EXPLOYATIONS THE TEXAS A&M UNDERGRADUATE JOURNAL

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THE VALUE OF MENTORSHIP

GAMAL AKABANI, PH.D.

Through life we tend to encounter many personal and professional obstacles and tribulations that become difficult, and in some instances impossible to overcome. As far as I know, no one is immune. The process of growing, maturing and becoming a valued member of our society is also not stress-free. We are always in search of opportunities to excel in our professional careers. This process is not isolated to educators but it is present for students. The path to success is a ladder full of up and downs. I customarily emphasize to my students that a degree in higher education is a not an assurance of success. A degree is not even required to achieve success in life! What is required is the ability to find opportunities to grow and the capacity to work hard enough and efficiently enough to attain your goals. This is when mentorship becomes important. Mentorship is not an altruistic endeavor nor is it an isolated sacrifice on the part of the student or mentor. I do not see mentorship as individual instruction or tutoring on how to do research in isolation. On the contrary, mentorship is about exposing students to the same or similar challenges we encounter in research and letting a student find him or herself through those challenges. Mentorship is a symbiotic, reciprocal relationship with a very unique goal: revealing



to a student the necessary tools so they can thrive. Mentoring is in itself an experiment.

I established the Systems-Radiobiology Laboratory at the Department of Nuclear Engineering; the laboratory's research paradigm is directed at the vast topic of cancer with an emphasis on production of medical radioisotopes and targeted radionuclide therapy. I ordinarily entice new undergraduate students to visit the laboratory and describe to them our research objectives by making them realize that the knowledge gained in radiological health and nuclear engineering can be applied and extended to other research areas, such as medical physics, diagnosis and therapy, radiobiology, and nuclear oncology. Many students become captivated and immediately become part of our research team; however, many become discouraged as they realize the vast volume of knowledge they need to gain and compile on top of their course load. Within few weeks many students fade away and those that remain, stay to the end. This is an intrinsic selection process in mentoring. Those students that persist are those willing to learn and allocate time and resources.

Today scientific knowledge evolves at a very fast pace; it is information driven and the customary means of instruction based on orthodox methods is becoming almost impractical when mentoring students. Social and economic forces are demanding from our graduates the capacity to integrate knowledge from multiple realms. Therefore, reading and the capacity to comprehend and assemble information from other scientific areas is the first skill students learn, giving them the opportunity to interact with others, students and professors alike, and contribute to current interdisciplinary research goals. This is an uncharted route, the beginning of an odyssey that we, mentor and mentee, embark upon. Let me be not so pretentious; as a mentor I am as volatile and impatient as any other teacher under academic stress. I have had my share of frustrations with the many students I have been involved. I am not perfect and many of my students can attest to that. It is through these frustrations, defeats and accomplishments that the seeds of success are planted, or so I hope. It mutually provides us with the opportunity to mature as a team. At then end of this precarious odyssey I can humbly state that it is me who ends up being the mentee.

I would like to state that mentorship is a social and academic endeavor that should be valued by the university as a whole. I applaud the scholastic value it is given by the Undergraduate Research Scholars Program and by celebrating those students and professors willing to go beyond the norm of education. Finally, I have to acknowledge that mentorship for me has become a reflection of myself on my students. Poor them! They are the mirrors of what I wanted to be but never realized.

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ADAPTIVE REUSE OF THE PARTHENON MICAELA ALLEN

INTRODUCTION

Held within the ruins of every ancient structure are the secrets of its creators; likewise, important changes of human history are often directly reflected in the architectural modifications. The Parthenon in Athens, Greece, for example, was originally designed as a temple dedicated to the goddess Athena, but over the course of time, it was adapted to serve other religions as well, including its transformation into a Christian church and, afterwards, an Islamic mosque **[FIGURE 1]**. My research explores the timeline of this incredible building and focuses on the architectural changes the temple underwent as different cultures claimed the building for their own religious traditions.

METHODS

My research was primarily literature-based and began with a series of essays published in *The Parthenon: From Antiquity to the Present* (ed. J. Neils). From the bibliographic references of this book, I compiled resources and searched databases, including *JSTOR*, *EBSCO*, and the *Avery Index to Architectural Periodicals*. In order to understand the adaptations of the Parthenon more thoroughly, I used Google SketchUp to create 3D computer renderings based on the building's archaeological remains and architectural phase plans over time.

ANALYSIS

The story of the Parthenon begins with the Greek triumph over the Persians at the Battle of Marathon in 490 BC. The original temple, known as the "Old Parthenon," was constructed in thanksgiving of that victory. The "Old Parthenon," however, was never completed; the unfinished temple was destroyed a mere ten years later when the Persians returned to Greece in 480 BC. This second Persian invasion included the defeat of the Spartans at Thermopylae and the sacking of the Athenian Acropolis where the "Old Parthenon" was located. The Greeks quickly retaliated in 479 BC and defeated the Persians at Plataea and Mycale, but reconstruction of the ruined temple did not begin for another thirty years. Between 447 BC and 432 BC, the Classical Parthenon was constructed as part of the Periclean building campaign, an extensive program of architectural activity, spearheaded by the Athenian general Pericles, which demonstrated the restoration of Greek power and prestige [FIGURE 2].¹

For the next 900 years, the Parthenon stood as a temple dedicated to *Athena Parthenos*, the virgin war-goddess and the namesake of the city of Athens. Constructed of Pentelic marble, this rectangular temple, designed by the architects Iktinos and Kallikrates, was among the largest of its time. The approximate 33x72-meter



[FIGURE 1] The Parthenon in Athens, Greece. Image courtesy of Kevin T. Glowacki.

base was framed by 46 Doric columns arranged in a peristyle 8 columns wide and 17 deep.² This unusually wide ratio allowed for a large inner chamber, or cella, to house the enormous statue of Athena. The eastern room of the cella was framed by 23 smaller Doric columns to emphasize the importance of the gold and ivory, or *chryselephantine*, statue. The temple itself was oriented so that sunlight would enter the cella on Athena's birthday (late August by modern calendars) and illuminate the statue; thus people would enter the Parthenon from the east despite the west end facing the gateway of the



Acropolis. The large east chamber did not connect with the smaller west chamber, or *opisthodomos*. This room could be accessed only from the west and may have served primarily as a treasury, its ceiling supported by four large Ionic columns.³ This combination of the Doric and Ionic orders was unusual for a Greek temple and continued in elements of the sculptural program, which embellished the inside and outside of the Parthenon. The *pediments*, or triangular elements of the superstructure on the front and back of the temple, depicted the birth of Athena on the east side, while the west showed the contest between Athena and Poseidon for control of Athens. The Doric metopes, or sculpted squares along the exterior of the temple, exhibited the struggles between gods and giants, Greeks and Amazons, Greeks and Trojans, as well as Greeks and centaurs, all symbolically celebrating Greek triumph over barbarism, namely the Persians. The continuous Ionic *frieze*, or horizontal band along the cella walls, portrayed a procession of figures probably taking part in the Panathenaic festival, the main celebration in honor of the goddess Athena.³

The third through sixth centuries after Christ were a time of change for the Parthenon and the people of Athens, as the Acropolis was sacked by the Heruli (a Germanic tribe), then the Visigoths, and finally the Slavs, who may have burned the Parthenon in AD 582.⁴ These periodic attacks were juxtaposed with the expansion of the Roman Empire and the spread

of Christianity to Athens. In AD 313, the Emperor Constantine established religious toleration for Christianity throughout the Roman world, but the religion had no major impact on Athens until Theodosius I officially declared it was to be the only state religion in AD 380. Still, the Parthenon remained a pagan temple until sometime after AD 438, when Theodosius II decreed the *Codex Theodosianus*, part of which stated that all temples should immediately be closed.⁴ Thus the Parthenon's life as a Greek temple ended. Like a phoenix, however, it was reborn as a church in the flames of cultural revolution as Christianity swept through Late Roman/Early Byzantine Athens.

Early Christians had several options when faced with the substantial number of pagan temples that were now at their disposal. The common practice was to reuse the building after several years of abandonment once the temple was free of pagan spirits. More commonly, a church or shrine was built on the edge of the temple platform, while the temple itself was

avoided. However, some temples, like the Parthenon, underwent direct conversion, wherein the temple was immediately cleansed and adapted for use as a church.⁵ On the extreme end, this cleansing consisted of burning the temple, while at the other end of the spectrum, it merely consisted of erecting an altar and raising a cross.⁵ It is unknown how and when the early Christian community of Athens initially cleansed the Parthenon. Depending on when this transformation occurred, it is possible they might have utilized the fire of the Slavic sack as its symbolic cleansing. Despite these uncertainties, there is ample record of the structural adaptations made to the Parthenon as a Christian Church.

The architectural forms of Greek temples and early Christian churches differed because they served different purposes. Temple rituals occurred outside before an altar in front of the temple and usually to the east, while the building itself housed a devotional statue. In contrast, the main activity at a church was an interior celebration of the liturgy. The typical form of early Christian churches was a basilica—a long rectangular space divided into three horizontal aisles by two colonnades in which light entered through rows of windows in the walls. One entered from the west and was directed east to the sanctuary marked by an *apse*, or semicircular protrusion. The Parthenon, being a long rectangular space, was perfect for adaptation into a church after minor changes **[FIGURE 3]**.⁶ The



"Like a phoenix, however, it was reborn as a church in the flames of cultural revolution..."

main eastern cella chamber, already divided by two rows of columns, easily became the nave, or main congregational area, and side aisles of the church. The statue of Athena was long gone by this point, though when and who removed it is unknown, so the Christians did not have to worry about discarding it. The entrance was reoriented to the west, while the former entrance in the east was widened and sealed off by the apse. A tiled roof with windows covered the old cella building, and additional window openings were punched through the superstructure at the level of the frieze to allow further lighting. The west chamber became the narthex, or entrance porch, and three doorways were cut into the wall separating the two chambers, thus creating a processional axis through the church. A baptistery was also added in the northwest corner of the narthex.³

When transformed into a church, the Parthenon was rededicated to the Theotokos, the Virgin Mary, in place of the virgin goddess Athena. Thus, several sculptural elements of the Parthenon were either reinterpreted or subjected to early Christian iconoclasm. The "pagan" scenes of the metope sculptures of the east, north, and west, for example, were badly damaged for religious reasons, except for one metope on the west that may have been interpreted as a depiction of the Annunciation.³ Conversely, the pedimental sculptures and frieze were mostly undamaged, excluding where window openings were punched into the frieze for lighting. It is unclear why the Christians would have preserved some elements of the exterior pagan sculpture after going to such great lengths to cleanse the interior. Looking at a processional view of the arrangement, the possible intent may have been to emphasize the victory of the church over paganism; as worshipers entered, they first viewed pagan figures followed by the contrasting Christian interior.³

In subsequent years, the church was further Christianized when it was converted into a Byzantine cathedral. Again, the exact time of this conversion is unclear but engravings found on the wall indicate that the Parthenon was already functioning as a cathedral by AD 693.⁴ Little is known about what transpired in the building during this time, until 1175, when Michael Choniates was appointed as bishop of the cathedral. During his tenure, the interior décor of the cathedral expanded to include a painting of the Last Judgment on the entrance court, scenes from the Passion in the narthex, gallery images of saints and bishops, and a mosaic of the Theotokos in the apse ceiling. The apse was expanded around this time to extend to the east columns in order to accommodate this grand mosaic.

