started!

The first meeting wasn't as simple as I had imagined. His whole family showed up that morning. This was a great sign because we understood that the program was meaningful to the family, and the opportunity to watch the little boy grow was something the whole family enjoyed. We soon learned that he was nonspeaking except for very few words such as "Papa," which he uttered often because his grandfather was prominently positioned in the bleachers cheering him on with his parents and siblings. Being nonspeaking, this boy could present a challenge. We learned very quickly that without reliable communication, there was no way for us, or him, to convey when he wanted to finish an activity or what he wanted

to do next; so when he decided he was done, he would run to the next activity. If you could have seen my co-clinician and me that Saturday, you would have thought we were running a marathon. One minute we were across the gym, shooting hoops and the next we were downstairs in the hallway riding bikes. It soon became overwhelming and unpredictable. For the seven Saturdays remaining in the Clinic, we couldn't continue to run around the gym aimlessly chasing this boy from one activity to the next. There had to be something we could do.

Problem

After that first Saturday's experience in the Clinic, one problem was solved and another one discovered. The problem solved was the idea for my paper for my Introduction to Special Education class! I was going to research the disorder CDG and in the process of my research, it would help me understand the child I would be working with over the next seven weeks. The problem discovered was much bigger and more complicated than I expected. I couldn't allow myself to have this child go eight weeks without communication between us. Communication is the key to any relationship and especially a relationship between clinician and child. If we didn't discover some method of communication, the three of us would be running around the gym nonstop, potentially unproductive and unsafe. This problem seemed bigger than I could solve on my own, but only a few days later, a solution emerged.

In the same Intro class in which I was writing the paper, we learned of an opportunity to apply for grant money to help with our research. We would receive a sum of money to buy books, materials, and anything we would need to enhance the development of our research papers. I decided this would be the perfect opportunity to discover how this child and I could communicate better. I would do my investigation and purchase an augmentative device to help break down the communication barriers. An augmentative communication alternative is a non-traditional method of communication for children with physical and other disabilities who cannot use speech or legible writing¹. I found it intriguing how these two circumstances, CPDC and the Adrian Tinsley Grant money, could be bridged together to get a completely unique experience. I became aware that this is the type of situation that Special Education teachers frequently experience in the classroom. If communication is broken between two or more people, one must know how to solve the problem, and it is more than likely an augmentative device could help bridge the gap. I realized that I needed to learn more not only to help myself but also to be able to help the child we were working with. The literature search conducted for the paper helped me to help him. Many times the medical information was more in-depth than I needed to know, but I began to put the pieces together and came to my own understanding of what CDG really was.

I very quickly learned that this was a rare congenital disorder and that there are only 1,000 known patients with this disease worldwide, but that number only includes those who are correctly diagnosed. It is hard to find information about this disease in medical books, journals or even through doctors' anecdotes. In 1980, the first article about CDG was published in *Pediatric Research* by Jacken et al., and it described twin sisters with the disorder. Problem areas that were identified in the twin sisters were psychomotor retardation, cerebral and cerebella levels and fluctuating hormone levels. After 15 years of studying the twin sisters, doctors were still unsure of the nature and cause to their problems. What they did know was that their plasma protein transferring was underglycosylated, so the disorder became known as Carbohydrate-deficient glycoprotein syndrome, or CDGS². Congenital Disorder of Glycosylation is one of several rare inborn errors of metabolism in which the Glycosylation in different tissue proteins or lipids are defective³. Glycosylation is a process by which sugars are chemically attached to proteins and together they form glycoprotein, which produces energy for the body within the blood⁴. In CDG, the sugars and the proteins are unable to perform this task. The type of CDG that a person has is determined by the characteristics of the two categories, which are Type I and Type II. Type I deals with just the beginning of the glucose process, whereas Type II deals with the process as a whole⁵. Each category has sub-categories that have different aspects and characteristics. Interestingly, because it is such a newly discovered disorder, not all the subcategories are determined. The child I was working with had a type of CDG that fit into Type I, but not a subtype, so his mom told us the doctors called his CDG, Type Ix.

The child we were working with had many of the typical symptoms of a child who has CDG. From what we learned at the Clinic and through his parents, he has weak leg muscles as well as weak arm strength. When he runs, he wobbles from side to side, demonstrating his lack of balance. He wears glasses because he has poor vision. Some days he wore them and other days he didn't, because they often fell off his face due to the lack of control while doing activities. He is cognitively impaired as well as nonspeaking. When we met him, he had just turned seven and he was learning how to spell his name out loud. He was always energetic, willing to try anything. He had a short attention span that made continuing activities for several minutes difficult. At times when he didn't feel like doing a task, he became very stubborn and would want to take toys away from other children and throw balls when not instructed to. Then a few moments later, he would be ready to go and perform the next activity. He had a charm about him that would light up the room and make everyone smile⁶.

After doing the literature search, I learned that the reason

CDG is so commonly misdiagnosed is because at birth, it presents like many other disorders such as cerebral palsy. Doctors have come to realize that they misdiagnosed children with CDG in the past. There is no treatment for most people with CDG. However, some patients with CDG-Ib are able to have mannose supplementation to relieve symptoms⁷.

Now that I had a knowledge base for CDG, I became more familiar with the child himself. I came to the conclusion that because it is a vastly misunderstood disorder and there is not much research on the disorder, I would need to understand more about augmentative devices and figure out which way would be best to communicate with the child. I knew I needed something simple and accessible so we could carry it around with us during the mornings while accomplishing our goals in the gym and in the pool.

Communication Techniques

With limited research data on CDG, researchers have experimented with learning techniques used for other children who are nonspeaking or experience varieties of communication breakdowns. Those techniques, particularly ones used for children on the autism spectrum, can also help children with CDG learn to communicate more effectively. Communication has a huge impact on what the child comprehends and expresses and as a result, if the communication is clear, the personal outcomes can be achieved. Nothing is more frustrating to a child than not being able to communicate their wants or needs, as my co-clinician and I quickly experienced on that first Saturday. It was not only frustrating for him, but for us as well. As much as we didn't want to show how frustrated we were, he easily sensed our frustration, which made it more challenging for him to concentrate on one activity.

When children go to school, they are no longer communicating with just their families. They are interacting with their peers and teachers. Special Education teachers are aware of how to communicate with children with special needs, but effectively communicating with other children in the classrooms, when one has a myriad of developmental, physical, and cognitive needs can be tricky. What might have worked at home with the parents might be ineffective with teacher or peers. Since CDG is still not well understood and strategies are not fully developed, students with CDG are vulnerable and may not receive the help they really need⁸. Just as teachers in the classroom need to adjust their practices to each child, at the CPDC we needed to do the same. It may have required more work to help a child with CDG to achieve his goals, but in the end, the smile on his face and the trust he developed for us, made it all worth it. These have been the most rewarding experiences I have had in the educational field.

When children are very young and have not yet learned how to talk, they use expressive language to portray how they feel. This is exactly what nonspeaking or disabled children do. Many times one is able to tell that a child has a developmental disability due to the lack of developing language competence. Both conventional and idiosyncratic nonspeaking behaviors are demonstrated by some individuals with disabilities⁹. Communication breakdowns occur when one is not able to convey a message to someone. Communication breakdowns happen more often in children with developmental disabilities such as cerebral palsy and autism than with their typical peers¹⁰. These types of communication breakdowns are characteristic of a child with CDG. This is especially true in the case of the child described in this paper.

In a 2004 study done by Brady, Marquis, Fleming and McLean, it was found that “children’s communication rate and parents’ responsiveness to children’s changes in behavior predicted children’s overall level of performance in expressive language”¹¹. This study emphasized that improvement was found in the child’s paralinguistic language and also in the responsiveness of the partner with whom the child was communicating. After a communication breakdown has occurred, the repair has to happen. A communication repair is a second attempt to communicate a message when a breakdown is encountered¹². While repairing communication breakdowns, repetition was the most frequently used approach in all conditions¹³. Repairing communication breakdowns is an important strategy for any two people, especially between a student and a teacher¹⁴. My experience communicating with the child on that first Saturday was a lot of waiting for the child’s responses to our questions. The challenge was that he didn’t know how to respond to us in a way we could comprehend. Even the idiosyncratic sign language that he used with his parents, was not comprehensible to us. For example, on the first day while we were doing an activity, he suddenly placed his arm across his chest and stood there. We didn’t recognize what he was trying to communicate and we wasted valuable learning time trying to figure it out. We later learned from his family that crossing his arm meant “all done.” Later, we used this sign to tell us when he was finished with an activity. These experiences were the preludes to experimenting with augmentative communication strategies.

Augmentative communication is a non-traditional method of communication for children with physical and/or other disabilities, who cannot use intelligible speech or legible handwriting¹⁵. There are two types of augmentative communication systems--aided and unaided. Aided systems are devices a person uses that can be as simple as paper and pencil strategies, or as complex as a computerized device with

synthetic voice output. Unaided systems involve one’s individual body¹⁶ such as using up/down eye gaze to communicate yes or no. There can be some problems with both systems. If an aided system is too complex or has too many pieces, it could become a distraction and not work as effectively as desired. Even though unaided systems are the most readily accessible, some children may not produce a signal effectively because of physical impairment, or the person receiving the sign may not understand it.

While some unaided signs helped us once we understood the code, there was still a need for aided technology. We purchased a communication device called Talkables IV¹⁷. This augmentative device is set up with four buttons and four slots above the buttons for pictures. For each button, an individual can voice record what the picture shows. The voice could be changed at any time and the picture could as well. To use this device at CPDC, I was able to make my own various activity cards. These cards included the following: basketball, swimming, a bicycle and trampoline. I would put four of the pictures into the slots of the device and each week record my voice naming each of the activities. When the subject pressed the button he would hear my voice name the activity and know that the picture matched the name. This became our way to communicate to each other which activity was next.



Figure 1. A co-clinician and the child working with the augmentative communication device, the Talkables IV.

In addition to using an augmentative device and unaided signs, we employed interactive modeling strategies. Interactive modeling is verbal guidance accompanied by the instructor literally leading the student by the hand so that the student sees him/her doing it. While a child is learning, it is important for the teacher to deliver physical, verbal and social responses such as, “Good Boy!” or “Good Job!” These responses are used as rewards for the student to be aware of appropriate behavior¹⁸. In many circumstances, my co-clinician and I used this technique.

His responses were overwhelming when we praised him or clapped when he completed a task. He would have an ear to ear smile and give us hugs. One could tell from his smile that he was also proud of himself. Teaching students to learn certain behaviors is more demanding when working with multiple students with special needs. We used all these techniques to help shape the positive results that we were hoping to accomplish.

Impact

Armed with the augmentative device, my co-clinician and I saw major progress in our communication with the child. We had a means by which we could complete the goals we had set at the beginning of the eight week period. After our first meeting with the child, we came up with major concerns that we had for his physical demeanor. From these major concerns we established terminal goals we would work towards in the eight weeks. Once the three goals were set, the clinicians established three behavioral objectives to help reach the end goal.

It wasn't until the third week when we had the augmentative device to help us communicate with the child that we felt empowered to help shape the child's interactions, skill development, and goal achievement. Once we had the communication device, what a difference! We sat down at the beginning of the clinic and explained to the child what the device was and we showed him how to use it. When we covered everything, we got to work. We asked the question, "Which activity would you like to do first?" After the question we placed the device in front of the child. At first he pressed all the buttons and pulled out all the pictures. We explained again what the device was and we helped him put the pictures back into the appropriate slots. We then repeatedly showed him how to use the device, pressing only one button at a time. The next time he tried it, he pressed one button, heard the voice recording and it immediately reinforced his choice. We took his hands and started to walk towards the activity he had chosen and talked to him about how excited we were to participate in the activity he had chosen. We did this a few times and he began to understand the process of communicating his choices using the augmentative device.

The next Saturday however, when he first walked in, we went through the same process again. He wanted to press all the buttons and take out all the pictures. We understood that there was a week in between each clinic and he may not remember after the first one. We explained it to him again and by the end of the day, he knew what was expected and was making progress. He knew that if he wanted to move on to the next activity, he would have to go to the device and choose which activity he wanted next. Every Saturday we would re-introduce the device.

Not only was he making progress using a new communication tool, but he was also making amazing progress with his goals. By the end of the eight weeks, he was swimming by moving his arms and legs. Although his movements were not in rhythm or at the same time, he would try to move them when encouraged to do so. From where he started, this was a huge leap. At first, he wouldn't even move his legs because he knew we were

Table 1. Child's Major Concerns, Terminal Goals and Behavioral Objectives

Major Concerns:

- A-1: Lacks movement in arms and legs while swimming
- B-1: Lacks ability to bounce a ball with strength and accuracy to a clinician in front of him
- C-1: Lacks control and leg strength

Terminal Goals:

- A-2: Move arms and legs in bilateral motion in prone position while in the pool
- B-2: Bounce a basketball to a clinician standing in front of him
- C-2: Improve leg strength by peddling on a bike the length of the hallway (20ft)

Behavioral Objectives:

- A-3.1: Enhance ability to move legs in bilateral motion for half the width of the pool
 - A-3.2: Enhance ability to move arms in bilateral motion for half the width of the pool
 - A-3.3: Enhance ability to move both, arms and legs, in bilateral motion for half the width of the pool
 - B-3.1: Enhance hand-eye coordination by bouncing a basketball to a clinician standing 3 feet in front of him
 - B-3.2: Enhance hand-eye coordination by bouncing a basketball to a clinician standing 5 feet in front of him
 - B-3.3: Enhance hand-eye coordination by bouncing a basketball to a clinician 7 feet in front of him
 - C-3.1: Ride a bike moving legs continuously for the length of the hallway with maximum assistance
 - C-3.2: Ride a bike moving legs continuously for the length of the hallway with minimum assistance
 - C-3.3: Ride a bike moving legs continuously for the length of the hallway with no assistance
-

supporting him in the water, and he would just splash his arms to move forward. Eventually, he was able to swim the width of the pool with our assistance. He saw how proud we were of him as was his family, and we believe this helped motivate him to continue to practice and trust that we were there for him. One instance that is prominent in my mind occurred after he swam across the pool. We were congratulating him and he pulled me towards him, pretended to whisper something in my ear, and

then splashed me in the face! He thought it was the greatest thing and could not stop smiling.

With his second goal, he was able to accomplish bouncing a ball to a clinician 3 feet in front of him successfully and is continuing to work on longer distances. He preferred bouncing a basketball to other balls. Once in a while after bouncing, he would shoot hoops and he enjoyed doing that. He was able to work on his hand-eye coordination while having fun.

After the first clinic, his parents soon told us that he loved anything with wheels¹⁹. Getting him to ride a bike was never a challenge. He would go down the stairs to the bikes very excited. He knew he needed a helmet and even learned to buckle it himself. In the first weeks, he would choose a bike that was too small for him because he was comfortable with it. As the weeks went on, he began to feel comfortable with a bike that was just the right size. Once on a bike that was the correct size for him, he was able to learn the motion the legs make when riding a tricycle. During this time, he learned balance that is needed when riding a bike for his size rather than a bike that was too small for him. He was used to the smaller bike, where all the wheels were on the floor so this was progress as well for him. He would always have trouble starting the peddling on the bike, because of his lack of leg strength. So we would help him get started and then encourage him to continue. By the second to last clinic, he was able to start peddling by himself and continuously peddle after that. Although it was only for a few feet, we could tell that he knew it was a true accomplishment and we did too.

Conclusion

I think back to all that was accomplished and I still can't believe it. He made so much progress and he recognized when he did something exceptional. He would look back at us, smile and wait for our reaction. Then I think about what might not have happened if I hadn't figured out how to solve our communication dilemma. The three of us would have continued to run from activity to activity. We would have wasted valuable time trying to figure out what he wanted. Instead we solved the problem and used that time to work towards his goals.

What made this whole experience even more remarkable was being able to help him feel just like any other child doing activities in the gym or pool. He accomplished what seemed like the smallest goals. But these were major accomplishments for him. After the communication device was introduced, he trusted us and we understood what he wanted. The barrier that was blocking him from being successful was broken.

Special Education teachers accomplish small goals that are major accomplishments every day when working with challenged students with unknown potential to learn. They take a circumstance that they may have never encountered before and use their problem solving skills, their creativity, and their determination to create solutions. Just as we used the augmentative device to help the child we were working with, Special Education teachers bridge the communication gaps with their students as well. These augmentative devices help the child express feelings like any other child and help them to adjust to new environments, new people, and new expectations more readily. Many children have unique disabilities and no case is exactly the same but they can be helped to reach goals greater than first thought possible. That is just what we did at CPDC.

My unique experience with a student with CDG taught me that it doesn't matter what the "disability" is. An individual uses everything that they know and all their resources to help make each experience better. The condition of CDG helped me understand this. There are many other children out there with similar situations. The communication device took a problem that seemed to have no solution and turned it into a successful outcome for the child and for ourselves. The three of us were placed into a circumstance that involved a rare disorder that we seemed to have no control over. The augmentative device made communication an option when we never thought we would have one. Even though CDG is not widely known, it presents situations just as other disorders may and the same key idea stands in all situations: communication. Using an augmentative device is what helped me communicate effectively with the subject. As with all relationships, communication is key.

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Computer Programming to Advance Gravitational Lensing

ALEX ROCHE



Alex Roche is a graduating senior of the class of 2013 with a major in physics and mathematics.

He intends to continue his physics education in graduate school.

The purpose of this research was to create a computer code that would numerically test a Poisson equation relating the mass distribution of a lens galaxy cluster to weak gravitational shear. Einstein's theory of general relativity predicts that space-time is bent by massive objects, and in weak gravitational lensing, galaxy clusters act as lenses. The observable result is that galaxies far behind the gravitational lens will appear slightly more elliptical than they actually are. The ellipticity of the background galaxies is quantifiable and is directly related to the weak gravitational shear, and the shear is used to determine the mass distribution of the lensing cluster. Within the gravitational lensing community, there are two other well known methods of determining the mass distribution of a lensing galaxy cluster from the weak gravitational shear. This new method is unique in that it uses a Poisson equation, potentially simplifying the approach to the numerical integrations required. Part of the overall goal of this project was to clarify the effectiveness of this Poisson equation method in relation to the existing methods, with the hope that the Poisson method is more accurate. The Poisson equation method described here refers to the method of numerical relaxation to determine the mass distribution of a lensing galaxy cluster by using the Poisson equation. Over 2000 lines of original C++ code were written for this project, and the code simulates a typical lensing galaxy cluster mass distribution, calculates the weak gravitational shear from the simulated cluster, adds realistic random noise to the shear data, then finally applies a second order Taylor series expansion of the Poisson equation to the noisy shear data and checks how closely the computed mass distribution matches the original simulated galaxy cluster's distribution. This project has provided the tools needed to perform more rigorous testing of the Poisson equation.

Initial testing suggests that the Poisson method for determining the mass distribution of a galaxy cluster is about as good as the existing methods. Exactly where it lies in relation to them is yet to be determined. The Poisson method can detect the total mass of a galaxy cluster $\pm 2.4 \cdot 10^{14} M_{\odot}$. Substructure was detected 80% of the time when the total mass of the system was above $1.6 \cdot 10^{15} M_{\odot}$ and the mass of the substructure was $4 \cdot 10^{14} M_{\odot}$. It was detected 50% of the time when the total mass of the system was $6.3 \cdot 10^{14} M_{\odot}$ and the substructure's total mass was $1.6 \cdot 10^{14} M_{\odot}$. Numerical error inherent in the method was less than 3% in total.

Introduction

General Relativity predicts that the path of light is bent by the gravity of massive objects. A galaxy cluster will behave approximately as a thin lens.³ Any light coming from far behind the galaxy cluster will be bent when it touches the lens plane. The amount that it is bent is related to the strength of gravity at that point. This phenomenon is called gravitational lensing. If the light from a galaxy sized circle, originating from far behind the lens, passes through the lens plane, it will appear as an ellipse to an observer on earth. The amount of elliptical stretching is the observable quantity in weak gravitational lensing.

Weak gravitational lensing can be used to determine the mass distribution of a galaxy cluster by analyzing the observed shapes of the galaxies far behind the galaxy cluster. Thomas Kling and Bryan Campbell derived, from fundamental principles of General Relativity, a new relationship between the mass distribution of a galaxy cluster and the observed shapes of the galaxies far behind the galaxy cluster.² The purpose of this research was to test new relationship, a Poisson equation relating weak gravitational shear to mass distribution of the lensing cluster.

Several outcomes were meant to be determined the C++ implementation of this new relationship between the mass distribution and the weak gravitational shear. The first goal was to determine if the method could accurately determine the mass distribution, without noise, to a low, acceptable amount of error. The second goal was to see if the method could accurately determine the mass distribution, with noise, of galaxy clusters ranging from 10^{14} to $10^{15}M_{\odot}$ (solar masses), including substructure of about 25% of the total mass along with location and shape of the cluster.

The Poisson method is designed to eventually be used with real data, which would come from a large field telescope. The galaxies that are far behind the galaxy cluster can be selected from the image by analyzing the color and intensity of their light. Since a single galaxy on its own could be oriented in any direction, its lensed image tells nothing about the mass distribution of the lensing galaxy cluster. To make a connection between image shape and mass distribution, a large number of galaxies in a given area have to be averaged. For this reason, the image taken by the telescope would be broken into equal bins, like boxes on grid paper. The shapes of the selected images in a given bin would be averaged and that bin would be interpreted as a single object, located in the middle of the bin area.

The mass distribution computation requires three grids of data. Each grid location corresponds to a physical location on the lens plane. Two of the grids hold the values of weak gravitational

shear. From real data, the shear would be computed from the observed shapes of the galaxies, but with our simulation we are able to compute it from the mass distribution. The third grid will hold the mass density that will be computed using the Poisson method. Before the Poisson equation is applied, the values on the edges of the mass density grid are estimated. If the data are taken with a wide enough field of view, the mass density should be about zero at the edges. Information gained using a wide field of view data set can be used to interpolate values for the edges of a narrow field of view data set, where the mass density would not be close to zero. If the Poisson method was applied to real data, a ground based telescope would be used for the wide field of view data and a more accurate space telescope would be used for the narrow field of view data.

Simulation of Data

The simulated mass distribution (mass model) used for the lensing galaxy cluster was a truncated isothermal sphere with a core radius. The 3-dimensional mass density is described by,

$$\rho = \frac{v^2}{2\pi G} \frac{1}{r_c^2 + r^2} \frac{r_t^2}{r_t^2 + r^2} \quad 1$$

Where r_c is the core radius, r_t is the truncation constant, v is the velocity dispersion. The truncation constant makes the mass finite at the origin. The core radius makes the total mass finite. This mass distribution is highest, but finite, at the origin and it decays gradually outward. In gravitational lensing theory, the thin lens approximation is used to describe a lensing cluster. For this reason, the 3-dimensional mass density is projected onto the lens plane by integrating along the line of sight.

$$\Sigma = \int_{-\infty}^{\infty} \rho dz = \frac{v^2}{2G} \frac{r_t^2}{r_t^2 - r_c^2} \left(\frac{1}{\sqrt{s^2 + r_c^2}} - \frac{1}{\sqrt{s^2 + r_t^2}} \right) \quad 2$$

$$s \equiv \sqrt{x^2 + y^2} \quad 3$$

The total mass of the truncated isothermal sphere model is,

$$M = \int \kappa^s \rho dV = \frac{\pi r_t^2 v^2}{G(r_c + r_t)} \quad 4$$

The weak gravitational shear quantities, γ_1 and γ_2 , can be computed from this mass model.²

$$\gamma_1 = \frac{\pi v^2 r_t^2}{r_t^2 - r_c^2} (x^2 - y^2) Q \quad 5$$

$$\gamma_2 = \frac{\pi v^2 r_t^2}{r_t^2 - r_c^2} (2xy) Q \quad 6$$

$$Q \equiv \frac{1}{\sqrt{s^2 + r_t^2} (r_t + \sqrt{s^2 + r_t^2})^2} - \frac{1}{\sqrt{s^2 + r_c^2} (r_c + \sqrt{s^2 + r_c^2})^2} \quad 7$$

The C++ program calculated the mass distribution that a typical lens galaxy cluster would have. From the simulated mass distribution, it then calculated the two weak gravitational shear quantities, γ_1 and γ_2 , that would normally be obtained from the observed shapes of the background galaxies in a telescope image. Randomly generated noise was added to our observable quantities to simulate real data. The added noise is described by a normal distribution, where the average is taken to be the exact value for the shear and the standard deviation is given by,¹

$$\sigma = \frac{0.3}{\sqrt{(\text{number of objects per bin})}} \quad 8$$

This standard deviation comes from the probability that galaxies are aligned due to gravitational lensing or due to some other cause. We assume a constant number of objects per bin. This form of noise is the generally accepted noise assumed in all weak lensing measurements.¹ Finally, the Poisson equation was applied to the noisy observable data.

The Theory

The point of this project was to test the effectiveness of this new Poisson equation at finding the total mass of a galaxy cluster.²

$$\frac{\partial^2 \kappa}{\partial x^2} + \frac{\partial^2 \kappa}{\partial y^2} = \frac{\partial^2 \gamma_1}{\partial x^2} - \frac{\partial^2 \gamma_1}{\partial y^2} + 2 \frac{\partial^2 \gamma_2}{\partial xy} \quad 9$$

This Poisson equation was solved for κ by using second order Taylor expansions of κ , γ_1 and γ_2 .

$$\kappa(x, y) = \frac{1}{4} [\kappa(x + h, y) + \kappa(x - h, y) + \kappa(x, y + h) + \kappa(x, y - h) - F] \quad 9$$

$$F \equiv \gamma_1(x + h, y) + \gamma_1(x - h, y) - \gamma_1(x, y + h) - \gamma_1(x, y - h) + \frac{1}{2} [\gamma_2(x + h, y + h) + \gamma_2(x - h, y - h) - \gamma_2(x + h, y - h) - \gamma_2(x - h, y + h)] \quad 10$$

Where h was the width and height of a bin. With this equation, if the values for γ_1 and γ_2 are known, then the values for κ at each bin can be determined, so long as the boundary conditions for are known.

The weak gravitational shear that the C++ program computes from the simulated mass distribution can also be computed directly from the telescope image. The C++ code does not simulate a telescope image, it simply computes γ_1 and γ_2 from the mass distribution. The moments of intensity are first calculated from the image data.¹

$$q_{xx} = \frac{\sum (x - \bar{x})^2 w(\bar{x} - x, \bar{y} - y) I(x, y)}{\sum w(\bar{x} - x, \bar{y} - y) I(x, y)} \quad 11$$

$$q_{yy} = \frac{\sum (y - \bar{y})^2 w(\bar{x} - x, \bar{y} - y) I(x, y)}{\sum w(\bar{x} - x, \bar{y} - y) I(x, y)} \quad 12$$

$$q_{xy} = \frac{\sum (x - \bar{x})(y - \bar{y}) w(\bar{x} - x, \bar{y} - y) I(x, y)}{\sum w(\bar{x} - x, \bar{y} - y) I(x, y)} \quad 13$$

Where (\bar{x}, \bar{y}) is the center of the image, $w(x, y)$ is a weight function that goes to zero outside the object, and $I(x, y)$ is the intensity of the light. The γ_1 and γ_2 from the Poisson equation are related to the observable quantities as follows.^{1,6,7}

$$\gamma_1 = \frac{1}{2} \frac{q_{xx} - q_{yy}}{q_{xx} + q_{yy}} \quad 14$$

$$\gamma_2 = \frac{1}{2} \frac{q_{xy}}{q_{xx} + q_{yy}} \quad 15$$

Data & Discussion

As mentioned in the introduction, data with a wide field of view (the large grid) were used to get boundary conditions for a narrow field of view data set (the small grid). For each data point on the graphs below, the following steps are done in the program, after picking a large and small grid size:

1. Create new matrices for γ_1, γ_2 and the exact values of κ
2. Add random noise to γ_1 and γ_2
3. Apply the relaxation method
4. Compute the error in the relaxed κ matrix
5. Repeat steps two through four to gain statistical significance
6. Compute averages and standard deviations of the errors

The error in an average is given by,⁵

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{N}} \quad 16$$

where σ is the standard deviation of the errors computed in step 6 and N is the number of noisy simulations we used for a given data point, as in step 5.

The error in a standard deviation is given by,⁵

$$\sigma_{\sigma} = \frac{\sigma}{\sqrt{2(N-1)}} \quad 17$$

The advantage of using a large number of bins is that it is possible to have a more detailed description of a galaxy cluster's substructure. The disadvantage is that there will be more noise, as there will be fewer objects per bin. The disadvantages of having too few bins are that the numerical method will be less accurate and we will have less resolution. A practical upper limit to our number of bins is that there cannot be less than one object in a bin. This limit is at around 150x150 bins for the large grid and 40x40 for the small grid. This is assuming that the large grid data is from a ground based telescope with a field of view of 12 mpc and the small grid data is from a space based telescope with a field of view of 1.14 mpc.

For noisy data, average error for all grid sizes is about zero. However, the standard deviation in the errors increases with bin number.

For computing the total mass of a cluster with the Poisson method, the result will be more accurate with fewer bins for noisy data but not that much less accurate for higher bin sizes. Changing bin size has a small effect. We see 8% more accuracy with an 11x11 small grid than a 39x39 small grid. For the 11x11 grid, one standard deviation is within 11% of the true total mass.

Without noise, we see that the accuracy increases, as expected, with more bins.

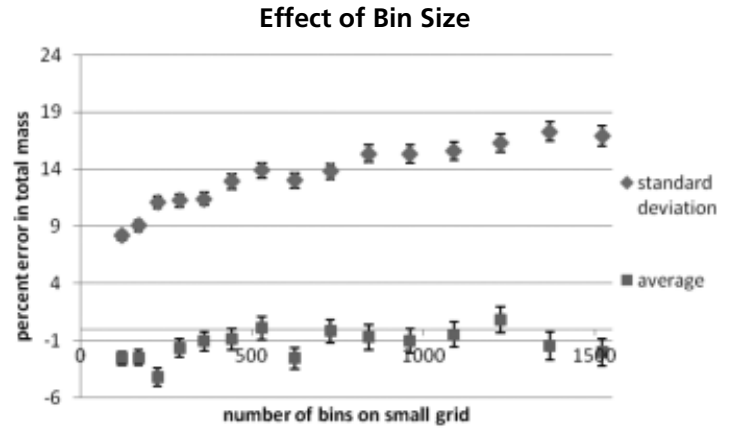


Figure 1. Small grid, 200 simulations per point. $v = 0.005c$, $r_c = 0.1$ mpc, $r_t = 1.5$ mpc.

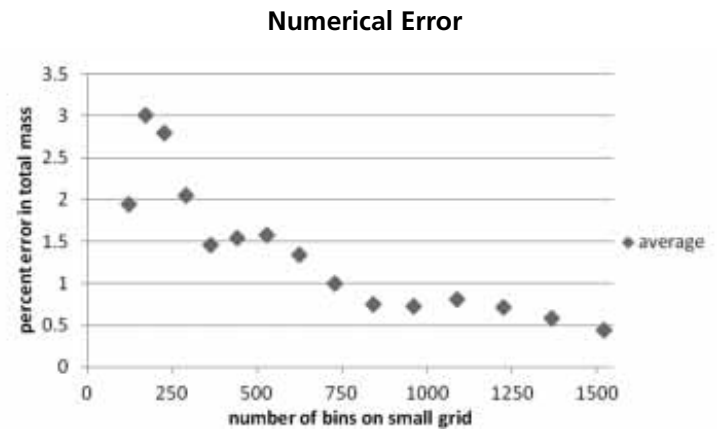


Figure 2. Small grid, 11x11. $v = 0.005c$, $r_c = 0.1$ mpc, $r_t = 1.5$ mpc.

The accuracy is acceptable in all cases with noiseless data. Numerical error is at worst 3% and at best 0.5% from true the total mass.

Naturally occurring galaxy clusters come in different widths. We tested the method to see how sensitive it was to a cluster getting wider and flatter but maintaining constant mass.

Effect of Width

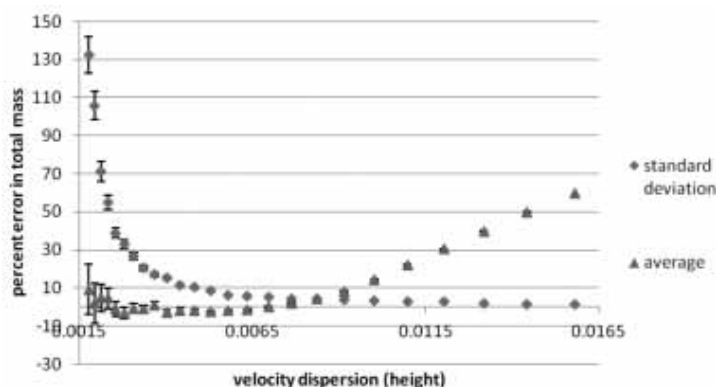


Figure 3. Small grid 11x11. 100 simulations per point.

Figure 3 shows that the data have a very wide tolerance for varying width of a galaxy cluster. So long as the cluster is not very dense or very disperse, reasonable accuracy is maintained. One cause of the inaccurate detection of highly disperse galaxy clusters is that as the mass is flattened, the mass density at the edges should increase. As a result, the choice of zero mass density as the boundary condition becomes less reasonable. When width and height are varied, the data have a minimum when $v = 0.007c$ and $r_c = 0.05 \text{ mpc}$. One standard deviation of the error can go beyond 20% error in the total mass when v is above $0.01c$ or below $0.033c$.

A hope for the Poisson method was for it to be able to detect lensing galaxy clusters in the range of 10^{14} to $10^{15} M_{\odot}$. Figure 4 is a plot of total error versus total mass of the galaxy cluster.

Effect of Width

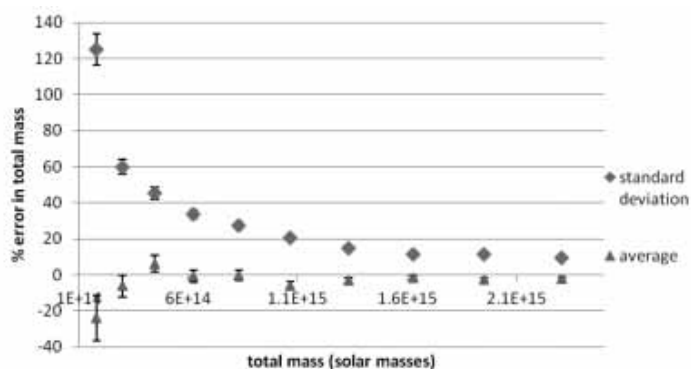


Figure 4. Small grid, 11x11. 100 simulations per point. $r_c = 0.1 \text{ mpc}$, $r_t = 1.5 \text{ mpc}$.

Clusters that were as low in mass as $\sim 5 \cdot 10^{14} M_{\odot}$ were detected. This was about as good as other existing methods of determining the mass distribution of a lensing galaxy cluster, in common

use. When the total mass goes below $1.3 \cdot 10^{15} M_{\odot}$, one standard deviation from the average was beyond 20% error in the total mass. At about $4.5 \cdot 10^{14} M_{\odot}$, one standard deviation from the average is beyond 50% error in the total mass. By converting percent error to error in mass, it was shown that one standard deviation of the data is within an average of $2.4 \cdot 10^{14} M_{\odot} \pm 4\%$ of the correct mass. Essentially, the resolution of the Poisson method, for the total mass, has a standard deviation of $2.4 \cdot 10^{14} M_{\odot}$.

The ability to detect substructure of about 25% of the total mass of a cluster was also one of the project goals. The program was used to generate two peaks that were separated enough that they could be resolved with the grid spacing, as shown in figure 6. Below is a plot of peaks detected versus total mass of the galaxy cluster.

Substructure Detection

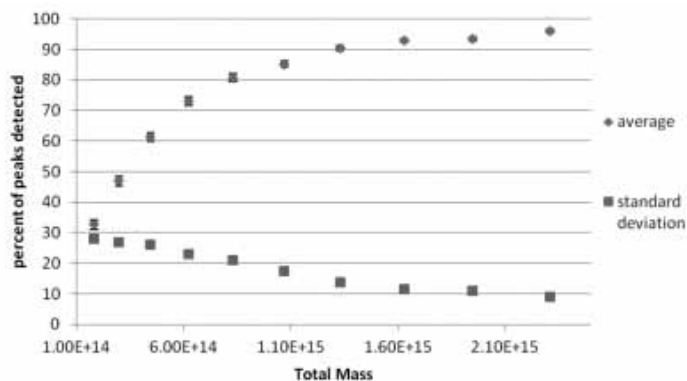


Figure 5. Small grid, 11x11. 300 simulations per point. $r_c = 0.1 \text{ mpc}$ and $r_t = 1.5 \text{ mpc}$ for both peaks.

The substructure was consistently detected as long as the total mass of the cluster was sufficiently large. Only peaks that were above 3 standard deviations were considered.

Mass Distribution with Substructure

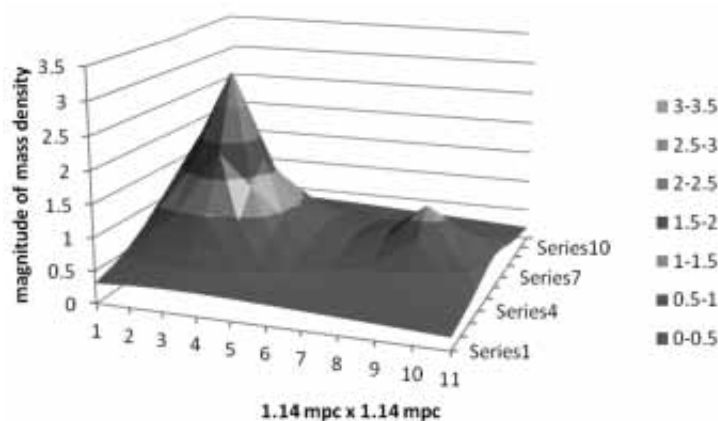


Figure 6. Small grid, 11x11. $2.3 \cdot 10^{15} M_{\odot}$. Exact values. This is the noiseless shape of the distribution used to detect substructure.

The substructure was detected 80% of the time when the total mass of the system was above $1.6 \cdot 10^{15} M_{\odot}$ and the mass of the substructure was $4 \cdot 10^{14} M_{\odot}$. It was detected 50% of the time when the total mass of the system was $6.3 \cdot 10^{14} M_{\odot}$ and the substructure's total mass was $1.6 \cdot 10^{14} M_{\odot}$.

There was less than 1% difference in total mass error between our interpolation and a perfect interpolation.

Conclusion

This project provided the tools needed to perform more rigorous testing of the Poisson equation. Initial testing suggests that our method for determining the mass distribution of a galaxy cluster is about as good as the existing methods. Exactly where it lies in relation to them is yet to be determined. The Poisson method can detect the total mass of a galaxy cluster $\pm 2.4 \cdot 10^{14} M_{\odot}$. Substructure was detected 80% of the time when the total mass of the system was above $1.6 \cdot 10^{15} M_{\odot}$ and the mass of the substructure was $4 \cdot 10^{14} M_{\odot}$. It was detected 50% of the time when the total mass of the system was $6.3 \cdot 10^{14} M_{\odot}$ and the substructure's total mass was $1.6 \cdot 10^{14} M_{\odot}$. Numerical error inherent in the method was less than 3% in total. There was less than 1% difference in total mass error between our interpolation and a perfect interpolation.