Christian liturgies continued to be practiced in the Parthenon even as ownership changed hands over the next few centuries. In 1204, Athens surrendered to the Crusaders and the Parthenon cathedral became known as the *Notre Dames d'Athénes* (Our Lady of Athens). Under their control, a bell tower with a spiral staircase was constructed in the southwest corner of the Parthenon's entrance porch. Over the next 250 years the cathedral was occupied by the Frankish Crusaders, followed by the Catalans (and the building became known as *Seu de Santa Maria de Cetinas*), and the Florentine Acciaiuoli banking family (*Santa Maria di Atene*).⁷

The middle of the fifteenth century was a turning point for the Parthenon when the Ottoman Sultan Mehmet II ousted the Acciaiuolis from Athens. Once more the cathedral was under new control, but this time the transition of power was accompanied by a transition of religion. The Muslim Ottomans transformed the Acropolis into a garrison base with a mosque, namely the Parthenon, at its center.⁷ By this point in time, a number of Christian sacred spaces had already been converted for Islamic use by the conquering Ottoman Empire, including the iconic Hagia Sophia in Istanbul. The rapid conversion of these places of worship usually involved minor architectural adjustments, since the Quran outlines only one requirement for a mosque the orientation of the worshipers towards the holy city of Mecca (in modern Saudi Arabia).⁸ Generally this orientation is defined by a *mihrab*, or prayer niche, in the *gibla* wall, the wall facing Mecca; in the case of the Parthenon, this is the south wall. Other conventional elements of a mosque are a haram (demarcated prayer hall), a minbar (pulpit), and a minaret (the tower to call the faithful to prayer).⁸ The Parthenon was adapted to fit these needs fairly easily by transforming the bell tower into a minaret, replacing the altar with a minbar, and repurposing the cella as the haram.⁷

The hallmark of Islamic architecture, however, is its largely aniconic ornamentation. Islam prohibits the use of human or animal figures in religious decoration, and therefore relies upon geometric patterns, vegetal motifs, and above all, calligraphy, including quotations from the Quran. When occupying the Parthenon, the Ottomans whitewashed many of the Christian icons and inscriptions covering the walls in order to adorn the structure with decorations appropriate to their own religious beliefs. The adaptations they made were minimal, however, in part because Islamic decoration is minimal at its core, and also because of their trepidation to upset the inherited Christian spirits in the Parthenon. Allegedly, one Turk incurred a withered hand after attempting to remove the apse mosaic, which greatly discouraged others from trying to remove the remaining Christian iconography.⁴



Exactly what modifications were made or what decoration was added to the Parthenon as a mosque are difficult to determine, primarily because, in 1687, a Venetian army opened fire on the structure, which unfortunately was also housing the Ottoman's gunpowder supply. Approximately 300 people were killed in the explosion and the center of the building 2. was entirely blown out.7 Although the Venetians were able to capture the Acropolis and hold it for a short time, the Turks were able to expel them a year later, reclaim the Acropolis, and start to rebuild. The Parthenon was in such poor condition, however, that the Turks resolved to simply build a small mosque in the middle of the ruined structure [FIGURE 4]. This mosque stood until the early nineteenth century, when the Greeks won their independence from the Ottoman Empire. With the foundation of the modern Greek state, the Acropolis became the focus of intense archaeological activity and reconstructive efforts soon began to restore the Parthenon to its original appearance as a Greek temple.⁷

CONCLUSION

Architecture is not mute; it is an art of communication that can tell a story that reaches across millennia. By studying the story of ancient buildings and their adaptive reuse over time, we also study the story of their builders and inhabitants. This analysis of a people's buildings, religious establishments, records, and architectural accomplishments allows us insight into their creativity and lifestyles. Observing this can help bridge the gap between cultures and peoples, both past and present. Thus the Parthenon, like all ancient buildings, is not only an architecturally significant structure, but is also a vehicle for understanding people and cultures.

"Architecture is not mute; it is an art of communication that can tell a story that reaches across millennia."

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SPACE RADIATION, MICROGRAVITY, EXERCISE, AND BONE HEALTH

KATHERINE ELMER

INTRODUCTION

It is well-known that the environmental conditions encountered by astronauts on spaceflight missions are vastly different than those they know from Earth. For a period of time, these men and women exist in an entirely different world. Unfortunately, spacerelated environmental changes are believed to cause physiological declines in the human body. These serious medical risks must be addressed by the team of scientists and physicians that care for astronauts before, during, and after missions.

This experiment focuses on changes in bone health that occur while in space. In particular, this project analyzed the fourth and fifth lumbar vertebrae, which are

bones that compose a portion of the spine located in the lower back. Spaceflight-induced bone loss is one of the major challenges facing long-term human space travel.¹ If our astronauts are to move forward with pursuing long-duration missions, it is imperative that we understand how to prevent bone degeneration, as well as mitigating losses during space exploration trips and promoting the healing process once astronauts return to Earth.



[FIGURE 1] Partial weightbearing model showing the titration of adjusted animal weights using shoulder and tail harnesses. Image courtesy Dr. Ericka Wagner.²

BACKGROUND

Due to its smaller size, the moon only has one-sixth the gravitational pull of the Earth. At this time, NASA is conducting research into the possibility of setting up a semipermanent space hub on the moon. As a result, many research projects are focusing on the long-term physiological effects of exposure to a lunar environment. Partial weightbearing that simulates lunar gravity results in a loss in bone volume. High-energy radiation, like space radiation, also negatively affects the skeleton. However, the combination of these two adverse conditions had not been extensively analyzed before this study. Additionally, it is known that resistance training (like lifting weights) is the most effective exercise mode to counteract disuseinduced bone loss. This project is novel in that it is the first to analyze bone integrity changes that take place during the period of recovery from space radiation and lunar gravity exposure. It is also unique in that it analyzes the bone of the lumbar spine, an area of the body often overlooked in space research. After returning from spaceflight missions, over sixty-eight percent of astronauts reported lower back pain.² While the most commonly-accepted

cause of this affliction is due to stress on nerve roots from the intervertebral disk expanding as the spine stretches, we cannot rule out physiological changes happening in the bone tissue itself.

METHODS

It is difficult to perform experimental analyses on astronauts themselves due to the nature of bone function tests and the limited sample size. As such, the use of an approved rodent model like that which was utilized in this study is an appropriate



[FIGURE 2] Climb training resistance exercise model shown with added weights on the tail.

alternative.³ This experiment involved an initial full-body exposure to heavy iron particles at Brookhaven National Laboratory, which mimics the effects of galactic cosmic radiation, or space radiation, that astronauts encounter while on missions. The animals were then shipped to Texas A&M University, where they experienced a 21-day period of partial weightbearing, simulating the gravitational field of the moon. Animals in the partial weightbearing group were placed into shoulder and tail harnesses [FIGURE 1]. The weight supported by the harness was titrated to one-sixth of the animal's mass, effectively putting the animal into a moon environment. A 21-day recovery period followed, where half of the animals took part in a resistance exercise program while the other half were allowed to rest and resume normal activity levels. Exercised animals began climb training on Day 22 [FIGURE 2]. The mice climbed up to the top of a vertical wire mesh ladder while supporting weights on their tails. Work output remained constant throughout the three weeks of the exercise protocol, and adequate rest days were provided to maintain animal wellness. This setup mirrored a spaceflight mission where astronauts complete a 21day lunar mission, and then return to Earth and begin a resistance exercise program.

After animals were terminated and their tissues harvested, the spine was removed and each individual vertebrae, or spinal bone segment, were dissected out. The fifth lumbar vertebrae were baked in an ash oven at 100°C for 15 hours to dry, then at 600°C for 15 hours to burn off all cellular tissue, leaving behind the calcified bone. The calcified portion of the bone gives a measure of bone mineral content. The fourth lumbar vertebrae were sent to Indiana University School of Medicine, where Dr. Matt Allen performed ex vivo, or post-mortem, microCT bone scans. The resulting pictures are very similar to what a doctor would see on CAT scan results, but on a much smaller and more detailed scale. These scans give a pictorial representation of the bone volume [FIGURE 3]. Finally, the sixth lumbar vertebrae were harvested from terminated animals and analyzed to determine the maximal force they could withstand before being crushed. [FIGURE 4] details the vertebral

"Spaceflightinduced bone loss is one of the major challenges facing long-term human space travel."

body of each sample, which is the cylindrical, weightbearing portion of the bone; each was shaved to produce a flat surface before being compressed from top to bottom. The cross-sectional area of the vertebral body was recorded, and the maximum force supported was normalized to the volume of each



[FIGURE 3] Top view of fourth vertebral body illustrating bone volume taken during microCT scanning. Image courtesy Dr. Matt Allen.

bone sample. Together, these three tests give a big-picture glimpse into what is occurring in the skeleton during the period of recovery from space radiation and decreased gravitational force.

RESULTS

This project focused on changes in bone structure and function that occur during the period of recovery from exposure to space radiation and reduced gravity. As such, all data were reported as change scores (Δ) and represent the difference in various bone integrity measures between the end of partial weightbearing period and the end of the study. This allowed our team to analyze only the bone adaptations occurring during the rest period and ultimately to compare changes over time and across experimental groups.

Results indicated that radiation had a negative effect on trabecular bone mass in the lumbar vertebrae. The trabeculae compose the inner core of the force-bearing vertebral body of lumbar spine bones. Their increased size corresponds to improved bone strength, while decreased thickness indicates reduced vitality. This suggests that exposure to space radiation does not allow supportive bone structures to grow in overall size or individual thickness during recovery from partial weightbearing. Further, the bones of animals who were exposed to space radiation showed significant declines in trabecular thickness, even six weeks after the initial radiation exposure. Their counterparts who were not irradiated showed increases in trabecular bone thickness during recovery from partial weightbearing, revealing that radiation-free bones were able to recover from the disuse environment more effectively.

Ash weight represents the true bone mineral content as measured by weight. The larger the number reported for ash weight, the higher the bone mineral content. Bone mineral content in animals exposed to space radiation was lower than in those who were not, showing that space radiation affects bone mineralization, or bone cell regrowth and turnover.

After analyzing the maximum force required before compression, and normalizing these values to the surface area of the trabecular bone matter, the variable termed "maximum stress" was determined. This was accomplished by dividing maximum force by surface area to yield maximum stress. As seen in similar studies employing the same method to test maximum stress, variability was rather high. Even after taking extreme care to ensure testing surfaces were parallel and bone samples remained secure, the variability was too high to yield significant results. However, the trends we noted closely mirror those seen during ash weight analysis. In a bone sample so small, this is promising.

CONCLUSION

It is well-documented in both animal and human research models that weightbearing exercise leads to improved bone health.^{4,5} The main effect of radiation on bone mass and trabecular thickness demonstrated in this study indicate that exposure to space radiation inhibits the bone's ability to respond normally to exercise. Not only does that



[FIGURE 4] Biomechanical compression test of fourth lumbar vertebral body (cylindrical, weightbearing portion of the bone). Image courtesy Dr. Steven Tomassini.⁶

radiation lead to a decreased propensity for bone to recover, it actually results in significant absolute losses in bone integrity. This is especially significant because the microarchitecture of the lumbar spine bones remains compromised even six weeks after an initial dose of radiation.