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Plimoth Plantation: Producing Historical Knowledge Through Performance

ASHLEY ROSE



Ashley Rose is a senior at Bridgewater State University double majoring in English and Elementary

Education. She is especially interested in performance as pedagogy both in and out of the classroom. Research for this project was supported by Bridgewater State University's Adrian Tinsley Program.

As one of the earliest living history museums, Plimoth Plantation has recently been criticized by museum and performance theorists for maintaining its reliance on first-person role playing. It has been suggested that these practices help codify the history that Plimoth represents to visitors. The Mayflower II, Hobbomock's Homesite, and the Seventeenth Century English Village are the three distinct museum sites that Plimoth Plantation uses to help present an important period of European colonization in American history to their visitors. Each of these three sites uses interpretive methods differently to reflect their individual goals. First-person interpretation works to bring history alive for museum visitors, allowing them the opportunity to touch the crumbling walls of a replicated seventeenth century Colonist's home and to help its owner grind meal to make dinner. Third-person interpretation and guides work differently to present historical information. Unlike role-players, third-person interpreters are able to present information from our contemporary understanding of history, and this new perspective changes visitors' ideas of the past. Second-person interpretation allows visitors to become role-players and historians, as they help create their own interpretations of history, for the duration of their visit. It is a more active kind of learning which allows visitors to not only become aware of historical construction as a process, but also to participate in it. Then visitors can take the critical skills they have learned and their experiences with them as they visit other museum sites around the world.

Museum and performance theorists have recently debated the balance of first, second and third person interpretation that should be incorporated into living history exhibits. This delicate balance must be established at Plimoth Plantation, in order to foster critical museum goers of the future. Once enough visitors have experienced historical interpretation for themselves, then they will be prepared to view other exhibits critically as well. Then even traditional museums will be free to shift their goals towards a more interactive experience. I have interviewed several staff members at the site in order to examine the effects of these emerging interpretive methods. Museum and performance theorists put pressure on Plimoth's staff and administration to abandon first-person role playing entirely. The museum does not see such a drastic change as an immediate solution. The decision to incorporate both second and third person interpretation at Plimoth Plantation will change the ways in which museum visitors think about history as they explore museum exhibits in the future because the combination of the two will

foster the understanding, in visitors, that history is a complex arrangement that is constantly being reevaluated.

Visitors are currently more responsive to the first-person interpretive model; some even pay more for guided tours. This kind of performance experience is based on limited visitor input and interaction. Incorporating third-person interpretation and second-person experiences would suit the needs of the critical museum goer that theorist Margaret Lindauer describes:

The critical museum visitor notes what objects are presented, in what ways, and for what purpose. She or he also explores what is left unspoken or kept off display. And she or he asks, who has the most to gain or the most to lose from having this information, collection, or interpretation publicly presented. (Lindauer 204)

The museum hopes to encourage visitors to approach the exhibits differently, and encourage them to interact, instead of passively observing at each of the sites. Involving visitors in the process of constructing history is something that cannot be addressed by role-players or museum guides alone. However, as museum theorists Michael H. Frisch and Dwight Pitcaithley state, their reactions are difficult to interpret accurately. "The audience, ironically enough, is perhaps the most consistently overlooked and most poorly understood element in contemporary discussions of public history and interpretive strategy" (153). There has been an obvious lack of visitor support for these new methods since they have begun including them within the various sites. Staff, visitors, and museum partners each have specific expectations for the museum to uphold and not all of them align at the moment.

Incorporating first-, second-, and third- person interpretation into all the sites would encourage visitors to become much more involved in a history that they can create together. Visitors can then gain a better understanding of how historical narratives are created and based on research. Visitors need to be made aware of the fact that historians do not simply discuss and write about facts which have already been agreed upon by other historians and cultures. This notion reinforces the idea that there is only one factual history and that any others must simply be inaccurate. History enthusiasts or descendants of English colonists are often baffled or enraged by the narrative presented at Plimoth Plantation if it varies from family stories or the narrative that they have been taught. First-person interpretation alone does not allow staff to address these questions about multiple possible narratives the way that a combination of interpretive styles would.

The Mayflower II seems to have the most clearly defined goals directing its interpretive methods. This site is unique in the fact that it employs a staff of fifty percent first-person and fifty percent third-person interpreters every day. According to Tom Leahy, one of the interpreters on the Mayflower II, the museum ultimately decided that that a completely immersive experience was impossible to achieve at the Mayflower II because of its location. The Mayflower II is located in the center of a very busy port within the town of Plymouth and visitors constantly ask questions about their surroundings. Unlike the Village, their surroundings do not coincide with a seventeenth century dialogue.

I was surprised to find that the staff of the Mayflower II are not so strictly tied to the first-person interpretive model. Leahy felt that the immersive experience never truly lasts at any of the sites. Visitors bring cameras and cell phones, and are aware that they have not stepped back in time. A limitation of this is that they are expected to interact with the past, but without permission to discuss any questions which might arise from our twenty-first century perspectives. Without the distance of third-person interpretation, staff and visitors become limited in their discussion topics.

Third-person interpretation allows staff members to discuss the story of the Mayflower II as well as the original story of the Mayflower. The Mayflower II was built overseas and made a journey all its own around fifty years ago; the staff onboard are proud of that fact. If the site used first-person interpretation alone, then its story would be lost to visitors. Through the implementation of both first- and third- person interpretation, the museum's history can be explored as well as the colonists'.

At the Mayflower II and Village, staff represent specific European sailors or colonists of the seventeenth century. This is unlike the staff at the Wampanoag Homesite, who are both in character and out of it through a combined first- and third-person interpretive style that is unique to the Homesite. Staff are stationed in replications of traditional Wampanoag homes and wear traditional clothing, but they speak from a twenty-first century perspective. While each staff member might not be of the Wampanoag tribe, they do identify themselves as Native Americans and their cultures are hardly long gone. The staff refuse to limit themselves to a seventeenth-century dialogue by role playing alone.

Through first- and third- person interpretation, the staff are able to discuss what happened after the early years at Plimoth, when the native tribe helped the Colonists survive. Bob Charlebois, a Native interpreter at the site explains, "This is the most symbolic place for two people and for two very different

reasons. One is the story of the English and of the ascendance of the English way in North America, a victory if you will, and the other is of my people, and it is a colossal Greek tragedy. If we can't tell that story here, then where else can we tell it that is so symbolic?" (Charlebois). At the Homesite, staff are able to address these issues along with modern political and racial issues which often arise. These questions often lead to higher understanding of both the Native cultures and of the visitor's own limited education. This initial confusion often sparks questions about the past and the present. Visitors are encouraged to join in many of the activities that Native staff have started for educational purposes. This also brings in a bit of performance theorist Scott Magelssen's idea of second-person interpretation. On a cold day, visitors strolling through the Homesite do not need to be told how important fire would have been to the tribe; they can experience it for themselves. The Homesite staff hope to teach visitors that there is indeed more to the story than what is explained at the Village and Mayflower II in first-person interpretation.

It seems that only the English Village shies away from this idea of varied interpretive styles, despite the museum's desire to address the limitations of a strictly first-person site. A first-person interpretive model does not encourage visitors to ask questions about the construction of history or the changes that the museum has undergone over the years. Visitors are not reminded that the historical documents that have been used in research are limited, since some documents haven't survived the centuries for researchers to work with. It also does not promote any questions or dialogue about the current state of racial or political matters, or the ways in which these issues would have severely impacted the events of the seventeenth century.

The most recent attempt to change this has been to place a third-person interpreter in a house at the very edge of the Village. The house was chosen because it was the earliest reproduction of a cottage that the museum has constructed, which is still standing. With a third-person interpreter in this house, visitors often ask why it looks different than the other homes that they visited. For a third-person interpreter, this sparks questions about the building processes and the ways in which the museum's ideas about history have changed over the years. A first-person interpreter would have been forced to avoid the question, so as not to break character. This is a lost opportunity to discuss the construction of history. However, visitors are told upon entering the house, that for a brief time, they have re-entered the twenty-first century, implying to visitors that their immersive experience will continue once they leave the staff member. The visitors' opportunity to ask questions which are unrelated to Plimoth's historical narrative is limited by the walls of the unique cottage.

Awareness of the different materials used to build these homes could create an important concept in the minds of visitors. Learning from a twenty-first century staff member that the original Village was built out of concrete, simply because the materials were cheaper and the goal at the time was only to *look* like a seventeenth-century home, changes the visitors' views concerning museums as historical authorities. When a third-person interpreter openly admits that the museum she works for has had to make interpretive and administrative changes over the years, visitors begin to rethink their earlier assumptions about an unchanging historical narrative. The opportunity to learn and explore a vast and conflicted history is presented to visitors, along with the chance to learn about the museum's shifting goals as time has passed.

However, only a few visitors took the time to speak with the staff member during my visits. A large number of visitors struggled to come up with a question upon entering, usually one about history after 1627 or why the building looked different, and then the visitors thanked her and left. Some thanked her and left without a single question. Clearly, the third-person interpretive model, alone, is not sufficient to encourage museum goers to think critically about history's construction.

Reimagining the Village as an interactive experience which is focused on *using* the interpreters' skills rather than relying on them to present a story could have the effect that critics are looking for. If the goal of first-person interpretation is to create situations where visitors can meet and discuss racial politics, the seventeenth-century economy and the daily issues that the colonists faced, then why not expand on this idea through second-person interpretation? These issues are relevant to a modern audience. Present visitors with the opportunity to make choices and discuss their opinions with staff members, whether or not they might have been historically accurate opinions. Second-person interpretation gives visitors and staff the chance to explore other possible narratives through performance and experiential learning. The goals of first-person interpretation would remain, allowing the museum to keep their financial draw, but there would be a significant expansion of these ideas. Simply expecting interpreters to present information and historical narratives to visitors reduces the interpreters' abilities to teach through any higher order of learning. Combining their first-person interpretive skills with second-person interactive methods could create a very productive environment where visitors participate and use the staff as resources to help create history.

Second-person interpretation creates a place where accurate historical information is not the goal. Instead the goal is for visitors to learn by doing. Racial and social issues can

be addressed in real time and with immediate reactions or consequences for visitor-performers. Visitors will be considering why they chose to behave differently than the historical figures they are exploring, and how history might have turned out differently if this hadn't been the case. Primary documents (copies, of course) could be provided to visitors and they could be allowed to interact with interpreters. They could write their own versions of history and learn the way historians do, by piecing together the puzzle of documents, thereby gaining a better understanding of the construction of history. The focus could be on what this modern interaction teaches them about what might have happened in the past. This kind of learning helps prepare visitors to change their misconceptions about where history comes from and who decides what is included in it. Visitors will eventually embrace the notion that there are many ways of interpreting history, if they continue to have positive and educational experiences while practicing that theory first-hand.

Starting at the Village will be crucial. Plimoth's two other sites have successfully included different methods of interpretation, making the shift to include second-person rather simple. To maintain an entirely first-person interpretive experience at the Village is to sacrifice the changes and goals that the museum hopes to emphasize in the future. Visitor involvement is the key, as it has always been at Plimoth Plantation, but presenting an accurate historical narrative must no longer be the only means of involving visitors. Visitors should be encouraged to become active participants, rather than active audience members while at the museum.

Thanks to visitors' suggestions, critical analyses and staff input, Plimoth Plantation has decided that a first-person interpretive Village does not suffice to support a clearer understanding of how history is created. A combination of first, second, and third person interpretation that emphasizes visitor involvement will help the museum take the first steps to fostering critical museum goers, who will then seek out intellectually challenging exhibits and interactive programs. If visitors are not yet receptive to these new concepts of history or these interactive exhibits then the museum's next important step is to show them how multifaceted history can be, and how their input can be both enjoyable and useful. The environment described here, where second- and third- person interpretation will emphasize, not only, events found within history books, but also the events left out of history books, will only be successful if the visitors and staff work together to create it.

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An Investigation of the Look Away Behavior in Domestic Dogs

SARAH SCOTT



Sarah Scott returned to Bridgewater State University to study psychology after completing a Bachelor

of Science in Business Management from Bridgewater in 2008. She spent the summer of 2012 conducting a research study that investigated visual communication in domestic dogs. She was mentored by Dr. Amanda Shyne of the psychology department. Her project was supported by the Adrian Tinsley Program summer research grant and was presented at Bridgewater State University's 2012 Undergraduate Summer Research Symposium and the 2013 National Conference on Undergraduate Research in LaCrosse, Wisconsin. Sarah was awarded a Bachelor of Science in Psychology in January 2013 and now works as a lab manager in the Cognitive and Affective Neuroscience Laboratory in the psychology department at Boston College. She continues to be enthusiastic about research and plans to pursue a graduate degree.

The unique phylogenetic and ontogenetic history of domestic dogs has had an effect on the way they communicate with one another. Research suggests that domestic dogs' ability to communicate through visual signals may vary by breed (Goodwin, Bradshaw, & Wickens 1997; Kerswell, Bennet, Butler, & Hemsworth 2009). In the current study, we investigate the effect of a visual communication signal, the look away, observed in both domestic dogs and their ancestor, the wolf, in order to examine whether or not domesticated dogs respond to this visual signal. Research indicates that domestic dogs respond appropriately to artificial dog models (Leaver & Reimchen, 2008). Therefore, we allowed live domestic dogs to approach an artificial model dog as it "looked away," turning its head approximately 45% to the left, from the approaching live dog participant. In order to reveal any pattern of behavioral responses among domestic dogs to the look away behavior, the observable behavior displayed by the live dog participant (in the moments following the model dog's look away) was recorded on video. Slow-motion review of the footage revealed that 36% of live dogs displayed some type of observable behavior (ranging from a brief break in eye contact to a blatant turn away from the model dog) after seeing the model dog look away, while 64% of live dogs displayed no observable behavior after seeing the model dog look away. A larger percentage of large dogs (dogs larger than the model dog) appeared to avert their gaze or look away after observing the model dog look away, and a larger percentage of small dogs (dogs smaller than the model dog) showed no observable response after observing the model dog look away. Goodwin et al. 1997 investigated the use of wolf-like visual signals in 10 breeds of domestic dog, rated according to their physical similarity to the wolf by a group of dog behavior counselors. It was found that wolf-like visual signals were observed less frequently in domestic dogs that are less wolf-like in their physical appearance. Dogs rated least wolf-like in their appearance also happened to be the smallest breeds examined in the study, while dogs rated as the more wolf-like in their appearance were larger in size. Using size as a heuristic indicator of physical similarity to the wolf, our data may indicate a possibility that less wolf-like domestic dogs may also respond to wolf-like visual signals less frequently.

While humans may understand many communication behaviors of domestic dogs, we often struggle in our understanding of dog-dog communication. Pet owners are not necessarily highly skilled in interpreting the communication behaviors that domestic dogs direct at each other (Tami & Gallagher, 2009). Pat Goodman explains, in the forward of *On Talking Terms with Dogs*:

Calming Signals by Turid Rugaas, that in our attempt to decode the “language” of domestic dogs, the behavior of wolf packs is often used as a model (Rugaas, 2006). While our knowledge of the social behaviors of wolves may be important for our understanding of domestic dog communication behaviors, there is research that suggests differences in domestic dog morphology may have an effect on their communication signals (Feddersen-Petersen, 2000; Goodwin et al., 1997; Kerswell et al., 2009; Kerswell, Butler, Bennett, & Hemsworth 2010; Leaver & Reimchen, 2008; McGreevy & Nicholas, 1999). Due to the physical effects of pedomorphosis (the retention of juvenile features into adulthood), the vastly different, novel morphologies of various breeds, and the popularity of certain features such as clipped ears and docked tails, many dogs are physically unable to use the same visual communication signals that wolves do. Recent research suggests that their repertoire of wolf-like visual communication signals is, consequently, shrinking (Goodwin et al., 1997). Goodwin et al. 1997 investigated the visual communication signals of 11 different domestic dog breeds, each rated by a group of dog behavior counselors as to their physical similarity to the wolf, measured by: “length of muzzle, eyes, shape of ears, ability to move ears, coat, tail, overall proportions of head and body, and ability to alter the height of the back from the ground” (Goodwin et al., 1997, pp. 300). The study demonstrated that as physical similarity to the wolf decreased so did the display of wolf-like visual signals (Goodwin et al., 1997). It has been suggested that domestic dogs now communicate with each other through other avenues due to the fact that visual communication is unreliable (Goodwin et al., 1997; Kerswell et al., 2009). Audition and olfaction have both been proposed as communication methods for domestic dogs (Feddersen-Petersen, 2000; Goodwin et al., 1997; Kerswell et al. 2009; Serpell, 1995; Wickens, 1993 as cited in Kerswell et al., 2009). It is possible that dog communication abilities may vary along with their morphology, as different breeds appear to have different visual signal repertoires (Goodwin et al., 1997; Kerswell et al., 2009). At the present time, we are unaware of any evidence of domestic dogs’ ability to receive and respond appropriately to the visual signals that they fail to display themselves (Goodwin et al., 1997). Our goal is to take the first step in an attempt to investigate this. Some clarification of the ability of domestic dogs to respond appropriately to the visual signals of other breeds would be of great value in our understanding of domestic dog communication. This information is important for pet owners, patrons of popular dog parks, animal shelter facilities, and dog day care facilities, where domestic dogs of all shapes, sizes, and breeds are in close proximity and may run the risk of misunderstanding or ignoring important communication signals.

For the current study, we observe the responses of domestic dogs to a wolf-like visual signal. The motion of “looking away,” avoiding eye contact and turning the head away from the other animal, has been identified in wolf ethograms as an act of submission (Fox, 1970 as cited in Goodwin et al., 1997), and has also been observed in the grey fox, another wild canid (Fox, 1969). M. W. Fox’s explanation of this behavior in the domestic dog is similar to the submissive gesture in the wolf; a behavior displayed when the dog is in the presence of a dominant conspecific, or when the dog is in an anxiety-provoking situation (Fox, 1969). More recently, the look away behavior continues to be described as a display indicating the dog is uncomfortable or in a conflict situation that they wish to abate (Coren, 2000; Rugaas, 2006). In Stanley Coren’s, *How to Speak Dog*, “eyes turned away to avoid direct eye contact” indicates “a signal of submission, with some undertones of fear” (Coren, 2000, pp. 260). These interpretations of the behavior imply that domestic dogs use this signal in a similar manner as wolves. Considering the observed differences between wolf social behavior and domestic dog social behavior (Feddersen Petersen, 1991 as cited in Feddersen-Petersen, 2000), and the variability in domestic dog communication, is it correct to assume that all domestic dogs interpret the look away in a similar manner, if at all?

We gathered evidence of the typical response of domestic dogs to the look away behavior through the use of a robotic, artificial model dog. Animal communication researchers often use robotic animal models in order to send and elicit messages from live animals of interest (Knight, 2005; Leaver & Reimchen, 2008; Young, 2007). Findings in Leaver & Reimchen, 2008, suggest that domestic dogs respond appropriately to artificial models. For this study, we used a realistic model dog with a remote control operated microcontroller and servo motor placed inside the neck. At Peter’s Park Dog Park in Boston, MA, we allowed live dogs to approach the model dog and, via remote control, the model dog looked away from the approaching live dog. The behavioral response of the approaching live dog was recorded.

METHODS

Subjects

Participants included all pet dogs present at Peter’s Park Dog Park (Boston, MA) that, with their owners’ permission, voluntarily entered the pen containing the model dog. Dogs that did not willingly enter the pen, dogs on a leash being held by the owner, and dogs that clearly did not look in the direction of the model dog were not included. A total of 61 dogs from various breeds were recorded. Identifying information, including the dogs’ breed, was not recorded.

Apparatus

A stuffed dog resembling a golden retriever, 14 inches tall at the shoulder, was used as the model dog. PVC pipes (1/2") were placed inside among the stuffing to act as a frame. A small motor (HS-422 Delux Servo) was attached to the PVC pipe inside the neck area and an attached microcontroller (Arduino UNO Rev3) was placed inside the shoulders. The head of the stuffed dog was attached with industrial strength Velcro to a plastic disc that was screwed, securely, onto the top of the motor. A small IR receiver (to receive the signal from the remote control), attached to the microcontroller inside the shoulders, rested at the back of the dog's neck. The microcontroller was programmed such that, with the push of the remote control button, the motor turned the disc, with the dog's head attached, to a position 45 degrees to the left. The fur surrounding the neck area effectively covered the small motor and muffled its sound, and the remote control was effective from up to 15 feet away. These factors increased the realistic nature of the model and its look away behavior.

Data Collection/Procedure

Data were collected in six sessions, the first on July 10, 2012 and the last on July 26, 2012. Sessions were held on both weekdays and weekends. They ranged from one to three hours long and took place at different times during the day: early morning from 7:00-10:00am (July 26), mid morning from 10:00-11:30am (July 12), early afternoon from 1:30-3:00pm (July 10), late afternoon from 2:45-5:30pm (July 13), early evening from 5:00-7:45pm (July 15), and evening from 7:15-9:15pm (July 17). All data collection sessions took place at Peter's Park Dog Park located in Boston, MA. A small area, approximately 6 x 11 feet was sectioned off in the corner of the park with an approximately 2.5 ft. tall plastic fence. The fence was covered with dark plastic in order to deter potential participant dogs from looking inside the pen before entering. The model dog was positioned inside the pen, approximately 8 ft. from the pen's entrance, with head and body facing the pen's entrance, "looking" directly at the entering live dog participant (see Figure 1). Interested dog owners brought their dog to the entrance of the pen where the door was opened for the live dog to enter. When the live dog stepped approximately 1 foot past the entrance of the pen (as indicated by a marker), the remote control was used to turn the dog model's head approximately 45 degrees to its left, "looking away" from the approaching dog. The dog participant was observed and filmed on a Sony XR150 or a Cannon Vixia HV40. Any obvious, distinct behavior of the live dog seen in the moments after observing the model dog's look away was recorded on a data sheet. After recording this information, an instant photo was taken of the live dog participant with a Fujifilm Instax210 instant camera, and the photograph was attached to the data sheet. This was



Figure 1. The Artificial Model Dog's Pen

done in order to correctly identify each live dog participant in the video footage and to ensure that each dog was recorded only once. The video footage was carefully reviewed and all live dogs' behavior in the moments immediately following the observation of the model dog's look away behavior fell into one of two categories. A percentage of dogs averted their gaze from the model dog for a brief moment after observing the model dog's look away behavior and were categorized as dogs that "looked away." The behaviors of dogs that fell into the look away category included momentary breaking of eye contact, sometimes only visible in slow motion (or frame-by-frame) review of the tape. Some dogs in this category blatantly turned their head away and paused or withdrew. Dogs that did not look away from the model dog after observing the model dog's look away behavior showed no observable behavioral response in the moments after observing the model's behavior and were categorized as such. Any behaviors that occurred after the moments following the observation of the model dog's look away, such as sniffing, making contact with the model, or leaving the enclosed area that housed the model dog, were not recorded.

It is important to note that some of the live dog participants appeared to lower their heads slightly at some point during their entrance into the pen or during their approach toward the model dog. This was not recorded or included in data analysis due to the fact that the angle of the camera made it impossible to determine if the head lowering was an intentional visual signal or merely an effect of the dogs' natural gait. Dogs that lowered their heads enough such that they averted their gaze away from the model dog were counted in the "look away" category.



Table 1. Percentage of Participating Live Dogs Who Displayed an Observable Look Away Behavior After Seeing the Look Away of the Artificial Dog Model, Separated by Size

Size (In Relation to Clancy)	Look Away	No Observable Change	Totals
Smaller	22.7%	77.3%	100%
Similar	30%	70%	100%
Larger	55.6%	44.4%	100%
Totals	36%	64%	100%

Table 2. Number of Participating Live Dogs Who Displayed an Observable Look Away Behavior After Seeing the Look Away of the Artificial Dog Model, Separated by Size

Size (In Relation to Clancy)	Look Away	No Observable Change	Totals
Smaller	5	17	22
Similar	3	7	10
Larger	10	8	18
Totals	18	32	50

Figure 2. Model Dog First Looking Toward Approaching Live Dog (top), And Then Performing the Look Away Behavior (bottom)

RESULTS

Of the 61 dogs, 11 were eliminated from data analysis. Six dogs did not see the model dog's look away behavior, as noted by slow motion review of the video footage. Four live dogs were eliminated due to insufficient reviewable footage, and one dog was eliminated because review of footage revealed that the model dog did not turn its head.

The behaviors of the remaining 50 dogs, displayed in the moments after they observed the model dog's look away, fell into one of two categories: 18 live dogs looked away from the model dog, and 32 live dogs showed no observable behavioral change in their approach (see Table 1). Live dogs that looked away from the model dog displayed behaviors ranging from a brief (only visible in slow-motion review of footage) break

in eye contact, to a blatant turn of the head away from the model dog. Some of the dogs in this category with the most distinct observable behaviors paused briefly or withdrew, while others showed no change in their speed of approach. All live dogs in this category averted their gaze away from the model dog at some point in the moments following the model dog's look away behavior. Overall, 36% of all live dog participants displayed an observable behavior (looked away) after seeing the model dog look away, while 64% of participants showed no observable behavior (see Table 2). When separated by size (dogs that appeared smaller than the model, the same size as the model, or larger than the model), the data shows that 22.7% of the small dogs looked away after observing the model dog's look away while 77.3% of small dogs showed no observable behavior, 30% of dogs the same size as the model looked away after observing the model's look away while 70% showed no observable behavior, and 55.6% of large dogs looked away after observing the model's look away behavior while 44.4% showed no observable behavior change.

DISCUSSION

The goal of this study was to observe responses to the look away behavior in domestic dogs, in order to find any evidence of the “understanding” of wolf-like visual communication behaviors. We use understanding here to mean that the dog observing the visual communication behavior displayed by another dog responds appropriately and accordingly to what previous research suggests the visual signal reveals about the signaling dog’s internal state. Popular belief and anecdotal evidence suggest that the look away is an act of submission, displayed when the domestic dog is uncomfortable with the situation. The model dog in this study was in an enclosed pen, and was approached by an unknown dog. When the model dog turned its head to look away from the approaching live dog participant, 64% of the time, the live dog continued to approach the model dog, with no discernable response to the visual signal that they observed.

An interesting explanation for this pattern of behavior is that some domestic dogs may understand and respond to the look away, while others do not. As discussed earlier, Goodwin et al. 1997, demonstrated that as wolf-like physical features decreased, so did the display of wolf-like visual signals. In Goodwin’s study, the smallest of the dog breeds that were observed (such as the King Charles Spaniel, Norfolk terrier, and French bulldog) were rated the least wolf-like. These were also the dog breeds that displayed the fewest wolf-like visual communication signals out of the breeds that were observed. Our data indicate that the smallest dogs of our study were the least likely to respond in any observable way to the look away behavior of the model dog (22.7% look away, 77.3% no observable response). Slightly more medium sized dogs responded to the look away (30% look away, 70% no observable response). Large dogs responded most often in some observable way to the look away behavior (55.6% look away or look away and pause, 44.4% no observable response) suggesting that they may have been the most likely to understand that the model dog’s signal indicated an uneasiness about being approached.

It is also possible that we observed a response in only 36% of live dogs because the majority of live dogs realized that the dog they were interacting with was a model. Despite the small percentage of obvious responses to the look away behavior, live dogs appeared to respond appropriately to the model dog during their initial approach. Some canine patrons at the dog park investigated the model dog during the experiment set-up and attempted to elicit play from the artificial model dog, or barked when the model was “looking” at them. Our experience was consistent with experience of other researchers that domestic dogs respond appropriately to artificial model dogs

(Leaver & Reimchen, 2008). Therefore, while it is possible that the live dogs knew the model dog was not real, we do not believe this was the case. All of the live dogs seemed to respond to the model dog as though he were, in fact, real.

It is important to note that the percentage of participating live dogs who displayed an observable behavior (36%) may be somewhat inflated, as we chose to include dogs in this category even if their look away was so quick that it was only visible in slow motion review of the footage and not seen in real time during data collection. This is important in terms of our understanding of domestic dog visual communication signals. It may be even more difficult for humans to observe accurate patterns in the behavior of domestic dogs if they are too quick to be seen in addition we have no way of knowing if other dogs are capable of discerning the behavior.

Our data are consistent with other studies that, together, suggest wolf-like visual communication signals are disappearing from the repertoires of domestic dogs as they become less and less wolf-like in their physical appearance. Further research is essential for more definitive answers regarding the use of visual communication signals in domestic dogs. We hope that future studies will investigate responses to the look away and other visual communication signals observed in domestic dogs in order to increase our understanding of how visual signals are displayed and received among dogs with varying visual signal repertoires.

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Diverse Mechanisms of Trinucleotide Repeat Disorders: An Exploration of Fragile X Syndrome and Huntington's Disease

CARA STROBEL



Cara Strobel authored this essay for the Cell Biology course in the spring semester of 2012. Given free

reign with a cell biology related topic, she wanted to explore and contrast the specifics of several prevalent disorders. Cara plans to apply to medical school in Spring 2013.

Trinucleotide repeat disorders are an umbrella group of genetic diseases that have been well described clinically for a long time; however, the scientific community is only beginning to understand their molecular basis. They are classified in two basic groups depending on the location of the relevant triplet repeats in a coding or a non-coding region of the genome. Repeat expansion past a disease-specific threshold results in molecular and cellular abnormalities that manifest themselves as disease symptoms. Repeat expansion is postulated to occur via slippage during DNA replication and/or transcription-mediated DNA repair. Trinucleotide repeat disorders are characterized by genetic anticipation, which is defined by the increasing severity and earlier onset of a disease as it is inherited through consecutive generations. Through the analysis of Huntington's disease as an example of coding trinucleotide repeat disorder and Fragile X Syndrome as an example of non-coding trinucleotide repeat disorder, this work will explore the nature of this devastating group of diseases and the underlying basic molecular processes that construct them. Despite sharing key characteristics, these diseases differ significantly in the wide variety of havoc the repeat expansions can create depending on their location and the nature of the disrupted function. Understanding of the mechanism and specifics of each individual disease remains critical for development of proper therapies.

Introduction

Trinucleotide repeat disorders are an umbrella group of genetic diseases that have been well described clinically for a long time; however, their molecular basis is still being elucidated. For example, Huntington's disease (HD), one of the most widely known diseases associated with trinucleotide repeats, was first described at the end of the 19th century, whereas the gene associated with this disorder was not discovered until the mid nineties of the 20th century (Chial, 2008). Currently, all known trinucleotide disorders are classified in two basic groups depending on the location of the relevant triplet repeats in a coding or non-coding region of the genome. The genome of a human cell could be viewed as a sum of the cellular DNA comprising its genetic blueprint. Coding

regions involve very small fraction of the human genome that codes for proteins. Protein molecules build most of the organism structures and function as working horses performing molecular work that underlies cellular physiology. The vast majority of human DNA does not code for proteins, thus comprising non-coding regions involved in orchestrating the regulation of protein expression. The execution of the genetic program of the human cell depends on the proper function of both coding and non-coding regions of the genome. As a general principle, mutations in coding regions inflict changes of protein sequence and function, whereas mutations in non-coding regions result in changes in the protein levels in the cell. Cells that are forced to work with altered or missing proteins exhibit abnormal physiology which on the organismal level is observed as disease symptoms.

Trinucleotide repeat disorders associated with coding regions include Huntington's disease, Kennedy disease (Spinobulbar muscular atrophy), Haw-River Syndrome (Dentatorubral-pallidolusian atrophy) and five different types of Spinocerebellar ataxia. These diseases are also called polyglutamine diseases since all of them are associated with repeats of CAG triplets, which code for the amino acid glutamine. The pathology of all diseases in this group involves pathologies of the nervous system (Cummings and Zoghbi, 2000).

Non-coding trinucleotide repeat disorders include Fragile X syndrome (associated with CGG repeats), Fragile XE syndrome (associated with GCC repeats), Friedreich's ataxia (associated with GAA repeats), Myotonic Dystrophy (associated with CTG repeats), Spinocerebellar ataxia type 8 (associated with CTG repeats) and Spinocerebellar ataxia type 12 (associated with CAG repeats). Some of these disorders have been found to be neurodegenerative (Fragile X syndrome) while others, like myotonic dystrophy, affect muscle maintenance (Cummings and Zoghbi, 2000).

Both groups of trinucleotide repeat disorders share common molecular features and most likely common mechanisms of repeat extension that are directly connected to the flow of genetic information in the cell. The DNA as a genetic blueprint is securely stored in the nucleus of the human cell and constantly monitored for its integrity. DNA replication, or DNA copying, takes place only before cellular division, to ensure that exactly the same genetic information is passed to the resulting offspring. Since proteins are needed continuously in the cell and the protein synthesizing machinery resides outside the nucleus, the genetic code is first copied into messenger RNA (mRNA) via a process called transcription. mRNAs are easily transported outside the nucleus and then recognized by the protein-making machines, the ribosomes, which translate

the genetic information into proteins. Any changes that take place in the DNA blueprint such as mutations can be subsequently traced as changes in RNA and could potentially affect the integrity of the corresponding proteins.

All trinucleotide repeat disorders are associated with genes whose natural sequence includes multiple repeats. By their nature, repeats present a challenge for the cellular machinery handling the DNA or RNA molecules that contain them. One can rationalize the challenge by comparing the error rates of reading a page of repetitive text versus a page of non-repetitive text. The likelihood of skipping or repeating a line by accident is much greater for repetitive text than for the non-repetitive one. Similarly, when DNA repeats are replicated or transcribed, there is an increased chance of error that will result in change of the number of repeats. Trinucleotide repeat disorders are associated with repeat expansion. One proposed mechanism for the expansion has to do with strand slipping during DNA replication. Petruska, Hartenstine, and Goodman (1997) conducted experiments with synthetic DNA containing trinucleotide repeats and concluded that repeated sequences promote slippage via DNA looping. In a region of repeats, separation of the strands of DNA during replication can cause single-stranded loops of repeats. When the looping takes place in parental DNA strand, the net result is reduction of the number of the repeats, simply because the repeats in the loop are skipped and not copied. If the newly replicating DNA loops out, the net result is repeat expansion since the repeats in the loop are copied twice. Alternative mechanism involves transcription-mediated DNA repair pathways. Repeated sequences confuse the transcription machinery, which stalls and activates the DNA repair systems of the cell that occasionally make an error leading to repeat expansion. It is thought that the DNA slippage mechanism is prevalent in actively dividing cells, whereas the transcription-mediated DNA repair mechanism is prevalent in non-dividing cells, such as neurons, for example. The repeat expansion can take place in both somatic and germ cells, thus offering an explanation why the severity of the trinucleotide repeats disorders can sometimes change during the course of the disease in a particular individual and between generations. As a consequence of the described molecular events, trinucleotide repeat disorders share a common phenomenon named genetic anticipation, which is defined by the increasing severity and earlier onset of a disease as it is inherited through consecutive generations.

Through the analysis of Huntington's disease as an example of coding trinucleotide repeat disorder and Fragile X Syndrome as an example of non-coding trinucleotide repeat disorder, this work will explore the nature of this devastating group of diseases and the underlying basic molecular processes that construct

them. Despite sharing key characteristics, such as trinucleotide repeat expansion and genetic anticipation, these diseases differ significantly in the wide variety of havoc the repeat expansions can create depending on their location and the nature of the disrupted function.

Molecular Mechanisms and Pathology of Huntington's Disease

Huntington's disease (HD) is one of the best known disorders within the polyglutamine diseases. It is an autosomal dominant disorder caused by the polyglutamine repeat expansion within the huntingtin protein (Htt) encoded by the IT15 (interesting transcript 15) gene located on chromosome 4. Individuals are affected by HD even if they inherit only a single abnormal copy of the gene. HD affects 1/10,000 individuals and is characterized by neurodegeneration. Specifically, it involves the depletion of neurons and an increased number of glial cells, primarily in the striatum region of the brain associated with movement planning, working memory, and decision-making. Other regions like the cortex, thalamus, and subthalamic nucleus are also affected (Sadri-Vakili and Cha, 2006). This atrophy of certain brain regions causes profound effects on the individual, but not until the fourth or fifth decade of life. An unfortunate truth of this, however, is that by the time the disease presents itself in symptoms, the mutated gene has likely been passed on to the next generation.

The three major types of symptoms associated with Huntington's are behavioral, motor, and cognitive. The disease presents itself as a progressive deterioration, usually taking the life of the affected individual 15-20 years after diagnosis (Longshore and Tarleton, 1996). Behavioral symptoms are the first to present themselves in the form of mood changes. Next, motor symptoms begin to occur in the extremities through involuntary twitching and loss of coordination. In conjunction with the motor symptoms, cognitive symptoms become more noticeable and complicated tasks become progressively more difficult to think through. As the disease advances, the severity of these symptoms becomes more intense to the point that the involuntary movements appear more like a frantic dancing as opposed to twitching. Changes in mood continue to develop though some people with HD become more apathetic in regards to their disease, losing interest in activities they used to enjoy. And finally, it becomes progressively harder for HD patients to think clearly as the disease worsens. In late stage HD, patients lose their involuntary movements and begin to experience rigidity and the lack of ability to move voluntarily at all.

It is well known in HD that the number of repeats is an important component of the disease. Huntingtin (Htt) is a natural protein found in numerous areas of the brain of all

individuals. All of the Htt proteins have the polyglutamine repeats, but the number of repeats can affect the onset, progression, and overall severity of the disease (Figure 1). Normal individuals have between 7-34 CAG repeats. Individuals with more than 40 repeats develop HD. If the number of repeats is over 70, a juvenile onset of HD is very likely. It has been observed in clinical settings that the severity and percentage of early onset of HD increases as the mutation is passed through

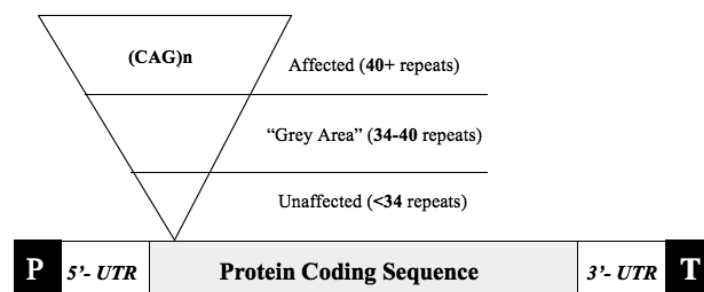


Figure 1. *Htt* gene structure and relationship to HD pathology.

CAG repeat expansions related to HD are located within the protein-coding sequence (in gray) of the *Htt* gene, thus affecting the sequence and the 3D shape of the protein. In contrast, the regulatory sequences of the *Htt* gene (Promoter (designated with P), Terminator (designated with T) and the UnTranslated Regions at the beginning of the gene (5'UTR) and the end of the gene (3'UTR)) are unaffected. The severity of the disease is directly correlated to the number of CAG repeats as depicted by the inverted triangle.

families (Longshore and Tarleton, 1996). There have also been differences in severity and onset depending on the parent from which the mutation was inherited. In HD, if the abnormal allele is inherited from the father, there is an increased risk of earlier onset, presumably from an expansion that had grown from the father's generation to his child's. It was found that the alleles involved are more unstable when transmitted through sperm as opposed to the egg, leading to changes in the number of repeats expanding through sperm transmission (Longshore and Tarleton, 1996).