These results apply most directly to astronauts who begin resistance exercise programs, like weight training, after returning to Earth from spaceflight missions. However, these data also have implications for many additional populations. Most directly, transarctic airline crews are exposed to smaller doses of the same type of space radiation on their longduration flights across the North Pole, where the protective ozone layer thins.^{6,7} When compounded with the sedentary nature of their careers, this exposure is alarming. In fact, in an attempt to protect their employees from physiological harm, the airline industry regulates the number of such flights it allows crew members to make annually.

we isolate results from animals not exposed to space radiation, it allows for an analysis of the effects of exercise during recovery from partial loading. These comparisons are especially important for patients on extended bed rest, spinal cord injury victims, patients afflicted with neuromuscular and musculoskeletal diseases keeping them from being ambulatory, and even individuals choosing to participate in a sedentary lifestyle. We see that outside of the scope of space radiation, exercised animals showed significant increases in bone mass, trabecular thickness, and ash weight during recovery from partial weightbearing. This further speaks to the efficacy of resistance exercise as a means of counteracting disuse-induced bone loss.

While the type of radiation differs, other occupations exposed to radiation include x-ray technicians and nuclear power plant workers. High enough doses over a period of many years may have similar

If

"...exposure to space radiation inhibits the bone's ability to respond normally to exercise."

effects to those observed in space radiation.

In conclusion, the change in bone growth of lumbar spine bone to exercise is blunted for up to six weeks following space radiation and partial gravity exposure. This novel study investigates the response of lumbar spine vertebrae to space radiation, reduced weightbearing, and resistance exercise during recovery. As a future physical therapist, I see the importance in providing a quality of care to my patients that allows them to enjoy the best quality of life possible. Were I to continue working more deeply in this subject area, I would love to see a multi-disciplinary 3. approach that works to optimize exercise equipment used in space, design spacecraft and suits that effectively block out space radiation, and focus on proactively addressing the health and wellness needs of our astronauts. It is my hope that as a scientific community, we take the time to press further into these results. Not only does the lifelong health and safety of our nation's astronauts depend on it, but in an increasingly sedentary world, so does the happiness, health, and well-being of many.

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WEIGHT DISCRIMINATION IN SIMULATED JURY SCENARIOS

JESSICA SMARR

INTRODUCTION

According to the Centers for Disease Control and Prevention, over one-third of adults in the United States are obese, and the medical costs associated with obesity consumed an estimated \$147 billion in 2008 alone.¹ The serious physical health risk associated with obesity is unusual in that it also carries with it a stigma not associated with most other medical issues. Anti-fat bias (i.e., discrimination against overweight and obese individuals) has been found in healthcare professionals, teachers, potential employers, romantic partners, and family members of overweight and obese individuals.² Not only can carrying extra weight pose a serious risk to physical health, but the bias and discrimination experienced by overweight or obese individuals can also carry with it emotionally damaging effects.³ This discrimination may also prevent obese and overweight individuals from becoming healthier. In a study of 318 physicians, 23% did not recommend any treatment to their obese patients and 47% found it inconvenient to counsel patients about weight loss.⁴

Overweight and obese individuals are often externally ascribed negative personality traits and considered to be lazier, greedier, and more likely to have emotional problems than their leaner peers.² Previous research has found evidence of medical, professional, and educational discrimination based on weight, but does this discrimination appear in arenas where more ethical components of the discrimination associated with anti-fat bias may be applied? We attempted to examine this issue by testing whether or not individuals suffer more in a situation of moral judgment (i.e., as perpetrators in a hypothetical criminal sentencing) with an increase in weight or differences in sex. Specifically, we hypothesized that the crimes of women with a higher Body Mass Index (BMI) would be judged more harshly and that these women would receive more severe punishments than lower BMI women, low BMI men, and high BMI men, respectively. With better understanding of the application of anti-fat bias, as well

"Previous research has found evidence of medical, professional, and educational discrimination based on weight."

as how it may function differently for men and women, more constructive actions may be taken to prevent this discrimination and its negative effects.

BACKGROUND

It has been long accepted in social science research that judgments of others in simulated jury settings, wherein participants are asked to 'judge' one or more alleged perpetrators, are influenced by the appearance of the target. More attractive individuals fare better when judged in simulated jury tasks, and ethnicity and race have also been shown to play a role in the same tasks.⁵ But does weight play its own unique role in this situation? Recently, researchers found an effect of the weight and gender of perpetrators upon jurors' perceptions of guilt and responsibility. Men were significantly more likely to find obese women guilty of a crime than they were to find lean women guilty of the same crime, whereas there was no difference found in the judgments of lean versus obese men. Regardless of weight or gender, no significant difference was found in women's judgments of individuals from the four groups.6

This gender gap in the application of the anti-fat bias has been observed in several studies, with women paying a higher price for increased weight. Furthermore, women report experiencing significantly more discrimination than do men in social, occupational, and medical spheres.⁷ Specifically, with increased weight, women have been found to be more negatively evaluated in the workplace when compared to their male peers and received lower salaries as their weight increased.⁸

Gender differences exist not only in the recipients (targets) of discrimination, but also in the participants (judges).⁶ As previously noted, men's decisions were significantly impacted by the weight of the person they were judging, but women's responses were not. An intricate relationship seems to exist between gender and weight discrimination, as judgments based on weight are not merely a function of salience or internal criticism; where women judge the body image of others less harshly than do men, women are more critical of their own body image.⁹

RESULTS

291 undergraduate students enrolled in psychology



[FIGURE 1] Sample of alleged perpetrator images used in questionnaires.

courses at Texas A&M University participated in an experiment designed to further explore the role of anti-fat biases in judgments of others. All participants were randomly assigned to complete one of four digital questionnaires, which included personality trait surveys and 16 criminal scenarios. Each criminal scenario was accompanied by a picture of an alleged perpetrator, and participants were asked to judge the severity of the crime committed and assign what they deemed an appropriate fine amount and/or jail sentence length. Each participant received one of four sets of defendant pictures: lower weight females, higher weight females, lower weight males, or higher weight males. All purported defendants were Caucasian. Online mug shots were altered to simulate lower versus higher weight [FIGURE 1].

Preliminary analyses of the data revealed that the sample of participants was relatively high in disgust sensitivity, which is an individual characteristic referring to three aspects of disgust—moral, sexual, and pathogen. As individuals who are highly disgust sensitive have been found to be harsher in their judgments when evaluating obese individuals, we controlled for individual differences in disgust sensitivity in all subsequent analyses.

We predicted that higher jail sentences would be assigned to female perpetrators with a higher BMI, relative to lower BMI females, low BMI males, and high BMI males, respectively. This prediction is consistent with previous anti-fat bias research suggesting that women, more so than men, pay a higher price for a higher BMI. When comparing the four groups to one another individually, we found a marginally significant effect of weight and gender on differences in assigned

"High BMI women were, on average, assigned almost three more years in jail than lower BMI women."

jail sentences. Because we hypothesized that high BMI women would pay the greatest price for their body image, we also analyzed the data using a planned contrast test, comparing the jail sentences of high BMI women to the other three groups as a whole. This analysis found that high BMI women received significantly longer jail sentences relative to the other groups. As seen in **[FIGURE 2]**, high BMI women were, on average, assigned almost three more years in jail than lower BMI women.

The fines assigned to perpetrators were marginally predicted by perpetrator BMI, such that high BMI perpetrators were assigned greater fines than low BMI perpetrators across both sexes **[FIGURE 3]**. We found no differences in judges' ratings of the perceived severity of the crimes as a function of the targets weight or sex. No significant differences were found between the judgments of men and women participants.

DISCUSSION

The current experiment demonstrated that higher BMI women are judged more harshly as perpetrators in hypothetical criminal sentencing scenarios (i.e. given longer jail sentences) compared to lower BMI women, low BMI men, and high BMI men, respectively. These findings suggest that, in support of the given hypothesis, that women may be punished not only for their crimes, but also for additional body weight in a trial setting.

CONCLUSION

As much of the current literature on anti-fat bias has focused on the discrimination towards obese



[FIGURE 2] Average jail sentences as a function of perpetrator sex and BMI. High BMI women received the harshest sentences.

individuals, this current study adds a surprising finding to this body of work. Instead of looking at the difference between normal weight individuals and obese individuals, we only slightly increased and decreased the weight of our stimulus pictures. The fact that a seemingly modest increase in weight for the same woman resulted in almost a three year increase in assigned jail sentences was both surprising and alarming, given its serious implications for the criminal justice system.

These results, if replicated in real-world settings, may carry lasting consequences for women within the criminal justice system. For incarcerated women, weight gain is a serious concern throughout their sentence.¹⁰ If overweight women do indeed face harsher sentences, as the current findings suggest, a vicious cycle may exist in which overweight women are given longer sentences, leading to more prisonrelated weight gain and the possibility of negative repercussions in parole sentencing scenarios and increases in the recidivism rate of these women.

Future research must be conducted to both gain a greater understanding of how this relationship between weight and sex truly functions in a jury setting and to deter potentially unjust applications of anti-fat bias in that setting. Increasing the weight difference in the high versus low BMI categories may also be done to evaluate whether a greater effect of anti-fat bias may skew ⁵. sentencing rates even further with a larger difference in weight. Also, as the current findings support the existence of anti-fat bias when perceiving the guilt and deserved punishment of an alleged perpetrator in a simulated jury setting but not yet in an authentic 6. application; asking acting judges to complete similar surveys could offer a better understanding of how and whether this phenomenon persists in the real world.

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[FIGURE 3] Average fine assignments as a function of perpetrator BMI. High BMI perpetrators received the larger fines.

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JOURNEY TO THE CENTER OF THE SILQUE

ALYSSA NICOLE MANGAN-RETA AND NANDINI PATEL

This topic was given to us by our professor, Dr. Lawrence Griffing. This started as a class project for BIOL 430, which is Biological Imaging. We used digital imaging of many microscopy methods to study the siliques of the *Capsella bursa-pastoris* in our lab and lectures every week. More commonly known as "Shepherd's Purse," *Capsella bursa-pastoris* is a small, flowering weed that grows all around the world, typically in colder climates. As the subject of our laboratory investigation, we were already in contact with this organism, and had the resources to manipulate, observe and investigate it. We had a basic understanding of *Capsella bursa-pastoris*, but as our knowledge of microscopy grew, so did our curiosity to learn more about it on a subcellular level.

Through the microscopy and photography techniques taught to us, we were inspired to explore the differences between two techniques: bright field microscopy and fluorescence dark field microscopy. Each procedure results in an image that reveals distinct features of the *capsella bursa-pastoris* siliques, which are the seed pods of the organism. The seed pods show the developmental cells of the *Capsella* plant. This is a very diverse and complicated area of biology, but while the material is complex, it has been a pleasure for us to learn from Dr. Griffing and our Teaching Assistant, Krishna Kumar.

"...as our knowledge of microscopy grew, so did our curiosity to learn more about it on a subcellular level." The bright field microscopy techniques show the lateral slice of the silique. This technique shows the growing embryonic cells within the seed. It has a dye to highlight the membrane of the seed itself. Meanwhile the fluorescence microscopy shows the texture of the silique while showing us the nuclei of the embryonic cells. The 4',6-diamidino-2-phenylindole (DAPI) dye shows us the nuclear components of the seed from the silique. We have also included a picture of the silique in its natural state to show how the purse-like silique is arranged on the plant. Through microscopy, we can see the subcellular components of the siliques and their seeds, allowing for a better understanding of the organism at the macro level.

In addition to interpreting the data and pictures the techniques yielded us, we have learned the details of the equipment being used. In this case, we used the Olympus BX40 Microscope for the bright field and fluorescence microscopy. These images were obtained properly through Kohler Illumination, a technique that we used during instruction of how to maneuver the light fields and lenses to get a focused sample. Also, the Photoshop techniques we learned in class helped us refine these images through color level balancing, histogram stretching and exposure adjustment.

This work would not have been possible if we had not gained the knowledge necessary to perform the experiments and microscopy that the images were obtained with. Our newfound knowledge helps us with the photo-processing aspect as well as while we took the pictures. We learned how to properly calibrate the microscopes to ensure quality images while avoiding any interference from outside contaminants such as dust, dirt particles and smudges.

After learning and applying all of the techniques we've learned from our imaging class we have a new perspective on the science of digital photography and microscopy. This new view of how we can study the world around us has been so interesting for us to experience and has given us yet another area of biology to love. The knowledge and intricacies involved in these techniques and field of study has fueled our quest for new discoveries in the field of microscopy through our examination of the object of our study, *Capsella bursa-pastoris*.

Bright field microscopy





Main silique arrangment

USING COMMON CHARACTERISTICS TO IMPROVE COMPUTER-AUTOMATED DESIGN

JORDAN CAZAMIAS

INTRODUCTION

A staggering number of real-world objects, both natural and man-made, follow a certain structure in their design or form. Cars, for example, may be widely varied but share many commonalities in their overall design: they all have headlights and taillights, wheels, windshields, etc., and all in relatively similar positions. These common elements are necessary for a car's function, but the automotive industry (and the consumer!) don't want all cars to look alike. How do we easily generate new and exciting automotive body designs while still retaining elements critical for car function? Our approach is to use computer modeling to identify the common elements of a structure such as a car and then allow the design process to change all other variables, thus quickly and easily generating anything from a Smart Car to a Lamborghini. To do this, we need to identify this hidden, common structure—essentially a collection of de facto rules for how different objects should be built. Understanding these rules, then, can help us to understand an object's design at its core.¹ Taking this one step further, if we had a way to encode these rules so that a computer could understand them, we could leverage the vast computational power at our disposal to analyze and even modify these rules, which would potentially allow for novel ways to easily generate and even optimize



[FIGURE 1] Examples of designs created by users of the Context Free and Structure Synth programs. All of these designs are created with random variation, meaning that they will be different every time they are generated.

object designs. The critical idea is that computers could be used to model not just a single object, but an entire class of objects, simply by identifying common features of the objects. Knowing these required features would then allow you to randomly generate as many functional designs from the class as you want without being limited by any unnecessary design restrictions. Imagine downloading a file from an online gallery of object classes (for example, office chairs, gearboxes, or skyscrapers), pushing a button, and having a full design made for you in seconds. This capability wouldn't be limited to one design, but as many as you would need. Creating a forest for a video game level? Using this technology, you could make a simple generator that could crank out a thousand different tree models. Trying to create the perfect logo for your product?

"This capability wouldn't be limited to one design, but as many as you would need...

Why not generate dozens of variations and have a focus group vote on their favorites? This would have enormous implications for automated design processes

such as procedural generation, digital prototyping, and more.² Plus, with the advent of the 3D printing industry, these generated designs could easily be made physical, greatly expanding the applicability of this technology.

BACKGROUND

A useful data structure already exists to model the design of objects and classes of objects. This tool is called the **shape grammar**.³ Shape grammars are a geometric adaptation of the **formal grammar**, which is a set of rules for how strings of characters are generated from a list of symbols. These types of rules are widely used in computer science for defining the syntax of programming languages and for parsing both programs and natural human languages. On a similar note, the shape grammar consists of a set of primitive shapes and a set of rules for building up a full design using the primitive shapes as the building blocks. Rather than provide a step-by-step list of instructions, which could only lead to creating the same design, a core principle of grammars is that many different rules could be applied during a step and one of these rules is chosen at random. This creates random variation in the designs, essentially allowing a computer to be "creative" within practical constraints.

Shape grammars are straightforward to build using existing software tools. The Context Free program (available at contextfreeart.org) has been designed to allow the creation of 2D art and designs by building shape grammars, and Structure Synth (available



[FIGURE 2] A short example of a shape grammar created with Context Free that generates branching tree-like structures. To generate a design, the grammar begins with the starting shape, shown in Step 1, and randomly applies rules (indicated by the matching numbers at each step) until no more rules can be applied, as shown in Step 7.

at structuresynth.sourceforge.net) is an equivalent program for 3D models. Both programs define a simple language to build these shape grammars, and only require basic programming experience. [FIGURE 1] demonstrates some of the examples of user-generated designs using both of these programs. [FIGURE 2] shows a simple Context Free program and

...thus quickly and easily generating anything from a Smart Car to a Lamborghini."

the underlying mechanisms behind design generation using shape grammars.

Using these programs to create basic designs is quite straightforward. However, fine-tuning these shape grammars presents a much bigger challenge. The main issue is that these grammars can contain many hardcoded parameters. For the grammar shown in **[FIGURE**] **2]**, any of the numbers in the grammar code can be considered a parameter for the grammar. How does a designer know which balance of parameter values will generate the best designs? Manually adjusting these parameters is one solution, but requires repeatedly checking the grammar's designs and can turn into a tedious process of trial and error. Furthermore, some of these parameters are very sensitive to modification; in other words, a very small change in a parameter values may result in a drastic change in the resulting designs generated by this grammar. See [FIGURE 3] for an

example. Therefore, this problem begs the question of whether the ideal balance of parameter values could be found by a computer through optimization techniques.

This research proposes a framework for shape grammar optimization that draws from research in grammar induction. Grammar induction is a process whereby a grammar is generated from a set of example designs (essentially the reverse process of design generation).² A crucial drawback of induction, however, is that the example designs used must be specially labeled, which requires domain-specific expertise in the field of formal grammars. Unlike a pure grammar induction strategy, an optimization framework could serve as a viable tool with a low barrier to entry for any designer, even one with minimal programming knowledge. This framework should allow the refining of a grammar to better generate objects so that they achieve the designer's criteria. These criteria may be any that the designer deems necessary for the designs to have, be it a capability to perform a certain task, a fundamental design pattern, an appealing aesthetic, or a combination of several features. Most importantly, the criteria do not have to actually relate to an object's shape, or even be any measure that is easily quantifiable by a computer, so long as an object can be judged based on these criteria in some way.

I hypothesize that shape grammar optimization would not only be possible with such a framework, but could be used to create grammars of a quality that surpasses that of grammars with only manually adjusted parameters.



[FIGURE 3] With a few small changes to the rule probabilities, or other attributes, of a shape grammar, we can modify the structure of shapes without even making major changes to the grammar itself.

METHODS

Optimization framework

The details of this proposition are illustrated in **[FIGURE 4].**

Here is a more detailed explanation of this process:

- 1. As input, a grammar *G* is provided. This grammar has various parameters π_1 , π_2 , ..., π_n which will be adjusted.
- 2. From grammar *G*, *k* grammar variants *G*₁, ..., *G*_k are created. These are copies of grammar *G* where some of the rule probabilities have been modified, typically in a semi-random way.
- 3. From each of these grammar variants, multiple **exemplar designs** are generated. These exemplars will be scored based on how well they achieve the designer's criteria.
- 4. The grammar *G* and the grammar variants fit somewhere within the **configuration space**, or the space of all possible variants of grammar *G*. Because each of the *n* parameters is a variable for grammar *G*, this space is an *n*-dimensional space.

specific algorithm that fills in the more general steps of the framework with specific implementations. Therefore, a pilot experiment was created that uses a specific implementation of the framework in order to test its effectiveness. To simplify the experiment to be feasible within the timeline, a text grammar was used rather than an actual shape grammar. However, because

this text grammar was designed for generating new words (instead of parsing human language), this grammar can be considered to be a design grammar, just like shape grammars. Thus, the goal of design optimization can be applied to this grammar just as well as with any shape grammar.

As specified in the optimization framework, a criterion was chosen as a goal for the text grammar to achieve. The criterion chosen was: **How well would this word fit as the name of a spell or incantation from the Harry Potter series?** Besides being easily understood by human evaluators, the Harry Potter criterion is a favorable one because it has a clear success state. Essentially, some words would fit much better than others as Harry Potter spells (namely, words with roots derived from Latin as opposed to a completely unrelated language such as Japanese). A preliminary Harry Potter grammar was created from an analysis of the most popular Harry Potter spells, and was then optimized over five rounds. In each round, between 5 and 8 grammar variants were generated, and 25 words



5. The goal now is to find the more **optimal grammar** *G'* within this configuration space by taking grammar *G* and shifting it to a more optimal position. The details for how to do this can vary, but the new grammar should end up closer to the positive variants than the negative variants.

This new grammar is called grammar G'. Because G' is closer to the higher quality grammar variants in terms of parameter values, it will be considered more optimal than G.

Pilot experiment

The optimization process described above is just a general framework. To apply it in a real setting, one would need to create a were generated from each variant. Each word was rated on a 1 to 5 scale by human evaluators (also, a score of 0 was assigned if the word contained a nonsensical combination of letters; for instance, *ccaneva* was given a score of 0). The mean score for each variant was calculated and used to measure the success of each optimization round. **[FIGURE 5]** shows examples of actual words generated during the experiment, with their assigned scores.

RESULTS

After gathering the scores for each of the variants (with 800 words evaluated in total), the overall round scores for the Harry Potter criterion were compared. The results are shown in **[FIGURE 6]**.

The trend line indicates that the overall round score is improving by about 0.1 per round. A linear regression analysis confirms that this upward trend is statistically significant (p = 0.0009). In addition, a one-way Analysis of Variance (or ANOVA test) was run, which confirmed that some of these round scores are significantly different (p = 0.0168). To determine which round scores can be considered different, Tukey's Procedure was used to compare each pair of round scores. According to Tukey's, Rounds 4 and 5 had significantly different scores than Round 1 (p < 0.05). This result strongly suggests that the optimization process is indeed improving the quality of the grammar variants over several rounds.

DISCUSSION AND CONCLUSIONS

The data obtained from the pilot experiment suggests that the optimization process we used significantly improved the Harry Potter grammar over several rounds, and is an encouraging step in supporting our hypothesis. This pilot experiment, of course, is only the first step in exploring the potential for using this framework to optimize shape grammars. We are currently setting up a new experiment where we are implementing an optimization process for actual shape grammars using the Context Free program. We will also make a significant improvement by using computer vision techniques rather than human evaluators to measure the quality of the grammar exemplars. This will be more challenging to achieve, but will enormously speed up the evaluation time needed to evaluate the grammar variants. With this extra time, more optimization rounds can be run and a more



[FIGURE 6] The overall round mean scores, plotted with a linear regression line. One-way ANOVA and Tukey's Procedure were also used to analyze the data (results not shown here).

fine-tuned optimization can be achieved. The use of computer vision techniques can also eliminate much of the variance that arises from human-centered studies.