There are several ideas of how glutamine expansion within the huntingtin protein causes HD. It is important to note, however, that neither mechanism is not fully understood. It has been proposed that the glutamine repeats cause a change in function of the Htt gene. For example, the mutant Htt protein binds to an intracellular protein HAP-1, to which the natural form of the protein would normally not bind. The HAP-1 protein has been noted to be involved in trafficking of vesicles and organelles, including mitochondria whose major function is energy production in the cell. The Htt protein, though found all throughout the body, is present at high concentrations in the brain. It is also thought that inefficient energy production

contributes to HD pathology since HD-related neurodegeneration could be reversed experimentally by treating with drugs interfering with energy-associated signaling (Varma, H., et al., 2007). Another idea for the effect the trinucleotide repeats have on Htt and subsequently the brain has to do with the way that the expansion affects protein folding, the process by which proteins adopt their 3D shape. When the Htt protein is misfolded, it gains a toxic function. The misfolded Htt protein has the potential to interact with nearby proteins that will cause selective degeneration and neuronal death (Cummings and Zoghbi, 2000). A second effect of the misfolded proteins is the potential for the formation of aggregates. The proteins attach to one another and form groups that can affect the nuclear architecture and the functions that it carries out (Cummings and Zoghbi, 2000).

Lastly, mutated Htt protein can alter transcription by interfering with histone modifications. Histone molecules are part of the efficient DNA packing in the cell. Strands of DNA wrap themselves around histone to become more compact when genes are not used (transcribed). When DNA needs to be transcribed, the strength of the hold the histone has on the DNA weakens and the DNA can be more easily accessed to allow the genetic information to be used to make proteins. When the mutant Htt interacts with histones, chromatin becomes more compact, therefore inhibiting necessary transcription (Sadri-Vakili and Cha, 2006). Changes in transcription regulation in the brain clearly have profound effects on brain function and degeneration, and they are found frequently in those individuals diagnosed with HD (Sadri-Vakili and Cha, 2006). It is quite possible that mutant Htt protein inflicts brain damage via multiple mechanisms since the Htt is a large multifunctional protein in its natural form. Logically, when it does not work properly, multiple physiological circuits of the cell could be disrupted.

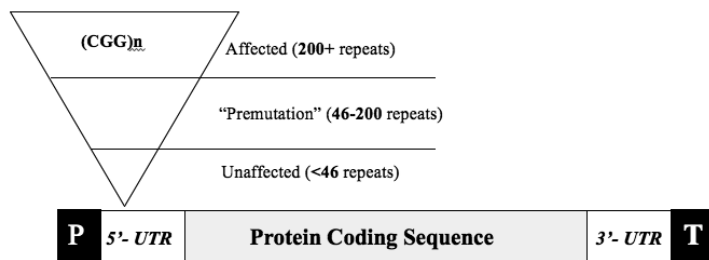


Figure 2. *FMR1* gene structure and relationship to Fragile X pathology. CCG repeat expansions related to **Fragile X syndrome** are located within the regulatory 5'UTR sequence (in white, on the left) of the *FMR1* gene, and do not affect the sequence and the 3D shape of the encoded protein. All regulatory sequences are labeled as described in the legend of Figure 1. The severity of the disease is directly correlated to the number of CCG repeats as depicted by the inverted triangle.

Molecular Mechanisms and Pathology of Fragile X Syndrome

Just as the mechanism for HD is speculated upon and not fully understood, mechanisms for a fellow trinucleotide repeat disorder, Fragile X Syndrome (FXS), are also the subject of intensive research. Since FXS was one of the first trinucleotide disorders to be recognized and studied, the mechanisms are much better understood. The FXS relevant repeat is located in the 5' untranslated region (Figure 2) of the *FMR1* (Fragile X Mental Retardation) gene on the X chromosome (Longshore and Tarleton, 1996), i.e. no changes in the protein itself are taking place, rather its amount is being changed. In contrast, the HD repeat is located in a translated region on chromosome 4, i.e. the defect alters the encoded protein directly introducing more glutamines. FXS is an X-linked dominant disorder that is one of the most commonly inherited forms of mental retardation, second only to Down syndrome. Since males have only one X-chromosome and females have two X-chromosomes, the disease manifests itself differently between males and females. Males usually display a significant intellectual impairment, but there is a range of severity. There are several distinctive physical features for FXS that include a long face, large ears, flat feet, and hyperflexible joints (National Fragile X Foundation, 2012). In terms of behavioral symptoms, increased aggression, ADHD-like attention issues, and social anxiety are all common in males affected by FXS. Males pass the disease only to their daughters since they are the ones inheriting an X chromosome from their father, whereas male offspring inherit their father's Y chromosome. In contrast, females can pass the disease to both sons and daughters and display less severe phenotypes as compared to their male counterparts. The differences in severity of the phenotype are at least in part associated with the X chromosome inactivation phenomenon in females. Each female cell randomly inactivates one X chromosome. If the inactivated chromosome contains a defective copy of the *FRMP* gene, then the cell will appear normal because the working X chromosome contains a functional copy of the gene. As a result, female bodies contain a variable mix of normal and defective cells, leading to a broad range of severity of the symptoms. Only one third of affected females have a significant intellectual disability and the behavioral symptoms are the same, but less severe than those affected males where all cells in the body have a defective X chromosome (National Fragile X Foundation, 2012).

FXS affects 1/1,250 males and 1/2,500 females and, like an HD, there is a range of repeats (Figure 2) that can cause the disorder (Timchenko and Caskey, 1996). Individuals with stable repeats that do not display the phenotype of FXS have repeats ranging from 6-46, and unaffected carriers have 50-200 repeats. The unaffected carriers, who have the coding for the

premutation, can pass along the expansion to their children. Those individuals with over 200 repeats in the FMR1 gene will exhibit the described phenotype. Just like HD, FXS displays unusual inheritance patterns of the nucleotide expansion. In addition to genetic anticipation, FXS is characterized with a parent of origin phenomenon or Sherman Paradox (Timchenko and Caskey, 1996). When a male with premutation has children, he passes on the premutation with minimal if any change in the number of the repeats. If a female passes on premutation alleles, the section is very likely to expand and develop into a full mutation resulting in Fragile X syndrome. This phenomenon is attributed to differences in the processes of sperm and egg formation (Timchenko and Caskey, 1996). Some individuals can have the FXS mutation but show no symptoms, a phenomenon known as incomplete penetrance.

Similar to HD, FXS is associated with a particular gene; FMR1 coding for FMRP, or fragile X mental retardation protein. In healthy individuals, FMRP is expressed in many tissues in the body with the highest levels in the neurons of the brain, testes and ovaries (Timchenko and Caskey, 1996). FMRP is an RNA-binding protein that shuttles between the nucleus and the cytoplasm presumably regulating the transport of specific mRNAs. In addition, FMRP has been found to associate with ribosomes in the dendritic protrusions of neurons, which suggests potential role in the translation of mRNAs specific for this area of the cell. FMRP interacts with several proteins; however the biological significance of the interactions is not understood (Cummings and Zoghbi, 2000; National Institutes of Health: FMR1, 2012).

The accumulation of trinucleotide repeats associated with FXS results in alteration of the expression of the FMR1 gene leading to limited or absent fragile X protein production in the cell proposed to lead to disrupted neuronal communication. Two mechanisms have been experimentally supported: 1) decreased efficiency of translation initiation, most likely caused by the repeats impeding the proper assembly of the ribosome on the FMR1 mRNA and 2) transcription silencing via methylation of the DNA region governing FMR1 transcription resulting in lack of FMR1 mRNA and thus lack of Fragile X protein. The second mechanism is observed only in patients with more than 200 repeats (Timchenko and Caskey, 1996).

Collectively, both mechanisms result in insufficient levels of FMRP necessary for proper functioning, thus neuronal abnormalities and loss are observed and mental retardation occurs (Cummings and Zoghbi, 2000; Longshore and Tarleton, 1996).

Do all trinucleotide diseases have a common mechanism?

An interesting comparison has been made between HD and FXS in terms of the underlying mechanisms. There is a difference in the way in which the mutation affects the primary function of those pathways. Fragile X syndrome results from a reduced level of the FMRP or loss of function; whereas Huntington's disease results from changes in function of the associated protein (Cummings and Zoghbi, 2000; Longshore and Tarleton, 1996). In HD, the increase of the number of trinucleotide repeats causes the formation of aggregates and the acquisition of potentially toxic qualities that cause the neuronal death noted in the disorder. In FXS, the hypermethylation of the promoter region on the FMR1 gene causes a decrease in transcription, reducing the amount of FMRP which is vital for the proper development of neuronal tissue. It is the loss of function that causes the phenotype, not a gain in toxic function, as in the case of HD.

Despite their extensive differences, there have been attempts to link the trinucleotide repeat disorders together mechanistically. For example, Kaplan, Itzkovitz, and Shapiro (2007) proposed a universal mechanism for trinucleotide disorders specifically referring to the size of the repeat and how that affects the onset of the disorder. They explained that patients with large nucleotide repeats are born with all relevant cells having a copy of the mutation and as the individual grew older, the toxic effects of the repeat's misfolding or other behavior within the body grew progressively in numbers. There is a threshold for the amount of toxicity that is tolerated before phenotypic manifestations of the disorder begin to arise, and later in life with more and more developing due to these disorders, the phenotype begins to appear at these later points. Those with a greater number of repeats have a more severe display of the disorder and an earlier onset. According to their proposed mechanism, the trinucleotide repeat is more potent when it is longer and it therefore produces more drastic effects and quicker presentation. Though this mechanism does match the progression of HD, FXS is one trinucleotide disorder that does not manifest in this way. FXS presents itself from birth and does not progressively get worse. It very well may fit the mechanisms of other trinucleotide disorders, but one of the most well known of the group does not fit the proposed "all-encompassing" theory. The clinical observations could be very well explained with the underlying molecular events. Since Fragile X is caused by lack of functional FMRP, the increase of the number of repeats will not change the condition simply because all FMRP has been lost already.

As illustrated through the analysis of two of the most prevalent disorders, the trinucleotide repeats in both coding and non-coding regions of the genome do share several similarities, but

are very different mechanistically and phenotypically. They share the same basic type of molecular defect, but depending on the location of the trinucleotide repeat, the affected proteins can gain functionality in some cases, while in others can lose functionality, both of which can result in neuronal loss and subsequent symptoms. In addition, the natural functions of each affected protein are very different and their disruption results in widely varying abnormalities in cell physiology. Therefore, it seems unwise to try to offer a universal mechanism that would incorporate all aspects of the trinucleotide disorders and lead to development of common strategies for their management and treatment. Thus, it is highly unlikely that a universal mechanism would apply to all aspects of the various trinucleotide diseases solely based on the fact that they stem from the same type of mutation. Understanding of the mechanism and specifics of each individual disease remains critical for development of proper therapies.

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The Role of Temporal Comparisons in Judgments of Gender Equality

MEGHAN SULLIVAN AND ZEELY SYLVIA



Meghan Sullivan (left) is a graduating senior with a major in Psychology and minor in Mathematics, and Zeely Sylvia is a recent graduate with a major in Psychology. This research was conducted under the direction of Dr. Laura Ramsey, which originated in her Psychology Research Methods class and developed into an ongoing project. Meghan and Zeely presented this study at the BSU Undergraduate Research Symposium and will present at the Association for Psychological Science Convention in Washington, D.C in May, 2013. Meghan will begin the pursuit of a Ph.D. in Cognitive Psychology in the Fall of 2013, and Zeely is currently working as a research assistant in Providence, Rhode Island. She plans to apply to graduate schools for Fall 2014.

While women have achieved great advancements in social status in the past century, sexism remains a widespread issue. Perceptions of sexism today could be affected by comparisons to the past, when sexism was much worse. The current study investigated the effect of using different temporal reference points to make judgments about the state of gender equality today. Based on temporal comparison theory, a process of making judgments of the present based on an individual's view of the past, it was expected that those considering the past would see gender inequality as less of an issue currently than those considering the present. Participants included 29 males and 66 females recruited online through Facebook and primed into a past or a present mindset by reading an incidence of sexism framed in either 1963 or 2008. The conditions were compared on a variety of measures to detect any differences in their perceptions of modern gender equality. Participants in the present condition perceived significantly more progress needed to achieve gender equality and perceived society as favoring men significantly more than those in the past condition. Understanding how temporal comparisons can affect ongoing efforts to promote women's progress can inform efforts toward social change.

The Role of Temporal Comparisons in Judgments of Gender Equality

Sexism in society today is a pervasive issue, and women are still a long way from achieving gender equality. Women continue to earn less income, are underrepresented in positions of power, and face more discrimination as compared to men. In 2009, the median earnings of all working Americans, aged 15 and older and regardless of work experience, was \$36,331 for men and \$26,030 for their female counterparts (U.S. Census Bureau, 2010). In 2011, only 16.1 percent of board seats at *Fortune* 500 companies were held by women (Catalyst, 2011). In a recent study, researchers found that women experience sexist events on a regular basis, severe enough to impact their psychological well-being (Settles, Cortina, Malley, & Stewart, 2006; Lim & Cortina, 2005).

Although sexism is clearly still entrenched in our society, the ways in which it has changed over time may ultimately make it harder to eradicate. Prejudice is no longer as blatant as it once was due to the nature of the current social and political climate (Swim, Aiken, Hall & Hunter, 1995). Sexism was previously characterized by the outspoken endorsement of stereotypical views of women and promotion of conventional gender roles, but contemporary forms of sexism

reflect a subtle and covert belief in prejudicial attitudes toward women (Swim, Hyers, Cohen, & Ferguson, 2001). This new form of sexism, called “modern sexism,” is described by Swim and colleagues (1995) as a denial of continued discrimination based on sex and a feeling that women’s demands of equality are unwarranted, resulting in resentment of women. Similarly, “neo-sexism” reflects a difficulty in reconciling modern-day egalitarian values and persistent sexist attitudes toward women (Tougas, Brown, Beaton, & Joly, 1995). These forms of sexism implicitly convey that any current inequality between men and women is justified, and consequently that further change is unnecessary.

The current climate of covert sexism makes it more difficult to detect how much sexism is prevalent, which then makes progress achieved harder to gauge. Sexist attitudes, while covert, may also have an effect on perceptions of progress made and change necessary to achieve gender equality. This gradual change allows for a wide diversity in terms of how an individual may perceive sexism in modern society. Since individual perceptions of progress towards equality are often subjective, there is no specific standard against which it can be judged.

One way someone could evaluate the degree of sexism in today’s society is to compare it to a previous era. Much social psychological research has shown that comparison processes are very important when making judgments. Research on social comparison theory (Festinger, 1954) has consistently shown that individuals perceive themselves in comparison with others. In particular, people tend to experience increased self-esteem when comparing themselves to less fortunate others (Tesser, 1988; Wood, 1989). Temporal comparison theory then extended social comparison theory by showing that these comparisons could be made between two different points in time (Albert, 1977), an idea that has often been applied to personal and intergroup assessments (Wilson & Ross, 2000; Zell & Alicke, 2009; de la Sablonnière, Tougas & Perenlei, 2010). When considering the struggle towards gender equality, more progress today may be perceived when compared with the past. However, in considering the present with the end goal of total equality, progress made is insufficient.

Previous research has shown that these comparison processes affect perceptions of sexism. In a recent study, Eibach and Ehrlinger (2010) found that temporal comparisons influence men’s and women’s perceptions of current progress toward gender equality, such that men perceived a greater amount of progress than women. They found that this discrepancy seems to be because men and women are employing different temporal comparisons. Men tend to gauge progress by

comparing present day conditions to those of the past. In other words, they are measuring how far society has come since a particular time, which makes the progress seem significant. Women, in contrast, make their judgments of modern equality by comparing it with a future ideal of complete equality (Eibach & Ehrlinger, 2010), making the current progress seem less impressive.

The implications for adopting one common reference point over the other may be significant. According to Spoor and Schmitt (2011), comparing past inequalities with present conditions may actually decrease the amount of group identification and solidarity that women experience towards their gender. This idea originates from social identity theory (Tajfel & Turner, 1979), which states that group identities are created via comparisons with other groups, and that the value of an individual’s social identity is based on his or her judgments of a positive social identity based on these comparisons. Any comparison which undermines the individual’s in-group by way of higher social status or advantage is conceptualized as a threat to one’s social identity. In a study by Spoor and Schmitt (2011), it was found that when women drew upon intergroup comparisons with men they were confronted by a social identity threat, as the low status gender group. This led to a greater expression of solidarity and activism in women. In contrast, women who made temporal comparisons with women in the past were not confronted with a threat; in fact, compared to past generations of women, they were the higher status social group. This led the women in this study to identify less with their gender group and express less solidarity. Considering that women are still subjected to sexism and discrimination in the United States, this lack of group identification could work against the progression towards gender equality. Considering also that collective action towards inequality is more likely when one perceives discrimination against their in-group (Foster, 1999), it is likely that temporal comparisons would be damaging to feminist causes.

The aim of the current research is to understand how the perception of sexism framed in the past leads people to think about sexism in modern society today. Based on previous studies, we would expect to find a difference in perceptions of sexism today between conditions primed with an instance of sexism dated in the past or present. As it is difficult to obtain objective evidence for progress towards gender equality, we would expect participants to use temporal comparisons influenced by the prime in their evaluations of progress today. We predicted that, compared to the past condition, the present condition would perceive that less progress has been made and more change is necessary to achieve gender equality. Furthermore, thinking about sexism in a past context would facilitate the endorsement

of modern sexist beliefs that imply that sexism no longer exists in modern society.

METHOD

Participants

Ninety-seven participants completed the study after being recruited through a social networking website, *Facebook* (2012). Twenty-nine were males and 66 were females (3 did not specify their gender). Ages ranged from 18 to 58 years ($M = 27.90$, $SD = 10.17$), although 50.5% of the sample were between the ages of 22 and 24. The sample was 85.6% Caucasian, 2.1% African American, 2.1% Latin American, and 7.1% specified other ethnic backgrounds (an additional 3.1% did not specify their racial identity). Participants were predominantly single (75.3%), but some were married (13.4%) or divorced (7.2%), and 4.1% did not indicate their marital status.

Materials and procedure

Participants were invited to take part in a study titled “Gender Equality.” An event was posted on the *Facebook* website from the researchers’ personal profile pages, asking people to participate and share the survey link with their own friends. Upon clicking the link attached to this event, a new window opened an external website, hosted by *Google Docs* (Google, 2012), which included the questionnaire. An informed consent prompt explained their rights as a participant, and participants gave their consent to participate by continuing to the survey.

In order to approximate random assignment to conditions, participants next indicated their birth month. A response of January-June placed participants into the past condition ($n = 43$), while July-December placed participants into the present condition ($n = 55$). On the next page, they read a brief vignette describing an incident of workplace sexism to prime a specific reference point as a standard for comparison:

It is (YEAR). Mary and Andrew are both 25 years old, college-educated Junior Executives at Company X. They are both dedicated to their jobs and have similar goals within the company. One day, a fellow co-worker lets it slip to Mary that Andrew receives a considerably larger salary than her. Mary is shocked and outraged; she and Andrew have the same exact job description.