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First, I would like to thank Dr. Dylan Shell; he has been a great mentor and guide throughout this process. I would also like to thank Ben Fine, my graduate student advisor, for his encouragement and his inspiration for this project idea.

The 3D building models in **[FIGURE 1]** were created in Structure Synth and provided by yhancik at flickr. com/photos/yhancik/3179604858 under a Creative Commons license.

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Score:	0	1	2	3	4	5
	Msoipaftio	Cisopmuro	Revsutio	Cerio	Rapuris	Sermonio
	Hmeerio	Raotudo	Recedudru	Mamaados	Sespovio	Noros
	Siudegmu	Rapmaves	Votasis	Potis	Ravesos	Serperis

[FIGURE 5] Several examples of words generated by some of the grammar variants in the experiment, along with the scores they were assigned.

THE POWER OF PERSONALITIES: A GLIMPSE INTO CELL PHONE ADDICTION

MORGANNE BLACKSTOCK AND ABIGAIL DEMIANO

INTRODUCTION

Think back on a time when you were rushed and were scrambling to get to an important event, only to realize when you had reached vour destination that you had left your cell phone miles away at home. Does it leave you with a pit in your stomach? Many people relate to this feeling of anxiety or loss without their cell phone. Although this seems silly, the obsession with cell phones is a prevailing problem facing our society. Have you ever looked around in class and noticed the tremendous number of students furiously typing away at a text message? Have you ever peeked into the car next to you at a stoplight only to find the driver distracted on their phone? This infatuation with cell phones has consumed today's American population. As undergraduates, we wanted to design a study that analyzed the driving force behind college students' cell phone dependence. What are the characteristics of the students who decide to skim the latest news on Facebook during class rather than devote time listening to the professor lecture? Why is it that the person in the car

next to you is unable to put his or her phone down and focus on driving? Questions such as these spurred on our study, as we sought to find the root of cell phone addiction. What we wanted to know was simple: **Do certain personalities drive cell phone dependence more than others**?

BACKGROUND

The obsessive nature of cell phone use in society is not a new problem. In fact, many researchers have published studies on the relationship between cell phone usage and personality.¹ Our study is unique to the previous studies as we analyze other variables, such as the NEO personality inventory and Levenson Locus of Control, in order to understand the relationship between the personalities of college students and their dependence. Previous instrumental studies spearheaded by an Australian research team at Queensland University of Technology have focused on Australia youth (ages 15-24) and their cell phone habits.¹ Through these studies. a strong correlation between cell phone usage and specific personality variables have been found. For instance, they found that there is a distinction between frequency of mobile phone use and mobile phone involvement. The frequency of cell phone use could be predicted by one's self-identity while both self-identity and validation from others predicted mobile phone involvement.

"This infatuation with cell phones has consumed today's American population."

METHODS

A survey was given to 452 Texas A&M University undergraduate students (209 males, 243 females) to find the relationship between selected personality variables and cell phone usage. The participants were enrolled in large Introductory **Psychology and Sport Management** classes, and the survey was given as extra credit in order to encourage student to participate. The survey participants completed contained questions regarding their cell phone usage and questions that investigated their personality traits by using items related to:

- NEO-PI Big-Five Personality Inventory
- The Levenson Multi-dimensional Locus of Control (LOC) scale
- Balanced Inventory of Desirable Responding (BIDR) Scale.

The NEO-PI Big Five Personality Inventory measures an individual's

Item #	Item Statement		
Item 1	"I often think about my cell phone when I am not using it."		
Item 2	"I often use my cell phone for no particular reason."		
Item 3	"Arguments have arisen with others because of my cell phone."		
Item 4	"I interrupt whatever else I am doing when I am contacted on my cell phone."		
Item 5	"I feel 'connected' to others when I use my cell phone."		
Item 6	"I lose track of how much I am using my cell phone."		
Item 7	"The thought of being without my cell phone makes me feel distressed."		
Item 8	"I have been unable to reduce my cell phone use."		

[TABLE 1] Eight statements were surveyed about students' psychological measures in relation to cell phone usage.



[FIGURE 1] The Big Five Personality Traits and the Characteristics of each personality.

extent of extraversion, agreeableness, conscientiousness, neuroticism, and openness to experience.² The Locus of Control Scale measured the degree to which a person believes he or she has control over one's life (i.e. external controls ["powerful other" or the environment] or internal controls [their personal drive]).³ The Balanced Inventory of Desirable Responding Scale assesses whether the individual is responding truthfully or if the student is providing dishonest answers in order to make his or herself look better (i.e. selfdeception).

In order to focus on personality measures and the extent of cell phone use, we created three different categories to gauge cell phone usage: the number of daily calls made/received, the number of daily texts made/received, and total phone use. These three categories were used to see how traits such as openness, extraversion, agreeableness and neuroticism played a role in cell phone use. The three categories of cell phone usage were also utilized to examine gender differences of the various aspects of cell phone behavior

There were a total of 8 items surveyed about students' psychological measures in relation to their cell phone usage, as seen in **[TABLE 1]**. These items were also used to analyze the differences between genders and their psychological attachment to their cell phones. Finally, a general regression analysis was employed to assess the relationship between the Big Five, Locus of Control (LOC), and BIDR measures.

RESULTS

Our study uncovered three significant findings that are further discussed below.

A) Personality significantly impacts cell phone dependence.

B) The psychological aspects of personality greatly influence a student's cell phone dependency.C) A college student's gender has significant influence on their cell phone usage.

A) An individual's personality had a strong influence on one's degree of cell phone use. **[FIGURE 1]** shows the characteristics of the Big-Five Personalities that were surveyed. The correlation found for each Big-Five Personality trait can be found in **[FIGURE 2]**. In regards to amount of calls made and received, there were distinct personality differences. Where individuals who are highly extraverted made the largest number of phone calls (t=3.13), individuals who are

highly agreeable made the smallest number of phone calls (t=-3.88). Extraverts also ranked very high in the total cell phone usage (t=3.12) while people who are agreeable had very low total cell phone usage (t=-1.95). People who scored high on openness ranked even lower than agreeable individuals in total cell phone usage (t=-2.65).

B) The psychological characteristics of a student also influenced cell phone usage. There were a total of 8 items surveyed about student's psychological measures in relation to their cell phone usage, as seen in **[TABLE 1]**. These statements measured a student's personality and degree of self-deception ("fake it 'til you make it") in relation to a student's cell phone usage. Three particular items led to some interesting correlations.

Item number 3 states: "Arguments have arisen with other because of my cell phone use." As one might suspect, people who are considered agreeable rarely engaged in arguments due to their



[FIGURE 2] Personality Scales

cell phone use. However, surprisingly, extraverts had very high number of arguments resulting from their cell phone usage. Beyond this, individuals who scored high on the neuroticism scale surpassed the extraverts in the extent of arguments that have arisen due to cell phone use!

- Item number 5 states: "I feel 'connected' to others when I use my cell phone" also generated significant results. People who scored high on self-deception and impression management very much agreed that using their cell phone made them feel connected to others. However, individuals who scored high on neuroticism scored the highest in agreeing that they feel connected to others by using their cell devices.
- Item number 7 states: "The thought of being without my cell phone makes me feel distressed." When placed in a situation without their cell phone these individuals felt extreme distress, so as one would expect, individuals with neuroticism attained the highest score in this category.

C) Finally, gender differences in cell phone usage were observed (results can be seen in **[FIGURE 3]**). While males had higher call activity, females had a higher rate of total phone usage. When looking at individual items, females scored higher than males in almost every aspect. Females tend to think about their cell phone when they are not using it or use their cell phone for no particular reason at much higher rates than males. Beyond

"...cell phone usage among college-aged students is highly related to aspects of personality and gender."



[FIGURE 3] Gender Differences

this, females were found to "feel connected" to others when they use their cell phone more so than males. However, we found that females are not the only ones with a cell phone addiction. In fact, males and females both scored very high and similarly on many items. For example, both males and females highly agreed with the statement of "the thought of being without my cell phone makes me feel distressed." Not only do both males and females feel this distress, but both genders also feel that they are unable to reduce their cell phone use. Even more interesting was the high texting "addiction" exhibited by both males and females.

CONCLUSIONS

This study is influential because it relates to current-day cell phone dependence issues that will advance into greater obstacles in upcoming years. Through our research, it is clear that cell phone usage among college-aged students is highly related to aspects of personality and gender. The results support what many people would assume, that certain social or gender-specific attributes lead to an increased use of cell phones. More specifically, it is evident that neurotics and those who are highly self-deceptive had the highest level of cell phone obsession. On the gender spectrum, females were the biggest culprits of high cell phone usage compared to males. Future research from this study can be expanded in many different

directions, such as looking at cell phone behaviors of adults. For example, as a generation that grew up without cell phones as part of their childhood, what psychological traits or personality factors encourage certain cell phone behaviors? The fast-paced evolution of electronic devices allows endless opportunities for future studies since the technological environment is everchanging.

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SYMBOLIC AND GEOLOGIC MARBLE: ALICANTE ROJO

ALEXANDRA FRENZEL

INTRODUCTION

Marble is a multifaceted stone, characterized as a crystalline, metamorphosed limestone by geologists. However, in Christian tradition, marble represents "lithos christos" because it symbolically parallels Christ and his biblical depiction as a stone.¹ Because of its stability as a building material, aesthetic potency, and myriad of

sacred associations, marble has assumed a prominent position in Christian art and architectural history. This paper examines the symbolic faith implications of this stone and takes as a case study the geologic history of Alicante Rojo, a Baroque marble with a rich history. Qualitative and quantitative analyses reveal the sacred, secular, and geological significance of this multi-dimensional rock.

"...the various visual and sensory properties of this stone inspire architects and artisans alike..." space with colored marble, an architect transforms a visually emotional response, produced by a painting, into a sensory feast experienced by walking through a sacred building. The power of this stone alters the overall atmosphere of the structure by physically cooling down the space and producing a singular type of acoustical environment, thus immersing the viewer in solemnity and reverence.

As in painting and sculpture, colored marble in architecture carries with it symbolic associations. In its emblematic functions, the stone is divided into three groups: white, blue, and red.

THE SYMBOLISM OF WHITE MARBLE

White marble is most closely associated with Mary's

virginity and purity. This stone has a "translucidity that confers upon it both its sparkle and its shining polychromy."¹ Visually, the material conveys the majesty and unblemished nature of Mary upon her conception of Jesus. Because of this, white marble permeates both artistic and architectural portravals of the Annunciation. In Fra Angelico's Annunciation (1430), white marble columns, white arches, and white walls frame the scene of the archangel Gabriel announcing to Mary she will give birth to Christ. Architecturally,

the Basilica of the Annunciation in Nazareth (built in 1969) represents not only Mary's purity but also the sacredness of the scriptural event through the architect's emphatic use of white marble and other white materials.