The paragraphs were identical for both conditions with the exception of the time period: in the past scenario, participants were told the incident happened in 1963, while those in the present scenario were told that it occurred in 2008. The “past” was operationalized as 1963, a year well before the feminist movement of the 1970s and 1980s but not so far as to seem

irrelevant or unfamiliar. They then rated the anecdote according to how just they perceived the situation on a 7-point scale (1 = *not at all just*, 7 = *very just*) to ensure that the scenarios were perceived exactly the same, with the exception of the date.

Following this, all participants continued to the next page to complete questions measuring perceptions of sexism in modern society. Participants were first asked to indicate how much progress had been made toward gender equality in the United States since the 1970s by responding on a scale ranging from 0 (*very little progress*) to 7 (*a great deal of progress*). This single-item measure of perceived progress toward equality was based upon a similar measure used in past research that successfully measured assessments of progress towards racial equality (Eibach & Ehrlinger, 2006; Eibach & Keegan, 2006). Participants also indicated their perceptions of whether society in the United States generally favors men or women on a scale from 0 (*men are heavily favored*) to 7 (*women are heavily favored*). Lastly, participants indicated how much change in American society would be necessary to achieve gender equality on a scale from 0 (*very little change*) to 7 (*a great deal of change*).

Participants also completed two validated measures of sexism. First, participants completed 8 items from the Modern Sexism Scale (Swim et al., 1995) to assess beliefs that discrimination against women no longer exists. Components of the scale include denial of continuing discrimination (e.g., “Women often miss out on good jobs due to sexual discrimination” [reverse scored]), antagonism toward women’s demands (e.g., “It is easy to understand why women’s groups are still concerned about societal limitations of women’s opportunities” [reverse scored]), and resentment about special favors for women (e.g., “Over the past few years, the government and news media have been showing more concern about the treatment of women than is warranted by women’s actual experiences”). The items were rated on a scale from 1 (*strongly disagree*) to 5 (*strongly agree*). Scores were averaged (after reverse coding when appropriate), with higher scores indicating more sexism in modern society ($\alpha = .82$).

Participants then completed the Neo-sexism scale (Tougas et al., 1995), a 10-item measure focusing on how respondents express sexist attitudes without necessarily specifying whether they believe women to be inferior to men. Sample items include “In a fair employment system, men and women should be considered equal” (reverse coded) and “It is difficult to work for a female boss.” Participants rated the items on a scale from 1 (*strongly disagree*) to 7 (*strongly agree*). Scores were reverse coded and averaged, with higher scores indicating greater approval of sexist attitudes ($\alpha = .82$).

Activism in gender equality was also assessed. Participants indicated their level of interest in 11 items of various activities, such as participating in political campaigns, supporting women's causes (breast cancer telethons, rape victim's vigils, pro-choice rally), or joining internet discussions in support of women's rights. Items were rated on a scale from 1 (*not at all interested*) to 5 (*very interested*) and averaged to produce a final score ($\alpha = .91$).

Finally, a brief demographic questionnaire concluded the survey to obtain basic information about the participants. After submission, participants received a confirmation and debriefing which thanked them for their participation.

RESULTS

To test the hypothesis that participants in the past ($n = 43$) condition would perceive sexism differently than participants in the present ($n = 55$) condition, a series of independent-sample t -tests were conducted (see Table 1). There was no difference regarding degree of injustice, indicating that the manipulation worked as intended and only affected temporal perceptions. Of note, participants in the present condition perceived significantly more progress needed to achieve gender equality and perceived society as favoring men significantly more than those in the past condition. Also, participants in the past condition had marginally significant higher scores on modern sexism than those in the present condition. No other differences between the two conditions were statistically significant, although the means were in the hypothesized direction for all of the dependent measures.

There were also notable gender differences within our sample. Men ($M = 2.61$, $SD = .93$) scored significantly higher than

women ($M = 2.19$, $SD = .81$) on the neosexism scale, $t(92) = 2.25$, $p = .03$. Men ($M = 3.12$, $SD = .78$) also scored significantly higher than women ($M = 2.83$, $SD = .61$) on the modern sexism scale, $t(92) = 1.97$, $p = .05$. Women ($M = 1.65$, $SD = 1.12$) perceived society as favoring men ($M = 2.21$, $SD = 1.54$) significantly more than men did, $t(92) = 1.98$, $p = .05$. Men and women were not significantly different in their perceptions of how much progress has been made toward gender equality since the 1970s, the amount of change necessary to achieve gender equality in American society today, or their interest to engage in activism activities. However, when including gender as a covariate in an ANCOVA testing the effect of condition on the dependent measures, the pattern of results remained the same.

DISCUSSION

The aim of the current study was to investigate the effect of reference points on perceptions of gender equality in modern society. Consistent with predictions, using the past as a standard for comparison led participants to perceive that more progress has been made toward gender equality, whereas thinking about a sexist event in the present led participants to perceive that society favors men more than women. Also, there were no significant differences between males and females in their ratings of progress, indicating that gender differences may have converged when adopting a similar reference point for comparison.

Although not significant, a trend was found in the perceptions of society's favoring of men over women, with women having a slight tendency to rate men as more favored. This may reflect women's experiences with sexism and discrimination in the past. As men are frequently seen in positions of power and

Table 1. Differences in Past and Present Conditions for Perceptions of Gender Equality

Perception Measure	Past Condition ($n = 42$)		Present Condition ($n = 55$)		df	t	p
	M	SD	M	SD			
Change Necessary	5.14	1.20	5.51	1.30	95	-1.42	0.16
Progress Achieved	4.67	1.24	4.11	1.36	95	2.08	0.04
Favored Gender	2.12	1.29	1.62	1.23	95	1.95	0.05
Degree of Injustice	2.07	1.89	2.07	1.92	95	0.00	1.00
Neo-sexism Scale	2.38	.75	2.29	.94	95	0.50	0.62
Modern Sexism Scale	3.05	.69	2.83	.63	95	1.64	0.10
Activism Scale	3.22	.94	3.43	1.04	93	-1.01	0.32

government statistics reveal a gap in salaries (U.S. Census Bureau, 2010), it is understandable that women perceived men as the preferred gender. More surprisingly, many of the men also perceived themselves as having higher social status. Despite male acknowledgement of their higher social status, men had higher ratings of sexism. Since the sexism scales focused on feelings of resentment toward women and denial of the existence of sexism, this difference may indicate a need for targeted recruitment strategies to promote activist activities for both genders. The higher rates of modern sexism among men may also be explained by social identity theory, which claims that social groups form mental representations of their status by comparing their group with other “out-groups,” which may also enhance group identity cohesion. (Tajfel & Turner, 1979). For men, a threat to their perception of higher status by the continuing progress of women and gender equality may explain their sexist attitudes and low rates of activism. Future research should address the influence of common reference points for the past and present conditions and the impact between males and females in either condition; the number of participants in the current study was insufficient to fully address this issue.

While the sample had a large variety of age groups, future research may wish to more fully investigate the influence of age on temporal comparisons and perceptions of sexism. The age range was between 18 and 58 years, which indicates a wide variance in life experiences for our overall sample. However, as most participants were not alive prior to the 1980s and 1970s, they did not experience conditions when gender inequality was greater in magnitude. This lack of direct familiarity of past conditions to gauge progress may have biased our sample.

The nature of data collection may have influenced the external validity of the study. The sample was recruited through a social networking site, which may have limited the potential to reflect population level characteristics. In addition, because participants were free to take the survey online without any regulation over the environment or time limits, there may have been a negative impact on the internal validity of the study.

The results of this study indicate that temporal comparisons may influence perceptions of gender inequality. Future research should continue to examine the consequences of temporal comparisons, as well as the effect of other types of comparison that could be used to gauge progress. For example, in comparing different cultures around the world, progress may be perceived differently. Future research should also address the complex influence of cultural differences on perceptions of gender equality.

The current research examined the effects of temporal comparisons between a past and present mindset and found some support for the effects of temporal comparisons in influencing opinions. Understanding how the use of past comparisons can affect ongoing efforts to promote women’s progress might be relevant for efforts toward social change. For example, while it is important to celebrate progress toward gender equality through events such as women’s history month, our results suggest that emphasizing sexism in the past may actually undermine future progress for women. A focus on inequality today may be more effective for encouraging further progress to equality, and so discussion of sexism in the past should be accompanied by an emphasis that sexism still persists today. Gender equality might best be achieved by referencing the end goal of total equality rather than advancements made in the past. With further research to examine the effects of temporal comparisons on perceptions of sexism, this possibility may be further supported and contribute significantly to the goal of gender equality.

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Virtual Ideals: The Effect of Video Game Play on Male Body Image

ZEELY SYLVIA



Zeely Sylvia received her undergraduate degree from Bridgewater State in January 2013,

graduating Summa Cum Laude with a major in Psychology. This research was funded by the ATP Summer Grant Program over the Summer of 2012. The project originated from her time working in the Psychology Department's Body Image Research Lab under the direction of Dr. Teresa King and Dr. Brendan Morse. It was presented at the BSU Summer Symposium in August of 2012, and more recently at the Eastern Psychological Association Convention in New York City in March of 2013. Zeely is currently working as a research assistant at The Weight Control and Diabetes Research Center in Providence, RI, and plans to apply to graduate programs for the Fall of 2014.

Popular media has long been cited as a negative influence on body image and self-esteem by perpetuating unrealistic ideals of the human body. However, the influence of video games has remained largely unexamined despite their growing popularity as a media form, particularly among men. The purpose of this study was to investigate whether playing video games that emphasize an unrealistic male body ideal has a negative impact on male body image. Male participants were randomly assigned to play a highly realistic video game with either a muscular character or a character of average build. Men in the muscular condition reported significantly more negative attitudes about their body (body esteem) and greater attention to muscularity than men in the control condition. Considering the wide-spread use of video games, as well as the increasing muscularity of the ideal male body in popular culture, this finding could have important implications for the psychological well-being of male gamers who are regularly exposed to unrealistic body ideals in video games.

The concept of body image encompasses all facets of an individual's relationship with his or her own body. This includes cognitions, emotions, and global satisfaction in regard to one's body, as well as behavioral aspects (Menzel, Krawczyk, & Thompson, 2011). Body image dissatisfaction (BID), defined by Crowther and Williams (2011) as negative and dysfunctional thoughts and feelings about the shape and weight of one's own body, is alarmingly pervasive in U.S. society today. A national survey conducted by Thomas Cash (1997) found that dissatisfaction has consistently increased for both men and women compared to reports from prior decades (Cash, Winstead, & Janda, 1986), and has continued to increase such that dissatisfaction is considered "normative" in U.S. society (Tantleff-Dunn, Barnes, & Larose, 2011). BID has been found to be negatively correlated with self-esteem and social functioning (Furnham & Calnan, 1998), and has also been regarded as a key risk factor for disorders such as anorexia (Garner & Garfinkel, 1980) and bulimia (Brannan & Petrie, 2011). Traditionally, BID has been viewed by researchers and the public as a primarily female affliction. The negative behavioral consequences of body image dissatisfaction, such as disordered eating, have certainly been more visible in the female population; women are three times more likely to be diagnosed with an eating disorder, for example (Blashill, 2011). Because of unrealistic thin ideals for women perpetuated by the media, dieting and starvation can become a strategy for women to strive towards thinness, which can lead to malnutrition and even death.

Early studies that attempt to compare body image across genders indicated that men were considerably more satisfied with their appearance compared to women (Rozin & Fallon, 1985; Zellner, Harner, & Adler, 1989; Feingold & Mazzella, 1998). However, more recent studies with males have found that body esteem, defined as the attitudinal and emotional aspect of body image, significantly decreases following media exposure, indicating that the connection between the media and BID is an issue for both men and women (Leit, Pope, & Gray, 2002; Arbour & Ginis, 2006; Farquhar & Wasylkiw, 2007). A possible explanation for this trend is that earlier studies utilized body image assessment measures that were designed for women and were therefore inappropriate to use with male populations (Cafri & Thompson, 2004). The development of male-specific measurements, such as the Male Body Attitudes Scale (Tylka, Bergeron, & Schwartz, 2005), has increased the accuracy of male body image research. Another reason for the increase in male BID may be due to sociocultural developments—specifically, the growing attention to idealized male bodies in the popular media. In contrast to the modern female body ideal, which emphasizes thinness, muscularity dominates the media depiction of male body ideals. Men are more likely to desire to gain weight and increase their muscularity to attain a mesomorphic physique (defined muscularity and a V-shaped body) (Pingatore, Spring & Garfield, 1997). This mesomorphic ideal has become more visible over time, which may account for the apparent increase in male BID (Pope, Olivardia, Gruber, & Borowiecki, 1999). A meta-analysis conducted by Blond (2008) of 15 studies examining the effect of exposure to media images of idealized bodies on male BID found that 30 out of 35 effect sizes were significant, indicating an increase in BID. These studies included magazine images and television commercials.

Surprisingly, there has been little research conducted on the effects of video games on male body dissatisfaction, despite the fact that most households own at least one video game console, and the majority of video game consumers are male (Entertainment Software Association, 2012). Considering that video games are one of the most popular forms of media today, with sales surpassing that of movies (Martins, Williams, Ratan, & Harrison, 2011), it is important that the psychological effects of these games be studied as systematically as other forms of media.

Only one published study, to date, specifically examines the relationship between video game play and male body satisfaction (Bartlett & Harris, 2008). In this study, 51 male participants were recruited to play the video game *WWF Wrestlemania 2000*, which was chosen because of its emphasis on muscular male bodies. It was predicted that exposure to muscular male

characters, in the form of the player's opponent, would lead to decreased body esteem. The researchers attempted to create a more immersive experience for the player by instructing them to make their own character as similar to them as possible. The participants played the video game for 15 minutes, either with a muscular opponent, or an obese opponent that acted as a control. The participants completed body image measures before and after playing the video game, including the Body Esteem Scale and the Swansea Muscularity Attitudes Scale. It was found that men with the muscular opponent reported decreased body esteem, as well as decreased positive attitudes towards muscularity.

With the results of this research in mind, the aim of the current study was to investigate the specific effect that playing a vivid, technologically advanced video game with visibly muscular characters would have on male body image. Because the majority of video game players are male, and considering that the body image concerns for men and women are strikingly different, only male subjects were recruited for this study. It was hypothesized that men who play a highly realistic game with a muscular character will report lower levels of body esteem compared to those who play with a character of an average build.

METHOD

Participants

Participants were twenty-six undergraduate students from Bridgewater State University in Massachusetts. The mean age was 19.88, $SD = 1.48$; mean weight was 179.04 lb., $SD = 37.00$; and mean height was 69.68 inches, $SD = 3.75$. Average BMI was 25.85, $SD = 4.62$ – BMIs above 25 are considered overweight. The participants were overwhelmingly Caucasian (88.5%), with a small representation of Hispanic (3.8%). Religious composition was 57.7% Christian, 34.6% Agnostic, and 3.8% Buddhist. Participants also responded to questions regarding their habits of video game play. The men in this sample reported playing an average of 1.5 hours of video games a day, and 7.3 hours a week.

Measures

The Body Image States Scale (BISS; Cash et al., 2002). A 6-item scale designed to capture state body image: a person's thoughts and feelings about their body at a particular moment in time. The BISS has been used extensively in experiments measuring the effect of media viewing on body image, because it is effective in evaluating body image changes as the result of stimulus exposure. All items are statements that begin with "*Right now I feel*" and each addresses a different component of body image, such as weight concerns and physical attractiveness.

The Sociocultural Attitudes Towards Appearance Scale-3 (SATAQ-3; Thompson, van den Berg, Roehrig, Guarda & Heinberg, 2004). This scale was developed and is widely used as a measure of an individual's attention towards media ideals and messages, and the degree to which they internalize these messages. Participants are asked to respond to various statements such as *I've felt pressure from TV or magazines to lose weight* by indicating how much they agree with the statement on a 5-point Likert type scale, where 1= *Definitely disagree* and 5= *Definitely agree*. The scale is divided into four subscales (Information, Pressures, Internalization-General and Internalization-Athlete).

Male Body Image Measurements The following three scales were used to assess body image and muscularity concerns.

The Male Body Attitudes Scale (MBAS; Tylka, Bergeron & Schwartz, 2005). The MBAS measures male body image on an attitudinal dimension; that is, how men feel about their bodies. Participants indicate their agreement from 1= *Never* to 6= *Always* in response to statements such as *I think I have so little muscle on my body*. There are three subscales in the MBAS that examine specific dimensions of male body image: Muscularity, Low Body Fat, and Height Concerns.

The Swansea Muscularity Attitudes Questionnaire (SMAQ; Edwards & Launder, 2000). The SMAQ is designed to evaluate how men perceive muscularity in terms of positives and negatives, and also the behavioral consequences of these patterns of thinking, such as working out to become more muscular. Participants are asked to indicate their level of agreement with statements such as *I feel more masculine when I am more muscular* on a 7-point Likert-type scale ranging from 1= *Definitely* to 7= *Definitely Not*. A two factor solution has been observed for this scale: the Positive Attributes of Muscularity and the Drive for Muscularity.

The Drive for Muscularity Scale (DMS; McCreary & Sasse, 2000). The DMS is a similar measure to the SMAQ, but it was designed to measure muscularity concerns for both sexes. Nine out of the 15 original questions were used for this study. Participants respond on a 6-point scale from 1= *Always* to 6= *Never*.

The MBSRQ-Self Classified Weight Subscale (MBSRQ-SCW; Cash, 2000). This is a 2-item subscale of the Multidimensional Body Self-Relations Questionnaire that gauges a person's self-perception of their own weight, and how they believe others perceive their weight. Responses range from 1= *very underweight* to 5= *very overweight*.

The Body Esteem Scale (BES; Franzoi and Herzog, 1986). This scale is designed to measure body esteem specifically. There are three subscales: Physical Attractiveness, Physical Condition, and Upper Body Strength. The BES asks participants to rate various body parts according to how positively or negatively they feel about each one (1= *Have strong negative feelings*, 5= *Have strong positive feelings*). Each subscale is summed to obtain scores, with higher scores indicating more positive body image.

Procedure

Permission to conduct the experiment was granted by the Institutional Review Board at Bridgewater State University. Participants were recruited via a sign-up board located in the Psychology Department. Randomization to a condition occurred in the sign up process, as each time-slot had been randomly assigned to a condition beforehand. Potential participants were offered course credit for participation in research, but they were also given alternative ways to earn the credit if they did not wish to participate.

Pre-test and Manipulation

The experiment took place in a small laboratory. There were no more than two participants in the room during a session, along with either a male or female lab assistant who was present at all times. Each participant was given an informed consent document and their signature indicated their willingness to participate in the experiment. The purpose of the study was kept vague to control for demand effects; participants were told that they were involved in an experiment that would "examine how playing video games affects the thinking patterns of college students." Participants were then administered a pre-test questionnaire that included demographics questions, the Rosenberg Self-Esteem Scale (RSES; Rosenberg, 1965), and questions about the participants' video game habits. The Rosenberg Self-Esteem Scale, a measure of general self-esteem, was included to verify that randomization had resulted in group equivalency.

Following the pre-test, participants received a brief written explanation of the video game they would be playing, as well as instructions on how to control their character. The game that was selected for the experiment was *The Elder Scrolls V: Skyrim*, a role-playing computer game developed by Bethesda Softworks in 2011. This recently released game had received critical acclaim for its detailed, realistic virtual technology (VanOrd, 2011). The game was also chosen for the customization features of the avatars, which could be manipulated to be extremely muscular or diminutive.

To increase the structural reliability of the experimental design, characters were customized beforehand so that all players would begin at the same point in the game with one of the same two

characters. Because the participants were also randomized beforehand, the screen was set up in one of two possible games which served as the conditions of the experiment.