THE SYMBOLISM OF BLUE MARBLE

While white marble is employed to depict Mary's purity and virginity in her earthly state, blue marble is used to symbolize her connection with heaven. From Byzantine icons to Parmigianino's *Madonna with the*

BACKGROUND

Marble has been used as a decorative element throughout the history of human cultures. From classical pagan temples to Baroque cathedrals to the Taj Mahal and beyond, the various visual and sensory properties of this stone inspire architects and artisans alike to feature it as a key component of their creations. In Christian tradition, marble symbolizes the occurence of a sacred event. In its use as a setting for depictions of both

Mary and Jesus, the color of this rock correlates with the biblical story being commemorated. For example, in Andrea del Castagno's *Last Supper* (1447), the artist ornaments the fresco with six colored panels adorning the back wall that serve to draw the viewer in and help them recognize the sacred narrative scene taking place. Whether in painting, sculpture, or architecture, this material is widely used to decorate sacred depictions of Christ's sepulcher. Symbolic marble is also abundantly utilized in sacred monuments. By saturating a holy



[FIGURE 1] A fragment of white marble.

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Long Neck (1534-1535), Christian iconographers and artists alike depict Mary cloaked in celestial blue robes. Her clothes symbolize her place in heaven while also reminding the viewer of her earthly presence. Artists such as Fra Angelico also relate her divine status by surrounding her with blue marble. In his Annunciation (1425-1428) located in the Museo del Prado, Madrid, the artist again portrays this sacred event with white marble architecturally framing the angel and Mary. But Fra Angelico also painted a star studded, blue marble ceiling canopying Mary, referencing her heavenly calling. In colonial Latin America, Antonio Francisco Lisboa, better known as Aleijadinho, sought to capture the same atmosphere in his church Nossa Senhora do Monte do Carmo in Sabara, Brazil. Two blue marble piers compose the arch that frames the entrance into the altar area. This work of architecture serves to partition the back of the church from the altar. The blue arch directs the viewer's eyes skyward to a ceiling painting of Mary reigning in heaven surrounded by angels.

THE SYMBOLISM OF RED MARBLE

Referred to as "lithos erythros," or red stone, red marble symbolizes the blood Christ shed for his followers through his execution on the cross.¹ In architecture, the red marble creates an atmosphere of richness and monumental gravity that surrounds and engages the senses of the viewer to further draw them into a personal sacred experience. No structure achieves this better than Guarino Guarini's Church of San Lorenzo in Turin. Sixteen red Corinthian and Solomonic marble columns decorate the interior of this church. Guarini's choice of red marble can be interpreted as tripartite in meaning: honoring the martyrdom of San Lorenzo, commemorating the soldiers who died during the reconquest of Turin for Spain, and tangibly connecting Emmanuel Philibert, Duke of Savoy to his new sovereign, Phillip II of Spain, after Spain's campaign to



[FIGURE 3] A red marble tile. Image published under a Creative Commons License. Source: commons.wikimedia.org/wiki/File:Coral_Red_ Marble_Tiles.jpg; Attribution: xingwangmarble.com



[FIGURE 2] An example of creole marble, a mixture of white and blue.

Image is a derivative of a photo under a Creative Commons License. Source: commons.wikimedia.org/wiki/File:Bok_Tower_door.jpg Attribution: Averette

take back the region. The stone's color references the sacred blood shed by Saint Lawrence, who was tied to a gridiron and roasted to death for his faith, just as Christ was sacrificed on the cross. One may also interpret the red as elevating the sacrifice of the soldiers to those of Christian martyrs for giving their lives in the pursuit of winning back Turin for Spain. In this regard, San Lorenzo also memorializes the return of Turin from French control to alliance with Spain. The geographical origin of the marble makes a political statement as well. To further cement the Duke of Savoy's ties with Phillip II, the architect chose to use a Spanish marble, emphatically linking Turin's victory, and the greater province of Savoy, with the foreign aid they received. The choice not only pays homage to their sovereign in stone, but also elevates the Savoy-Spain alliance by placing it prominently in a religious structure. The red, Spanish stone selected to ornament the altar of San Lorenzo is Alicante Rojo marble. This rock, originally mined in Spain, has as interesting and tumultuous a history as the building in which it resides.

THE GEOLOGY OF ALICANTE ROJO

Spain has a complicated and rich geological history. The country is divided into various sectors partitioned according to major tectonic events. The southeastern region is called the Betic Zone after the Betic Orogeny, a mountain building event which shaped the natural history of the region.² In order to further classify the geology of southeastern Spain, this area is subdivided into the stratigraphic sections which correspond to the rock units exposed on the surface. Alicante, the city from which Alicante Rojo marble is mined, is a part of the Southern Iberian Cover unit. The red marble for which the city is known is one of the many components of the Alpujárride-Maláguide units which Earth's natural processes have worked to expose.

The geological journey of the Alicante Rojo marble



[FIGURE 4] The altar of San Lorenzo in Turin, Italy. Image under a creative Commons License. Source: commons.wikimedia.org/wiki/File:Torino,_san_lorenzo,_08.jpg Attribution: Sailko

began about 201.3 million years ago.³ The depositional environment of what is now southeastern Spain was characterized by calm, well-oxygenated, deep water, creating an amicable setting for a multitude of shell bearing sea creatures such as crustaceans, mollusks, and coral reefs. As these organisms died, their shells accumulated on the ocean floor over the next 55 million years, eventually producing limestone, a sedimentary

rock characterized by a high percentage of shells and coral relative to other particles present at deposition. These layers formed the upper Alpujárride and lower Maláguide units.

During the late Mesozoic, approximately 55 million years after the start of

deposition, the African and Iberian tectonic plates began to converge. The Iberian plate slowly subducted under, meaning moved beneath, the African plate beginning in the late Cretaceous.⁴ The high temperature and pressure of the plate subduction metamorphosed the limestone into what is now known as Alicante Rojo marble. Although the formations were buried underneath kilometers of sediment, two subsequent orogenies uplifted the units to the surface.⁵ First,

during the Middle Eocene, the Alpujárride and Nevado-Filabride formations subducted beneath the Maláguide unit.⁶ This uplifted the overlying formation, exposing it to increased weathering. This weathering eroded away much of the new deposits covering the lower layers. The second orogenic event occurred in the Miocene. This tumultuous period of geologic history is characterized by a series of thrust faults resulting from

"Alicante Rojo transcends time and space, the sacred and the secular, the metaphysical and the geological."

the continual collisional pressure of the subducting Iberian plate under the African plate.⁷ Consequently, the underlying Alpujárride and Nevado-Filabride units were thrust above the Maláguide formation, exposing them. After this portion of earth's history,

the Betic Zone settled down and allowed for a period of stagnant deposition. Starting in the Neogene and continuing through the Holocene, layer upon layer of sedimentary particles have been deposited and lithified, a process of compacting and solidifying the sediment, to create the Southern Iberian Cover unit seen today in the Alicante region. Millennia of erosion have removed the cover unit to reveal the Alpujárride-Maláguide units bearing the Alicante Rojo marble.

CONCLUSION

Alicante Rojo transcends time and space, the sacred and the secular, the metaphysical and the geological. Through its use in the Church of San Lorenzo the red stone combines religious tradition with political symbolism and geological history in a sacred atmosphere. Each stage of the stone's formation and use produced a new set of scientific and cultural meanings. Initially, Alicante Rojo was the product of deposition, metamorphism, and uplift, purely scientific processes. Then, during the Baroque era, it was used to symbolize both death and life in a religious and political context: the death of martyrs and the life of a new alliance between Spain and Turin. Finally, in the present day, the viewer recognizes Alicante Rojo as an impressive red stone that ornaments the altar of San Lorenzo in



[FIGURE 5] Alicante, Spain. Image in the Public Domain under a Creative Commons License. Source: commons. wikimedia.org/wiki/File:Alicante-Promenade.jpg Attribution: Guenter Wieschendahl

Turin. Regardless of the time period, one can appreciate both the geologic and symbolic identity of this stone. As its meaning evolved through human history, so did its form in geologic time. This stone serves to remind the viewer that even a seemingly simple piece of rock, such as Alicante Rojo, carries with it a complex narrative of politcal alliances, marytrdom, religious symbolism, and a calling to look beyond the obvious, physical façade of an object into its hidden soul.

FUTURE WORK

I plan to further explore the intricacies of Alicante Rojo marble. My goal is to understand the methods by which craftsmen extracted and transported large stone building blocks during the Baroque era from Spain to Italy. I would like to be able to describe in detail the complete story of Alicante Rojo from deposition through extraction and transportation to its final resting place in San Lorenzo.

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OPTICAL SCREENING FOR BACTERIAL MENINGITIS

ZACHARY STEELMAN

INTRODUCTION

Even with the widespread use of antibiotics in modern medicine, bacterial meningitis continues to present an enormous problem in contemporary society, as demonstrated by the furor over outbreaks at Princeton and the University of California, Santa Barbara in 2013. In the developing world, where access to treatment is limited, the mortality rate from bacterial meningitis is increased by a factor of ten or more. The problem of treating bacterial meningitis today is not actually the treatment, but the diagnosis. Diagnosing the disease is a difficult task for most physicians, as it typically presents with very nonspecific symptoms.¹ In addition, the disease onset is incredibly rapid, with some patients dying within 48 hours of the onset of symptoms. Often, patients will die before a physician is even able to identify the problem. Better diagnostics for bacterial meningitis are severely needed to limit the mortality of the disease.

Current diagnostic tools for bacterial meningitis are slow and destructive. The most common procedure performed upon suspicion of bacterial meningitis is a lumbar puncture, in which a surgeon obtains a sample of cerebrospinal fluid, or CSF, from the body. The CSF and associated

"The problem of treating bacterial meningitis today is not actually the treatment, but the diagnosis."



[FIGURE 1] A 532 nm green laser (pictured) is passed through a series of optics in a setup for Brillouin spectroscopy. The collected signal is passed through an optical fiber, after which it is passed through a series of VIPA etalons (not shown) and displayed on a CCD camera. The bright spot in this image is a beamsplitter cube, a common element in many spectrometers.

tissues are the prominent location or in some way changing it so that of infection, so analysis of CSF is performed to look for evidence of the particular bacteria that cause the disease. Culturing the CSF to grow the bacteria and analyze them requires at least 24 hours,² usually longer; that is an entire day during which the patient is receiving no treatment while their condition continues to worsen. Physicians will also look for evidence that the CSF is infected, the most common indicator being an increase in the total protein concentration within

the CSF.³ There are several methods to analyze for total protein, but all of them are destructive, i.e., they require mixing of the CSF with dyes, diluting it,

less sample is available for further testing.⁴ Thus, a method of testing for total protein that works both rapidly and without altering CSF obtained from the body is highly desirable.

Brillouin spectroscopy, an emerging optical tool for material analysis, offers a possible method of quantifying total protein concentration without alteration of the fluid obtained from the body. While other types of spectroscopy (such as infrared, UV-visible, and Raman) commonly describe the chemical nature of the sample being analyzed, Brillouin spectroscopy describes the mechanical properties of the sample, without ever deforming or subjecting the



[FIGURE 2] (a) Basic spectrometer setup, and (b) functional diagram of a VIPA etalon.

sample to a force. Instead, Brillouin spectroscopy measures Brillouin scattering, which is an interaction between light and sound waves in a medium. Because the sound wave velocity within a material depends on the compressibility or "stiffness" of the sample being analyzed, Brillouin spectroscopy is an easy way to measure the compressibility of a fluid without ever subjecting it to a force.

Conveniently, adding proteins to a solution makes the solution less compressible.⁵ So by measuring the compressibility of CSF by Brillouin spectroscopy, it is possible to make a good estimate of the amount of protein present in the fluid, and thus, diagnose bacterial meningitis and begin treatment.

METHODS

A 532 nm (green) laser was used in an optical setup for Brillouin Spectroscopy, as previously reported.⁶ Light was collected out of the sample and injected via a fiber optic cable into the spectrometer (an image of the setup in action is shown in [FIGURE 1], and a diagram of the components is given in **[FIGURE 2-a]**). While most of the light collected was elastically scattered (i.e., did not change represent healthy fluid, wavelength) a small portion of the light was Brillouin shifted (the

wavelength had changed slightly). The magnitude of this frequency change, expressed in units of GHz, is key to determining the fluid compressibility. In order to separate the wavelengths, two Virtually Imaged Phased Array (VIPA) etalons were used. VIPA etalons are essentially small pieces of glass, inside of which the laser light is allowed to repetitively reflect and interfere (see [FIGURE 2-b]). The output of the VIPA etalon shows a spectrum, in which light whose wavelength is further shifted is projected at a steeper angle. In this way, we could determine the Brillouin shift of a given sample based on the spatial separation of the beams on a CCD (chargecoupled device) camera.

For samples, we mimicked human CSF by mixing porcine serum albumin (which is a protein very similar to human serum albumin. the primary protein component in human spinal fluid) with α -D glucose in a buffer solution. The concentration of protein and glucose were set to mimic that of healthy and diseased spinal fluid. Specifically, a protein concentration of 0.27 mg/mL was used to with a concentration of

2.5 mg/mL representing diseased spinal fluid. In addition, to get a better feel for the magnitude of protein concentration changes that we could accurately detect, we concentrated each of the two bodysimilar solutions using dialysis, allowing approximately half of the water and glucose to exit the solution while retaining all of the protein. This essentially magnified the protein concentration by a factor of two, to 0.54 and 5.0 mg/ mL, respectively. Ten samples of each solution were taken, and the Brillouin shift of each was measured. Finally, while efforts were taken to keep the laser source stable (at a constant temperature, and thus, wavelength), there was a slight drift of the wavelength throughout testing. This drift was calculated, and all data was corrected based on these results.

RESULTS

Upon spectroscopic characterization, solutions mimicking healthy and diseased spinal fluid samples were distinguishable by Brillouin spectroscopy to a 98.6% confidence level. Once the fluids were concentrated by dialysis, the distinction was even more obvious. showing that the two solutions exhibited different Brillouin shifts with an amazing confidence level of 99.994%. In general, increased concentration of protein resulted in an increased Brillouin shift, a pattern which held for both normal and concentrated samples. Glucose concentration, which typically shows a slight decrease in the CSF of bacterial meningitis patients, seemingly did not affect the result. The complete results for all tests are plotted in [FIGURE 3].

"This technology has a widespread potential for use in the medical field, particularly in developing nations..."


[FIGURE 3] (a) Brillouin frequency shifts of spinal fluid models. **(b)** The Brillouin shift increases monotonically with protein concentration, as expected. With repetitive testing and precise calibration, this technique shows promise for accurate protein quantification.

CONCLUSIONS

We have developed a method of screening for bacterial meningitis which is nondestructive, rapid, and which requires no reagents or chemicals. This technology has a widespread potential for use in the medical field, particularly in developing nations, where access to complete medical laboratories and testing reagents is severely limited. The test offers a very high accuracy even without concentration of the fluids by dialysis, and when fluids are concentrated, the accuracy in the testing method becomes extremely high. However, an ideal test requires no dialysis, and while the standard accuracy level of 98.6% is high, this number can be easily improved by utilizing better cameras, improving the data processing algorithm, and optimizing the optical system.

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PERMISSIONS

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TIMELESS ANTIQUITY

MANZIL QUADIR



Close family, especially our parents and friends, play a major role in influencing our deepest concerns and personal thoughts. However,

"While some consider it the science of capturing light onto a piece of film, I consider it the art of valuing a borrowed moment in time."

indistinguishable uniformity of the pots clearly shows how proficiently they have mastered their skills. These pictures elegantly

there are some very emotive figures in our world that tell stories and allow observers to discover their eves' touch and stir us deep inside, introducing a different sort of inspiration into our lives. For many, writer, activist, and Booker Award winner Arundhati Roy is the ardent and active symbol of lyricism. Her depth of thought combined with her passionate and sincere voice reveals a woman who simply speaks her mind. One of her most widely renowned quotes describes what exactly it means to live:

"To love. To be loved. To never forget your own insignificance. To never get used to the unspeakable violence and the vulgar disparity of life around you. To seek joy in the saddest places. To pursue beauty to its lair. To never simplify what is complicated or complicate what is simple. To respect strength, never power. Above all, to watch. To try and understand. To never look away. And never, never, to forget."

The quote above is indicative of a confident courage and an excellent summary of what I have learned from her writings and speeches. More importantly, it answers why it has inspired me to use the exceptional art of photography.

Capturing memories, preserving history, and treasuring moments. Photography has been a part of my life for about seven years now. While some consider it the science of capturing light onto a piece of film, I consider it the art of valuing a borrowed moment in time. This wondrous art has the incredible ability to reflect a timeless essence designed to be the only form of art that allows one to relive a moment. What catches the eve, though, is how it mirrors the gravity of natural beauty, the depth of human relations, and the wisdom of moments. It provides us a channel to portray and educate ourselves with the different visions and customs of what it means to be human. I took this set of pictures in the young state of Jharkhand, India in a small and remote village known as Peterwar. With cows, chickens, and monkeys wandering in the distance, people laboring away, and a gorgeous view of the fields, the village lifestyle is a strong contrast to the life in American cities. To witness such a drastic change of environment is incredibly breathtaking. Peterwar is home to the mid-aged artisans portrayed

in the pictures: artisans who have sweat and slaved away each day of their lives for a living by designing and shaping their life's work. The

"These pictures elegantly tell stories and allows observers to discover their eyes' sheltered ignorance."

sheltered ignorance. The amazing beauty of the human race and the graceful presence of Mother Nature coexist in such a way that it is hard to not share it with others by the means of photography. The dramatic cultural differences all throughout the world inspired me to learn the true nature of anthropology.

Anthropology is studying what it means to be human or the study of humanity. It is an umbrella term for human interaction, adaption and differences. It essentially understands the success of humanity by evaluating the incredible diversity of peoples around the globe. Following the path of the ancient and indigenous men and women to the footsteps of the modern men and women, anthropology employs archaeology, sociocultural, environmental and various other approaches to discover more and more about our society. Many believe that it is a dying field, but the value of anthropology is unfortunately quite underestimated. Understanding human existence teaches us a lot about acceptance and assimilation. Especially in the American melting pot, the purpose of anthropology can be seen as an attempt to provide the world of some security of human differences.

In essence, anthropology opens our minds to different perspectives just as the art of photography attempts to educate ignorance and reveal refreshing perspectives. Anthropology focuses on the idea that we are all servants to our society domestically, nationally, and most importantly globally. As a servant to my community, bringing awareness, and opening someone's eyes to an unseen culture is a great way to voice the leverage of photography as well as anthropology. Being an American has been an incredible blessing, but having the opportunity to be a global citizen has been an extraordinary grace. This impression could not be better put than by Roy's definition of what it means to live:

"To love. To be loved. To never forget your own insignificance. To never get used to the unspeakable violence and the vulgar disparity of life around you. To seek joy in the saddest places. To pursue beauty to its lair. To never simplify what is complicated or

> complicate what is simple. To respect strength, never power. Above all, to watch. To try and understand. To never look away. And never, never, to forget."

SAND DUNES: THE CLUE TO TITAN'S CLIMATE

JULIA CISNEROS

INTRODUCTION

The familiarity of our physical environment is something we take for granted. But the physical environment of Earth is changing in response to climate changeincreasingly severe storms scour its surface, temperatures increase or decrease and winds and currents alter their courses. What will Earth look like in the future and how do we begin to predict how environmental influences will affect the face of the Earth? One possible way to understand these interactions is to look at other worlds in our solar system that have very different physical environments, but very familiar landscapes. Mars, for example, has one-third the gravity of Earth and an atmosphere made mostly of carbon dioxide (CO_2) that is 140 times less dense than Earth's atmosphere. Despite these differences, evidence exists that ancient rivers flowed and sand currently blows across Mars' landscape. Titan, one of Saturn's many moons, is over 10 times colder than Earth and has an atmosphere made mostly of nitrogen (N_{a}) and some methane (CH₄), but rivers of liquid methane are actively flowing into lakes on Titan and vast dune fields have been discovered near its equator.¹ How can landforms present on Earth exist in such different worlds?

Until recently, our understanding of Earth's geology relied on what we could physically see and touch on Earth. Now more than any time in the past, planetary bodies within our solar system have become the

"...planetary bodies within our solar system have become the focus for learning more about our Earth."

focus for learning more about Earth. We compare planetary bodies with the understanding we have about Earth and examine how the physical processes that shape Earth's surface would change or stay the same under vastly different conditions. In turn, our understanding of Earth's processes allows us to examine the environments of these worlds. Today, we are comparing sand dunes on Titan and Earth to understand how dunes form in different physical environments and to determine what Titan's surface winds are like.

BACKGROUND

Titan, one of Saturn's moons, is one of the most Earth-like bodies in the solar system with its geologic diversity. Titan has rivers, lakes, mountains, and wind-blown sand dunes, but it differs in many

"Titan, one of Saturn's moons, is one of the most Earth-like bodies in the solar system..." other aspects.² Titan's average temperature is drastically lower (10 times) than Earth's, due to its being farther from the sun, which results in a system dominated by liquid methane and waterice. Rather than water lakes and silicate rocks, Titan's lakes are filled with liquid methane and its surface is water-ice. Titan is also the only moon in our solar system that, like Earth, has clouds and a dense atmosphere. From the dense atmosphere, organic compounds made from N₂ and CH₄ form and fall to the surface and are thought to have chemical compositions similar to the chemical precursors for life found on Earth.¹

Due to the interesting similarities and differences between Earth and Titan, we propose to compare the two bodies to learn more about sand dune formation processes on Earth and the climate of Titan. Sand dunes, a commonality between Titan and Earth, contain important records of climate. Climate affects wind patterns, and winds shape sand dunes; and when climate changes, winds change and sand dunes also change. Today on Earth, we are experiencing climate change, and sand dunes are responding accordingly. The sand dunes in our deserts also give us information about previous climates and by analogy to Earth's dunes, the sand dunes on Titan provide us with a tool to examine climate change on Titan.