In the first condition, or the control group ($n=12$), the game was played with a character of average size and shape. Muscularity was manipulated beforehand by the researcher using a sliding scale in the character customization screen. The average avatar's muscularity was almost exactly in the middle of the scale, so that the character did not appear significantly bulky, nor obviously skinny or sickly. The intent was to create an avatar that was similar in size and shape to the average American male. No other feature of the avatar was manipulated (face, skin color, hair, etc.). For the second condition ($n=13$), muscularity was manipulated to the highest point on the scale, allowing the avatar to appear significantly more muscular than the average male. All other features remained the same as the control group. Participants played the game, uninterrupted, for 45 minutes.

Post-Test

After exiting the game, participants completed the post-test questionnaires. These questionnaires consisted of the RSES, several questions about how the participant felt about the game, and the seven body image scales listed above. Participants were then debriefed and provided with a class credit slip for their participation.

Results

To test for group equivalence before the manipulation, a one-way multivariate analysis of variance (MANOVA) was run on the demographic variables and scores on the Rosenberg Self Esteem Scale (RSES). The results of this test indicate that there were no significant group differences before the experiment began for any of the tested variables, Wilk's Lambda = .95, $F(5, 19) = .20$, $p = .96$.

In order to test the main hypothesis, two separate one-way analyses of variance (ANOVAs) were conducted to determine if there was an effect of playing a video game with a more muscular character as opposed to a more average body type, one with the BISS and the other with the BES. These two measures were chosen for the main analyses because they specifically measured state body image and would most accurately reflect any changes that were a direct result of the independent variable. An alpha level of .05 was used for both tests. Men in the muscular condition reported significantly less favorable body image as measured by the BES ($M=97.38$, $SD=17.59$) than men in the control condition ($M=115.33$, $SD=14.32$), $F(1, 23) = 7.75$, $p = .01$, $\eta^2 = .25$. The 95% confidence interval had limits from 88.14 to 106.63, and the observed

power for the effect of playing with a muscular avatar was .760. These results indicate that playing this video game with a muscular avatar significantly decreased body image within our sample. The results of the BISS ANOVA, while not statistically significant, were in the expected direction: Muscular Group ($M=5.41$, $SD=.64$), Average Group ($M=5.94$, $SD=.78$), $F(1, 23) = 3.53$, $p = .073$.

In addition to these main tests, t -tests were run on all scales and subscales used in the post-test to look for any emerging patterns in the ways men might specifically be affected by the video game. The groups differed in the expected direction on all scales, with men in the muscular condition displaying higher muscularity and weight concerns, and lower body esteem, although only the differences for the Pressures subscale of the SATAQ, $t(23) = 2.09$, $p = .05$, and the Positive Attributes of Muscularity subscale (PAM) of the SMAQ, $t(23) = 2.26$, $p = .03$, were statistically significant. The differences between these scales lend further support to the hypothesis.

Discussion

It was expected that participants who played a highly realistic, immersive video game with a muscular character would display lower body esteem and higher muscularity concerns than participants who played the game with a character who had a more average body size and shape. The results of the current study provided some support for the hypothesis. Two scales were used to measure the main effect of state body image on the participants post-video game play: the Body Image States Scale (BISS) and the Body Esteem Scale (BES). The BES, for which a significant difference in body esteem was observed between groups, was the scale previously used by Bartlett and Harris (2008), lending further support to both the hypothesis and the reliability of the scale as a measure of state body image. The BISS, on the other hand, did not yield significant results, although the F -value was quite close to being significant.

All body image measures used in this experiment differed from one another between groups in the expected direction, with the muscular group displaying less body esteem and more muscularity concerns. Out of the seven scales used, the Pressures subscale of the SATAQ, and the Positive Attributes of Muscularity subscale of the SMAQ were significant. The significance of these particular subscales makes sense when compared to the findings of other research that has been conducted on male body image and media exposure. Research has shown that muscularity concerns play a large role in the construct of male body image, and may have a substantial influence on male body esteem (Tylka, 2011). The fact that the Pressures subscale is significantly higher for the muscular players suggests that being exposed to muscularity put more

pressure on men to look similar to these idealized characters. The Positive Attributes of Muscularity subscale, on the other hand, indicates that the exposure to a muscular character in video game play makes players more likely to see muscularity as positive, ideal, and attractive to the opposite sex. These patterns of thinking could conceivably develop into lowered body esteem if a man starts to compare his own body with an idealized video game character and finds himself lacking (Leit, Gray, & Pope Jr., 2002).

Only one other known study (Bartlett & Harris, 2008) has investigated the relationship between video games and male body image. Both this previous study and the current investigation observed a significant decrease in male body esteem after exposure to muscular body ideals in video games. This similar result was observed in both studies despite significant differences in experimental design. In the Bartlett and Harris study, the independent variable was the muscularity of the player's opponent, while the current study used the muscularity of the actual avatar that the player controlled. This difference may offer an explanation for a difference in results between the two studies. Bartlett and Harris, using the SMAQ, observed a decrease in positive attitudes towards muscularity, while we observed an increase. It is possible that perceiving muscularity in terms of an opponent could have led players to see this construct in a more negative light. A muscular avatar, essentially a virtual extension of oneself, would therefore have the opposite effect.

This study included several important limitations. First, the sample size was quite small, with only 25 participants. This limits the generalizability of the results, especially since the sample was a fairly homogenous group of Caucasian college-aged men. This study should be replicated with a larger and more diverse pool of participants. Second, unique features of the game selected for this study may have also served to limit reliability. Because of what is known as an "open-world" style of gameplay, participants were not guided by the video game towards one particular goal or set of actions, meaning that the actual experience of the game could have been significantly different from one participant to the next. Therefore, additional influences, such as the degree of success or failure that the participant experienced while playing the game, may have affected the self-esteem or arousal of the participant and influenced the results of the experiment, although it is important to note that the initial muscularity of the character in the game did not give the participant an unfair chance of success in the game, as strength and skill were accumulated only by the experience gained by playing the game.

These findings indicate a need for further research into the relationship between male body image and video games. If playing video games does have a negative effect on the body esteem of men, as our results indicate, it is quite likely that high rates of participation in this form of media may lead to higher rates of body dissatisfaction in the male population. It is a fact that the ideal male body has become more visible and muscular over the past few decades, which some argue is leading to a culture of muscularity in men that parallels the culture of thinness that has led to low self-esteem and disordered eating for so many women (Agliata & Tantleff-Dunn, 2004). Multiple studies have observed the psychological consequence of media exposure in males: with increased exposure, body esteem drops and muscularity concerns rise (Bartlett et al., 2005; Cafri et al., 2002). These consequences have the potential to cause body image and muscle dissatisfaction, which has been linked to poor psychological functioning. As a result, depression, low self-esteem, and even serious disorders such as muscle dysmorphia may arise. Future research should include longitudinal studies that explore behavioral effects of video game play on male body image, as well as studies that include specific measures of realism and game play success as potential covariates. The results of this preliminary investigation are intriguing, and they will hopefully serve to inspire greater scientific investigation of the relationship between video games and male body image.

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Car Modification: A Vehicle for Self Expression

EMILY KEARNS



Emily Kearns is a Sophomore majoring in Early Childhood Education and English. She wrote this paper

in the fall of 2012 as part of her coursework for an Introduction to Folklore class taught by Yasar Ozan Say. It is the culmination of a semester-long interview-based project. After graduating, Emily plans to pursue teaching and also obtain a Masters degree in education.

When considering what falls into the remarkably broad discipline that is folklore, some of the first images that come to mind are peasants and farmers performing folk dances, passing down folktales, and engaging in age-old rituals and ceremonies. I certainly never would have considered car modification to fall under the folkloric umbrella – after all, it seems far too modern, and we often have the misconception that folklore is concerned exclusively with the lower-class workers of the distant past. However, after looking closely at some of the more modern interpretations and definitions of folklore (of which there are many), it becomes clear that car modification – and even car repairs, to a certain extent – more than qualify as facets of this overarching genre. Folklore is divided up into three major sections: material, verbal, and customary lore (Wilson 1986, 229). Material lore has to do with folk objects and tangible items, verbal lore is relayed orally, and customary lore refers to rituals or practices. Car modification, the focus of this paper, is considered a type of material folklore since it deals most primarily with folk objects and how their owners interact with them.

Introduction: Car Modification as Folklore

The qualifications for what constitutes a folk object are markedly vague, and define nearly any object that has been created and/or noticeably modified by a person for the purpose of expressing themselves or a particular message. A few of the most common examples include the architecture of old barns, the patches of hand-sewn quilts, and carvings. A modified car meets these major guidelines: it is a physical object and has been changed from its original form to express the specific intentions of the owner.

As Simon J. Bronner emphasizes in his chapter entitled “Folk Objects” in Elliott Oring’s *Folk Groups and Folklore Genres*, “despite the ‘otherness’ of objects, humans nevertheless project their own ideas and emotions onto them and see them as reflections of themselves” (Bronner 1986, 204). In modern American society, this is perhaps most true in regards to cars; many car owners, regardless of their knowledge of automotive work, feel connected to their vehicles and value them beyond their essential purpose as a mode of transportation. I myself am capable of nothing beyond checking fluid levels and changing a tire, and yet have fondly named my car and view it almost in the same way a child views a favorite stuffed animal. I am not alone in this: cars hold a special place for many people who are not involved

in the intricacies of mechanical and automotive work. For the purposes of this paper, however, I will focus most prominently on the opinions and practices of David Carroll, a man who is invested in his car in ways that the average person is not.

I. David Carroll and his Pontiac

On a cold December evening – is there any other kind? – I sat down to interview David Carroll, a man whom I had the distinct pleasure of meeting about a year ago when he and my mother met by coincidence, became close friends, and later started dating. He currently lives in Methuen, MA, but maintains many connections with his hometown of Chelsea, MA. Though he works as a Massachusetts Auto Damage Appraiser by day, by night Dave is a man of many hobbies. Among his various pursuits are traveling, amateur video editing, computer work, cooking, home renovations, scuba diving, and automotive work. An incredibly likable and outgoing person, Dave’s goofy sense of humor and ability to relate to almost anybody earn him many friends everywhere he goes. He is a rare kind of person who is always open to new people and experiences, but also fiercely loyal and devoted to old friendships that he has maintained throughout his entire life. Dave is passionate not only about his relationships with other people, but also about all of his hobbies. For each of the activities that he is involved in, he has countless stories and experiences to share with anybody who will listen. This applies to his hobby of automotive work and car modification.

Ever since he was a teenager, Dave has had the same 1972 Pontiac Lemans that he originally purchased in 1984:



Since then, he has poured countless hours of labor, effort, and passion into this car, which has followed him throughout all the major events in his life. As he has changed, the car has changed as well.

Though the Pontiac still requires some tweaks to its interior before Dave will consider it “finished,” his work on it is nearly complete.



This paper will explore how people like Dave engage in this type of folklore, the different aspects of car modification, and how an owner’s perception of their car can change over time. Dave’s skill with mechanical work was born largely out of necessity, but also quickly took the form of self-expression. It is my belief that the Pontiac is a manifestation of the overlap between Dave’s practical skills and his personal self-expression, as well as a piece of art that represents him on many different levels.

II. Verbal Aspects of Material Lore

Despite the fact that folklore is divided into material, verbal, and customary lore, there is still a significant amount of overlap between these subgenres. Car modification is a perfect example: while it is mainly considered to be material lore, it can also take on many aspects of verbal lore as well. People who modify cars do not do so in a vacuum; they might work

in garages, talk about their hobby with friends, or engage in online forums and discussion boards. They may even visit car shows and meet with others who share their passion, bringing in aspects of customary lore as well.

Dave is quite vocal about his Pontiac, and is guaranteed to have a story to tell about each repair, stylistic choice, and car show that he has been a part of. This helps to keep him connected to the material aspect of his folklore even when it has been months since he was last able to work on his car. Integrating aspects of verbal lore into a largely material hobby is necessary with car modification (as with many other large-scale folk objects that take time to complete), since the amount of time spent actually interacting with the object is fairly low on a weekly, monthly, or even yearly basis.

Repairing, restoring, and modifying a car stands apart from many other types of material folklore simply because of the sheer scale and cost that such a massive project entails. Because of the intense level of dedication and the heavy investment of both time and money that are required for this hobby, modifying a car is a rather gradual process. Those who work on cars are not completely unique in this, however – certainly a barn, sculpture, or even an intricate quilt could take just as long and be equally labor-intensive to complete. Projects such as these make a verbal or customary aspect to the material folklore necessary; otherwise the tradition-bearer risks losing touch with their object entirely. Though Dave does not have sufficient time or money to constantly work on the Pontiac, he still practices the verbal aspect of his folklore often; this keeps him connected to his car even when he has not driven it in months. Dave has a fairly large storytelling repertoire, and it seems like he has a Pontiac story for every situation: some are short and make people laugh, some are long and impressive, and others are deeply sobering and meaningful to listen to.

Due to the fact that the details of automotive work are largely a mystery to the majority of people – I could not tell you the difference between a transmission and a drive shaft, and know few people who could – Dave uses his stories as a way to connect his passion to the people around him, even those who are much less knowledgeable than he is. He knows that my sister and I will relate best to the stories that describe the visible additions to the car, the interesting places he has taken it, or the humorous situations that it has put him in. He often relates the story of the first day he bought the Pontiac: it was so badly broken it would only drive in reverse, and he hurt his neck driving it backwards all the way to his house. When he talks to some of his friends, however, he will go on and on about the engine, the belts, and the brakes, and tell stories about the mechanics of the car that make no sense to somebody

who is outside of the folk group. To Dave, his stories are not only about feeling connected to his folklore, but also about communicating his love of cars with other people and sharing a part of himself with those around him. This often requires him to adapt the stories to fit the situation, something that he does exceptionally well.

III. Self Expression

When asked what first got him started with automotive work, Dave's response has surprising duality to it. He describes how he had "a dream" when he first saw this photograph of a Pontiac in a magazine:



I can picture him in his youth tearing the page out and holding onto it all these years, captivated by the image that he then strove to obtain for himself. He calls the car his "first baby" and regards it fondly, even lovingly. This is the answer that I expected him to give.

Far less romantically, however, he tells me that much of his knowledge of mechanical work was initially driven by necessity and economics. Dave was thrown out of the house on his eighteenth birthday, and had to learn how to support himself at a young age. At that point in his life, it was unrealistic to pay somebody else hundreds of dollars for car repairs when the

parts themselves only cost a fraction of that. It always made more economic sense to do the work himself, so he did.

There is an intense contrast between this practical application of skills and the sentimental attachment that Dave clearly has for the Pontiac. While he worked to pay the bills and support himself, he never let go of his first car, even when it became difficult to keep. He describes how there were many times in his past when he had to get creative in order to hold onto it, but it was always worth it: “a lot of blood, sweat, and tears in it, and it’s hard to get rid of it after that,” he says in our interview.

Throughout his life, Dave has possessed many other vehicles, but now, at age forty-four, the Pontiac is the only one he still has from his youth. When asked why, he simply smiles fondly and says, “It was my first car,” almost frustrated that he does not have any other, perhaps more compelling reason. However, I find this answer to be quite compelling. Despite the fact that much of Dave’s knowledge of cars was once a matter of economics and practicality, there is nothing practical about his current relationship with the Pontiac. Rather than being the means to an end that many cars become (despite our undeniable attachments to them), for Dave, the Pontiac is more of a method of self expression than anything else; it has transcended usefulness, and the traditional bond between car and driver. From his practical knowledge, he has created something almost entirely artistic that reflects his own tastes and preferences as an individual. Not only does it convey

the muscle car and sporty Pontiac image that he originally gravitated towards in his teens, but it is also a showcase of his passion and talent for automotive work that only grew as he got older.

The car stands as a compilation of Dave’s skills, as well as a method of expressing himself personally. Almost anybody’s car says something about them: it hints at their social class, their aesthetic tastes, and sometimes even their age. But far fewer people dedicate the time, money, and effort into creating something that truly represents them. Car modification is the overlap between practicality and creativity, making it the perfect vehicle for self expression.

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God of Manga or Devil of the Medium?

MICHAEL ROSE



Michael Rose is a second-year history major. He wrote this paper for his LANG 199: First Year Seminar

Elements of Japanese Culture in Fall 2012 under the direction of Dr. Minae Savas of the Foreign Languages department. He hopes to continue to achieve success over the next few years at Bridgewater State University.

Tezuka Osamu is one of the most accomplished manga artists from Japan. He set the stage for many more artists to come by breaking traditional norms, but the way he went about gaining his fame however could be called into question. *Could it all have been just a guise to take over the market? Osamu was so popular that he practically had a monopoly over the entertainment industry in Japan and became known as manga no kamisama, meaning God of Manga. His domination proved to be crippling to other artists. He was born into a fairly affluent family and would not have needed to become extremely rich from his art. Osamu endeavored to spread his work and educate as many people as he could reach, not only in Japan, but around the world. He had clear messages in his stories about life that he wished to convey to his audience. Believing his values to be important, Osamu strove to make sure that his work was readily available around the world.*

Anime and manga are highly popular forms of Japanese entertainment and art. Anime can be defined simply as “Japanese Animation,” while manga are as “Japanese Comics.” Both media forms are not only for entertainment purposes but are also considered to be art. As Isao Ebihara points out, they have begun to be employed for a variety of other uses, such as driving manuals and business information (256). Thus, manga and anime have been completely integrated into Japanese culture – to the point where both are used for many different forms of literature. Both forms are created in teams of various sizes because each panel or frame created can take hours of work; many artists are not alone in their work, but are a part of a company. Osamu worked with both, anime and manga extensively during his lifetime and was the person in charge of leading the productions.

Tezuka Osamu started his occupation in a rather nonconventional way by obtaining a degree in medicine. This allowed him to incorporate medical concepts into his stories. Despite his choice of study, he preferred he preferred drawing to his more academic musings (Kelts 41). After World War II, Osamu’s cinematic style of manga captured the attention of his audience (Schodt 160). He used many panels and pages to depict one facial expression or one important movement (Norris 243). The animation-like sequences can be seen very clearly in *Phoenix* when Akenamaru is turning into a sea creature and when the Phoenix is flying away (Schodt 169-84). His art style made it so that reading his manga was much like watching a movie or televi-

sion show. Clearly, something about his art works fascinated his readers and viewers and left them always wanting more. Whether it was the cinematic style or the context of the story, once Osamu's art grasped the attention of the audience, he gained an ever-growing fan-following.

Osamu soon began to take over the market as his influence spread, and "by the early 1950s, Tezuka was the most popular cartoonist in Japan" (Power 89). In less than ten years, he managed to ascend to the top of the entertainment industry. This was partly due to the fact that the industry was in shambles after the war (Kelts 41). Today, with a very established market, it would have most likely been much more difficult for him to achieve the same control and influence in the market.

"The Curse of Osamu" was coined by Roland Kelts, author of *Japanamerica How Japanese Culture Has Invaded the U.S.* (10). This caused new companies and young animators to be dwarfed by his influence over the market. This was particularly ironic because Osamu's comics were often what inspired children to become anime and manga artists (Power 89). No one could surpass the god of manga and anime. To this day, the curse is still in effect to some extent because of how highly regarded Osamu's work remains. There have been a few different versions of *Astro Boy* released since the original, because people still yearn for his stories even though he is no longer alive. New companies can face major difficulties staying afloat in the competitive sea of Japanese entertainment, thanks in part to Osamu's earlier influences.

Some scholars and large anime companies consider this curse to be an intentional ruse by Osamu. David d'Heilly, the founder of an art and design production company, asserts that there were far better ways to get his message across rather than "strangling" all of the other companies (Kelts 47). He argues that because Tezuka came from a middle-class family and had a degree in medicine to fall back on, he could more easily cope than other artists with the profit losses that came from selling his work cheaply. Some believe that he was purposely "dumping, selling his episodes cheap to keep others out" (Kelts 47). They believe wanted to conquer the industry so that he was the only artist being read and watched in all of Japan. Due to his overt and totally encompassing power in the market, he could very easily get away with selling his work so inexpensively, and people still point to him as the reason they are forced to sell their art for less money than they would prefer to.

Even though his actions may have seemed like a deceitful plot, other scholars argue that Osamu did not intend to shut out

other artists. What he actually aimed for was for his work to be well-known, and in order to do that he had to make sure his work was quickly bought up by companies who could broadcast it to the world. In fact, he also helped to create new talent:

Young artists considered it an honor to help the great master, working with little or no pay. Working for Tezuka also opened gateways for their careers. Tezuka introduced them to publishers and editors, who subsequently offered the young cartoonists their own series. This resulted in a great burst of new talents in Tokyo. (Power 90)

What he truly wanted out of his work and life was to spread his values to the world. This is exemplified by the fact that his stories often include lessons that teach humanism and to care for all life (Schodt 160). For example, in the animation version of *Phoenix* in *The Sun*, part one, Inugami finds a strange man and decides to help him. He only later finds out as they are sailing away that he is the general that had failed him and caused his face to be replaced by a wolf face. Instead of killing him, Inugami takes him on as his "servant," and they eventually grow close and become friends. The message of "caring for all life" is clear here in that Inugami gave the general a chance to live, and he developed a lifelong friendship that he otherwise would not have gained. This is what Osamu wanted to teach the world—that every life has value, no matter how big or small.

The God of Manga, Osamu Tezuka, was a person to be revered, not detested, for his contributions to the Japanese entertainment and art industries.

It was because of Osamu that many new and young people entered the market in the first place: whether he taught them directly or they were just inspired by his work. Miyazaki Hayao, a prolific director and animator in Japan, is a great example of a young artist who was inspired by Osamu. Miyazaki is known around the world, and he was in fact influenced by Tezuka's work to become an animator (McCarthy 28). What Osamu was trying to accomplish with his art was something that was entertaining for the audience while at the same time teaching them a lesson about life. In order to make sure that the world received his message, he sold his work cheaply so that it would sell quickly. It was not the profit that Osamu was interested in, but rather the flourishing of the art—and flourish it did. Although Osamu died in 1989 from stomach cancer, his legacy continued through his work, which is still popular today. Tezuka Osamu made many specialized and revolutionary contributions to the art, particularly the creation of story manga, "*sutorii manga*," published in a series (like most manga which is released today) the large saucer-like eye style, and characters

breaking the normal “enter on the left, leave on the right format.” Due to these influences, manga and anime exist as they do today: popular art forms and a worldwide commercial and cultural phenomenon.

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A Greener Disney

CIDALIA PINA



Cidalia Pina is a Geography major with a minor in Earth Sciences with an Environmental

concentration. This essay was completed as the final paper for Dr. James Bohn's seminar course: The Walt Disney Company and Music. Cidalia learned an invaluable amount about the writing and research process from Dr. Bohn. Both his class and submission to the *Undergraduate Review* have been a rewarding and positive experience. Cidalia will always be grateful for Dr. Bohn's wisdom, direction, and encouragement, without which, this paper would not have been published. Cidalia would also like to thank her husband Dave for his strength and support and their four children Lukas, Mason, Ian, and Emma for providing the never-ending inspiration to pursue her academic goals. This journey is a gift from all of them.

Disney brings nature and environmental issues to the forefront with its non-confrontational approach to programming meant for children. This opportunity raises awareness and is relevant to growing environmental concerns. However this awareness is just a cursory start, there is an imbalance in their message and effort with that of their carbon footprint. The important eco-messages that Disney presents are buried in fantasy and unrealistic plots. As an entertainment giant with the world held magically captive, Disney can do more, both in filmmaking and as a corporation, to facilitate a greener planet.

"Disney is a market driven company whose animated films have dealt with nature in a variety of ways, but often reflect contemporary concerns, representations, and shifting consciousness about the environment and nature." - Wynn Yarbrough, University of the District of Columbia

In what some consider Walt Disney's crowning achievement, *Bambi* is a magical and artistically inspirational wonder. However, is *Bambi* Disney's fantastical depiction of real nature or more Disney sentimental magic? This magic does not come from a wish or a wand, rather in the simple hand-drawn animations and artfully selected score. Disney carefully captured animal behavior and placed viewers deep in the forest with an immersive experience. The audience remains in the forest with the animals and forgets there is a world outside. Before computer manipulated graphics, with animated technology that we know today, Disney created a film with heartwarming and lovable creatures, sharing their lives in front of an impressionist backdrop. *Bambi* is a coming of age story, as we share in the lives of woodland animals, and witness a little fawn born a prince, survive and grow to be a strong and stately buck.

Equally beautiful to the artistic animations are the musical scores chosen for the film. The film is comprised mostly of instrumental scores, with the exception of the main title and opening score "Love is a Song" and the finale score. The two other songs in the film with lyrics occur in the spring scenes of the movie "Little April Showers" and "Let's Sing A Gay Little Spring Song" and again in *Bambi* and *Faline*'s romance scene "I Bring You a Song." Each score and song artfully blends instrument selection with the scene content. During each scene music complements the film to deliver lyrical emotion. For example, the heralding trumpets are used beautifully to emote majesty and strength in

the “Gallop of the Stags” and “The Great Prince of the Forest.” The more gentle and playful variations are reserved for scenes in which Bambi is playing with forest friends and discovery of their forest habitat. Strings and percussion instruments like the cymbals and triangle are perfectly chosen to illustrate the thunderstorm claps, and the raindrops falling during “Little April Showers.”

A film for children that features a happy baby deer Bambi, his friends Thumper, a rabbit, and Flower, a skunk, is not just a story about the lives of woodland animals, but also carries a message of conservation. The film takes place in a forest much like that of our North American wilderness. Images of Half Dome and El Capitan place the story in Yosemite National Park, causing the audience to feel protective of the habitat that Bambi dwells in. We recognize from the film that man does not belong in this environment and his portrayal is one to introduce the viewer to the concept of a Disney villain. Man is not only hunting Bambi and his friends, but in this film he also irresponsibly starts a forest fire. Effective and realistic, as this happens frequently, but sometimes hunting is part of conservation efforts not only to protect the forest, but also keep animal populations healthy and thriving. Man and wolves are the few natural predators deer have. When there is a healthy balance in nature, it is these predators that keep deer populations in a healthy range, and it is also part of the natural selection to prey on sick or weak animals. When there is an imbalance, either by removing or redirecting the natural predator process, the deer population can become overrun and create a different problem for our forest environment.

Overpopulation of deer can threaten our forest, as deer can consume underbrush, native plants and damage tree stock when they browse or strip bark off the lower trunk portion, causing enough damage to kill the trees. In a collaborative effort with the United States Department of Agriculture, Animal and Plant Health Inspection Service, the National Park Service concluded that in the last two decades, “an increasing deer population has prevented the ability of native forest to grow and mature and has reduced habitat for a range of native wildlife species” (National Park Service).

David Whitley discusses the “Eden” myth in his analysis of *Bambi*, and Disney’s “sentimental distortion of nature,” echoing the sentiments of many critics that Disney’s film is an appeal to our emotion and introduces concepts that distort our reality as a movie viewer (Whitley). In the original book by Felix Salten, the fire scene was absent, but chosen in the film to portray man as the evil element. In the movie *Bambi*, Disney uses fear with this sentimental view of nature (Yarbrough). Man did not need to be portrayed as the evil character. Man can and often are a

part of the conservation of our deer population and preserving the natural environment. Disney only needed to look to nature as a cue if they needed a villain factor in the film. Bambi and his forest family face the evils of starvation, overpopulation, disease and climate change that threaten their habitat. This would have been a more natural and realistic depiction of life in the forest.

Natural force is utilized in Disney’s film *The Lion King* where the young lion cub, Simba, has to learn important lessons and how to survive in the hostile African savanna. In Disney’s “Circle of Life” story the animal characters learn lessons about misuse of natural resources, and what happens when a kingdom is ruled by greed (*The Lion King*). Simba the young prince, loses his father the King, and blames himself for the accident. His uncle, Scar, the primary villain of the story, wants to take over the kingdom and urges Simba to run away. Scar wants to be the heir to the throne and considers Simba an obstacle to his ascension. Simba escapes Scar’s plan, but is still morally responsible for leaving his kingdom and their survival in his uncle’s corrupt control. Simba stays away and chooses to live his life carefree in an attempt to forget his problems. When Simba ignores his destiny as future king, the pride suffers as Scar depletes the land and their home of all the natural resources. The movie demonstrates what happens when poor management, greed and carelessness are practiced instead of management by sustainability and a balance of nature. Simba also learns not to run away from his problems, but rather to confront them, though it means having to take responsibility for his actions. When he realizes the pride needs him, he confronts his fear and fulfills his destiny as future King.

The ecological message in the film, although told through challenges that the animals face in Africa, is one meant to implicitly warn humans of their impact on the environment. However, scenes from the movie are hard for a young viewing audience to grasp. Betrayal from a family member, an uncle, death of a parent that a child is meant to feel responsible for, and understanding our role in death and rebirth through “Circle of Life” concepts are heavy subject matters to explore in a film that targets a young viewer.

Despite the emotional understory for young viewers, *The Lion King* is another cinematic achievement for Disney with a visual feast in terms of animation and music. The complex theme of life and death are made light in songs like “Hakuna Matata” that has an upbeat rhythm and memorable lyrics. Musical score and song also punctuate the dark scenes of the movie, when Scar sings “Be Prepared” (*The Lion King*). When Mufasa dies, and Simba blames himself, we feel his pain through the music. A choir that has theocratic tones accompanies the score. This

element in music could symbolize the concepts of Christianity's ideas of sacrifice, death and even murder. While the plot of *The Lion King* clearly parallels *Hamlet*, the fratricide also recalls Cain and Abel. Like Cain and Claudius, Scar, the fraternal archetype in this story, is motivated by jealousy and greed, and he murders his brother Mufusa to gain his throne. In fact, the wound that gives Scar his name could be seen as the mark of Cain (Bohn). The violent, dark and sobering score emphasizes the darkness of Scar's character, Mufasa's senseless death by a ruthless brother, and the total loss and devastation for Simba.

The opening sequence is one of the most breathtaking and inspiring songs and scores to accompany a Disney movie. In the "Circle of Life" sequence at the start of the movie, through the sunrise on the horizon of the majestic African landscape, to the animal parade honoring the birth of Simba, we are reminded the film has an environmental theme. Humankind could take notes from the fact that not every animal is friend or foe, and there is respect for his or her place in the animal kingdom. The balance of nature, although a baboon would not likely embrace a lion, is the message here, and when the balance is destroyed we have lost our place in this great "Circle of Life" (*The Lion King*).

Nature's balance and imbalance is explored in the Disney film *Pocahontas*. It is a story about English settlers discovering America, specifically early Virginia; and upon landing in the new world discovering a native people. Disney explores historical context in the film and makes an attempt to deliver environmental themes in the frame of the story. Pocahontas has a love and respect for nature, a relationship that is spiritual with the natural world around her. She is brave and courageous and open-minded, all the qualities that would create a great heroine for a Disney film. However the movie's eco- messages are lost among the "magic" and with the historical inaccuracies and stereotypes the movie fails to deliver the more important overall attempt of awareness of the natural world.

Despite the flaws in writing and message falling short, the animation is beautiful and the music does more to bring ecological awareness than the characters do. Native Americans are portrayed in the movie as living off the land with agriculture, instead of the more accurate hunting and fishing. They were also portrayed as "savages," misunderstood and ignorant (*Pocahontas*). The white men are again portrayed as the oppressive and violent fools, moving in and stealing the land of the native people. Their only hope is for the beautiful and barefoot princess of the woods, Pocahontas, to mediate between the white people and her native family. Disney again brings their magic to film, but not in a sensible way. Furthermore, the animals are anthropomorphic and seem to be Pocahontas's pets.

In a movie about nature's balance and respect, this would be far from the truth. The real-life Pocahontas was a young girl and did not have a romance with John Smith, nor did she have magical trees that were filled with the spirit of her grandmother to guide her. However, when Pocahontas sings "Colors of the Wind" we understand the bigger message of the film is the necessity of understanding our environment, the need to protect and preserve it for the future (*Pocahontas*) respect for the natural world around us, respect for each other and a respect for the cultural differences that make each of us unique. During the song "Around the River Bend" Pocahontas describes life as about making choices that are expected of her as a member of her tribe, versus those that are unexpected, challenging but fulfilling (*Pocahontas*). She comes upon a split in the river, and the proverbial choice: will she take the wide and even path or choose the narrow and winding path? In the film and in real-life, Pocahontas may identify with the more narrow and challenging path. With the film's stereotypes and inaccuracies, and their need to remake history into a fairytale, Disney has chosen for this film, the wide and expected path.

In 2008 Pixar Animation Studios and writer Andrew Stanton released the movie *WALL·E*, a love story between two robots. Stanton started developing this story during the production of *Toy Story* in 1994. *WALL·E* (Waste Allocation Load Lifter Earth-Class) is a robot left behind on a post-apocalyptic Earth that has been rendered uninhabitable because of over-consumerism and un-recycled waste left behind by humans. The *WALL·E* robots are left behind to clean, pick up, compact and stack trash into giant piles in an effort to clean up the Earth and make enough room for life again. The character *WALL·E* is the only unit left working on the desolate planet, and is truly alone with the exception of his friend the cockroach. Humans have escaped into space on the *Axiom*, sponsored by the big-box corporation "Buy-n-Large", which is responsible for assisting human consumerism (*WALL·E*). The humans have been in space so long with machines doing everything for them they have atrophied into shapeless blobs.

When *WALL·E* finds a living green plant while boxing up trash, the movie changes direction and sets in motion the revival of the planet. *WALL·E*, fascinated with finding the plant, gently transports it back to his recycling-truck home. *EVE* (Extraterrestrial Vegetation Examiner) is launched as the plant is detected from space. *WALL·E* falls in love at first sight with *EVE*. The infatuation is underscored in one of only three lyrical scores from the movie. It is an old song performed by Louis Armstrong called "La vie en Rose." *EVE* is the first and only visitor *WALL·E* has had to the abandoned planet. He tries to impress her with his collection of recycled treasures, but she remains unaffected, until *WALL·E* offers her the plant, the

item she has been sent to Earth to retrieve. EVE retrieves the plant and shuts down while she waits for the ship to return to collect her and the plant. WALL-E cannot let EVE go, so he stows away and follows the ship back to deep space where they rendezvous with the Axiom.

The plant found on Earth is meant to signal its survival, and that Earth can once again be habitable. AUTO is the automatic pilot and the main antagonist of the film (Disney). AUTO takes the command to “never return to Earth at all cost,” literally, and tries to prevent the Axiom from returning. In this film, despite the portrayal of humans as lazy, and technologically dependent on computers, they turn their thinking around and help WALL-E and EVE return home. Two passengers on the ship, John and Mary, who usually go about their automated day with no change, become more aware of their surroundings, noticing the pool and windows for the first time, after interacting with WALL-E. The Captain of the ship, who also interacts with WALL-E, together with these two passengers, all begin to ask questions, and rebel against the system that held them dependently captive. In a key scene the Captain argues with AUTO that he “no longer wants to just survive, he wants to live” (*WALL-E*).

Stanton never intended to create an environmental message in this film (Stanton). It is a love story. He wanted to tell a tale about a lonely robot left behind looking for humanity through the trash he collected and dreaming about a companion. WALL-E was programmed to clean, but was left on Earth so long he takes on human traits from the influence of his job, those remnants of humanity left behind, and the music and video he plays over and over. “Put On Your Sunday Clothes” is a song about leaving the old behind and trying something new, and it is WALL-E’s inspiration. The song “It Only Takes a Moment” is chosen when WALL-E and EVE have found each other and say “I love you, by holding hands” (Stanton). These songs are both sung by Michael Crawford from *Hello, Dolly!*

Lastly, the end credits have some of the best art sequences that describe how humans established a home on the Earth again. Alexander Ulloa, contributing writer for the title sequence review website, *Art of the Title*, describes the work:

Something beautiful.

Jim Capobianco’s end credits to Andrew Stanton’s *WALL-E* are essential; they are the actual ending of the film, a perfect and fantastically optimistic conclusion to a grand, if imperfect idea. Humanity’s past and future evolution viewed through unspooling schools of art. Frame after frame sinks in as you smile self-consciously. It isn’t supposed to be this good but there

it is. This is art in its own right. Peter Gabriel and Thomas Newman’s song, “Down to Earth” indulges you with some incredibly thoughtful lyrics and, from the Stone Age to the Impressionists to the wonderful 8-bit pixel sprites, you are in the midst of something special. In a great and successful attempt to preserve our likeness through the lens and canvas of art history, Jim Capobianco, Alex Woo and many others have rendered something epic; art without sublimation and an imprint of hope. (Ulloa)

Andrew Stanton understood that viewers may doubt mankind’s success upon returning to the planet, so it was a way to finish telling the story. The artwork end credits at the conclusion of the movie illustrate an evolution of civilization through music and art styles, and it is stunning.

One of the best features of this film is that it speaks to adults and their actions even if these complicated undertones do not reach the target audience. Children understand the message of friendship that WALL-E and EVE share. Whatever the intention of the film, the strong messages left with the viewer is that human consumption, waste and decisions by humankind can have long and devastating impacts to our Earth. Part of that message also conveys that it is never too late, mistakes and choices can be reversed to promote better environmental practices and choices for our future. Disney could keep this in mind when they package films for release with promotion products less than healthy for our environment. For example, the *WALL-E* movie was distributed with plastic watches that contained non-replaceable batteries. The Disney conglomerate and its commercialism is overrun with plastic waste, marketing trinkets and toy products from China, that litter our landfills.

Disney has made strides with *Disney Nature* and the conservation efforts of the Disney World Wide Conservation fund. Documentaries that promote environmental issues and conservation of resources, such as the films *Earth* and *Oceans* bring awareness and help to spread efforts for preservation of our planet. Other documentaries that bring us closer to wildlife like the films *Chimpanzee* and *African Cats* also demonstrate great care and effort by divisions of Walt Disney to growing concerns of natural habitats.

There is much debate surrounding global warming, and the negative effects of greenhouse gases on our planet. Whether the causes are natural and/or anthropogenic, scientists are concerned with increasing amounts of CO₂ in the atmosphere, and its contributing relationship with a warming trend. In the year 2010, the measurement of GHG (green house gases) with MtCO₂eq (metric ton of carbon dioxide equivalent), was

measured at 50,101 MtCO₂eq worldwide. The USA used to report the highest numbers of emissions, but has made great efforts in reducing its numbers. In 2010 the United States measured 6,714, the country of France 538, and the country of China, which now leads the world with output, reported totals at 111,181 MtCO₂eq (Europa). In their 2010 Corporate Citizenship Report, The Disney Corporation, including: business offices, retail stores, cruise ships, parks and resorts, reported just over 550 MtCO₂eq (Disney). Which means Disney, as a company, is producing more MtCO₂eq than the whole country of France. Reports of Disney's consumption and waste, as measured by CO₂ emissions, can put in perspective just how much Disney as a corporation affects our planet.

Disney's carbon footprint is enormous and they own the responsibility of balancing what they take with what they give back to the Earth in a healthy way. The message they send is a conflicting one. Efforts in environmental research and conservation and preservation can be easily undone without real efforts of eliminating waste. Disney imagineers and animators bring magic to the screen and light the lives of children everywhere. A world free from needless waste and consumerism, one governed by less greed and more artistry in making our planet green would be the best story to tell our children and future generations of fans. It could be the greatest fairy tale they write.

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