PROBLEM

The direction wind blows at Titan's



[FIGURE 1] Dune interactions with obstacles on Titan **(a)** and Earth **(b)**. The image of Titan is gray scale because of the radar used to capture it. The white area in **(a)** is the obstacle and the lines around it are the dunes. The dunes are in the same orientations in both pictures, elongated from NE to SW.

equator is unknown. Based upon the spin of Titan on its axis and numerous climate models, the equatorial winds should blow from east to west, just like the trade winds do on Earth.³ Because sand dunes form in the wind, we should be able to read the wind patterns from the sand dunes. But the sand dunes on Titan are very straight crested sand dunes called linear dunes, which, unlike some other sand dunes, do not have a morphology diagnostic of the winds that created them. However, these types of dunes are thought to form by two different winds about 135 degrees apart. Because the dunes are not diagnostic of the winds, the shape of the dune patterns as they interact with topographic obstacles, like mountains, has been used to suggest that Titan's equatorial winds are blowing from west to east, which is opposite the expected easterly winds [FIGURE 1-a]. Why don't the winds match up? Are we reading the dunes wrong? Are we reading the dune-topography interaction wrong? Unlike our understanding of dunes, we do not understand how dunes interact

with topographic obstacles and how to read this signature of the wind. Our approach to this problem is to study the way dunes form around mountains in Earth's Sahara Desert [FIGURE 1-b] using digital elevation models (DEMs) and computational fluid dynamic simulations (CFDs) to understand the way wind interacts with the topographic obstacles.

METHODS

To understand the way sand dunes form around topographic obstacles, we have to first find areas that contain both sand dunes and mountains. Surprisingly, several areas contain both landforms on Earth, like the Sahara desert. We look at the Sahara desert on Earth through satellite images, and we try to find similar landforms, or patterns, on

"Sand dunes, a commonality between Titan and Earth, contain important records of climate."

Titan with radar images, which are used to view Titan's surface instead of photographs because of Titan's thick atmosphere [FIGURE **1**]. When we find comparable landforms, we gather information about the elevation and wind velocity for the landforms on Earth. The elevation acts as a 3D model of the obstacle's surface and the wind velocity is both the speed and direction of wind. The wind velocity is important because we can make a direct correlation between wind and sand dune orientation. For our initial study, we used wind data from weather stations near our study area. The winds in this area of the Sahara are mostly unidirectional and unlike the multidirectional winds that are thought to be operating on Titan. Using the elevation and wind velocity, we put the information into a CFD program, called Wind Ninja 2.2.0, that tells us the way the wind acts when it comes in contact with the surface of the mountain obstacles. This program gives us new wind velocity outputs that reflect all the different ways the wind can interact with the obstacles.

After getting the new modified wind velocities, we calculate dune orientations. According to previous dune orientation experiments, the dune orientations are not automatically parallel or perpendicular to the wind direction.^{4,5} The orientation of the dunes is based on the maximum gross bedform-normal transport, or the maximum directional sum of the winds, but depending on the point of interest around the obstacle, the speed and direction of each wind is different.⁶ In our models, we account for the difference in wind speed and direction and predict dune orientation around the entire obstacle. A simple equation, which yields the maximum gross bedformnormal transport (GBNT), relates wind direction and velocity, and dune orientation. This equation and the modified wind velocities from the CFD are used in another program, called ArcGIS 10.1, to obtain the resultant wind speed and direction and predicted dune orientations around the obstacle.

RESULTS

We see that as the winds interact with the obstacles [FIGURE 2-a] they change direction and velocity. Initially, the winds travel in one direction and speed. As wind meets the obstacle, the wind directions begin to diverge around the sides. Wind speed increases as the winds diverge around the obstacle. Wind also increases in speed as it climbs up and over the obstacle. Wind speed is slowest upwind and downwind of the obstacle and fastest at the highest point and at points along the sides. Finally, the wind re-aligns some distance away from the obstacle and returns back to its original speed. Interestingly, wind velocity has the most variation in areas where the wind first meets the obstacle

In our initial analysis, we see a dune orientation about transverse, or perpendicular, to resultant wind flow, which was expected for our input winds. The dunes stay fairly consistent around the obstacle with no more than a $\pm 3^{\circ}$ offset from 190°, which is the dune orientation

if there were no obstacle present [FIGURE 2-b]. Though the change is minimal, the change in orientation is consistent around the obstacle. Areas north and south of the obstacle contain dunes oriented around 193° whereas areas east and west contain dunes oriented 188°. Similarly to wind flow, the largest amount of dune orientation variation happens where the wind first meets the obstacle.

DISCUSSION

We see a consistent pattern in the way wind interacts with our tested obstacle and affects the dune patterns. The minor differences of the two original winds' direction and magnitude made a large difference in final resultant wind. This difference arises because the resultant wind is a vector sum of both winds, so any change in one wind will add to the other wind. The dune orientations also change, but the offset is only $\pm 3^{\circ}$. This likely occurs because the differences among the modes of wind in our study were small. For future studies we aim to use more diverse wind



[FIGURE 2] (a) A comparison of the resultant winds and the produced dune forms on Earth. The image is of the smaller obstacle shown in the Earth satellite image. **(b)** This surface is grey because we used the elevations to produce a 3D surface. Wind direction is from east to west, and the change in speed is depicted through changes in colors. The dune orientation only depicts direction and has no magnitude associated with it. Direction of winds and dune orientation is measured in azimuthal coordinates and represented as arrows pointing in the positive direction.

"Once we understand how dunes on Earth interact with mountains, we can look at dunes around obstacles on Titan and look for the same patterns."

on Titan.

This study does provide some testable predictions for the dunemountain interactions on Titan. The overall patterns of change we see are most obvious in the areas where wind first meets the obstacle. This result may occur because winds are deflected in this region and velocity drops. In these cases, sand would be deposited and dunes would be scattered. This pattern is important because it gives a specific location to search for in Titan radar images. The consistent patterns of dune orientation that form in response to obstacles are also interesting. The patterns show a preferred dune orientation north and south and a different and opposite preferred dune orientation east and west in accordance with the predominant wind direction.

Through additional Earth-based analysis, we aim to correlate dune patterns observed around obstacles with winds. Once we understand how dunes on Earth interact with mountains, we can look at dunes around obstacles on Titan and look for the same patterns. Ultimately, we aim to resolve the wind controversy on Titan, which will broaden our understanding of how the atmosphere on Titan operates.

CONCLUSIONS

Through radar images, we see vast fields of linear dunes in Titan's equatorial region. Although the linear dunes on Titan are elongated 4. west to east, the associated winds do not match Titan's global climate models. Our study aims to better understand wind flow by looking at dune-mountain relationships

patterns, similar to those predicted in Earth satellite images. Through analysis, we see varied wind interaction patterns around mountains. The patterns we see reflect varied dune orientations and give better insight into the wind flow directions through winddune relationships. Through these patterns, we are able to pin point specific areas of interest where the most interaction happens. Our identification of wind-dune patterns is important because we can look for the same patterns on Titan images. Our future goal is to predict wind flow directions on Titan by identifying the wind-dune patterns around mountains.

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I WANT "YOU": PRONOUNS AND THE MILITARY

NEDDIE ANN FRENCH

Jackson* came back from Iraq a different man. In July of 2011, he returned to his home in Texas from his latest deployment at Balad Air Force Base in Iraq back to his waiting apartment, friends, and family but things felt different. Off, somehow. He began to notice within himself a severe shortening of his temper, difficulty concentrating for long periods of time, intermittent sleeplessness, and (most troubling of all) periods of unconsciousness that might last for hours at a time.

However, it wasn't until Jackson woke up one early morning on his bathroom floor, sitting in a pool of his own blood and suffering from self-inflicted wounds that he could not remember exacting, that he knew he needed help. He had nearly all of the symptoms of Post Traumatic Stress Disorder (PTSD) listed by *The Diagnostic and Statistical Manual of Mental Disorders*.

Jackson's story, as well as the stories of several other war veterans gathered during the first stages of my PTSD research, tell us something very important about the war experience: it changes people. Whether it teaches soldiers responsibility and courage or leaves them suffering from insomnia and blackouts, the experience of combat is *transformative*. In other words, war always leaves its mark.

This transformative aspect of war makes reintegration into civilian society particularly difficult for soldiers. How can veterans return to their previous lives when they have undergone such a change in identity? Moreover, how can returning soldiers be expected to relate their experiences of combat to their friends and family (civilians) who exhibit a fundamental disability to fully understand a war they did not themselves experience?

It is mainly this second question I focus on in my research. In particular, what conventions of storytelling—of relating the war experience—can help bridge the gap between civilian and soldier? Furthermore, how can an audience know whether or not the speaker is even *trying* to bridge the gap between their differing subjectivities? What if the speaker's intention is to distance him/herself from the audience and emphasize a fundamental lack of understanding between him/herself and others? In

answering these questions, I consulted Judith Butler's "Sovereign Performatives in the Contemporary Scene of Utterance," James Dawes' "That the World May Know: Bearing Witness to Atrocity," and Uri Margolin's "Shifted Temporal Perspective in Narrative."

Understanding whether the speaker is attempting to bridge a gap or clearly delineate the differences between himself and the audience is incredibly important to the idea of witnessing. Witnessing is defined by Kelly Oliver, author of Witnessing, Beyond *Recognition*, as the social interchange by which "subjectivity and humanity" are created.¹ Subjectivity, or the act of "see[ing] oneself as a subject," is partially defined by the ability "to imagine oneself as selfsovereign".¹ To have subjectivity, in other words, is to feel empowered—to feel a sense of ownership over oneself and one's identity. In stark contrast to this idea is the notion of *objectivity*. The philosophical idea of objectivity connotes the loss of one's subjectivity, by which a person becomes an object lacking a strong sense of self and identity.

The transition from subject to object is, in its simplest terms, a result of "traumas directed at...identit[y] and sense of [self]".¹ People lose their subjectivity when they feel they are no longer able to connect with portions of their identity—or even that they lack an identity altogether. The means by which lost subjectivity is restored is the act of witnessing; the key to witnessing lies in the act of *recognition*. As Oliver states, "we come to recognize ourselves as subjects or active agents through recognition from others".¹ Only when an outside subjectivity (another person with a sense of agency) confers recognition upon us can we come to understand ourselves as active, empowered agents. In other words, recognition and witnessing require a dialogue between the objectified person or peoples and a subjective agent, so that the subjective agent may confer recognition upon the object.¹

When soldiers return from war, the trauma of combat often problematizes their sense of subjectivity—they may feel a loss of identity or an inability to relate to aspects of their previous life. This can cause difficulty in reintegrating and make a return to civilian life uncomfortable. Since subjectivity is restored through

"Pronouns tell a story far more complex than the average reader might recognize."

witnessing—through dialogue with an audience—it is important for civilians to learn how to talk to war veterans and how to listen to their stories properly. In understanding the different ways in which they might use the second-person as means of connecting or disconnecting, civilian audiences may become better witnesses.

In my research, I analyze the use of second-person pronouns in various war narratives. I examine the ways in which soldiers can use second-person narration (referring to themselves or others as "you") as a means of connecting with the audience or, sometimes, distancing themselves from the audience when relating stories of combat. This delicate interplay of pronoun use throughout narration helps to properly position readers/listeners toward the narrative, aiding in the act of witnessing and allowing them to better understand the thoughts and experiences of soldiers. Much of my early research was modeled after the work of Lesley Stirling and Lenore Manderson, as well as the pronoun theories of Patricia O'Connor.

In 2011, Lesley Stirling and Lenore Manderson conducted a linguistic study of the pronoun *you*, in which they analyzed testimonials of mastectomy survivors in order to understand the ways in which second-person perspective appears in the narration of traumatic experiences. They noted that, most often, interviewees used the pronoun "you" at particularly emotional moments in their interviews, with some of the most important and personal revelations concerning their experiences with breast cancer revealed through a second-person perspective.² Using two of the "you" forms delineated by Stirling and Manderson in their study, we can extrapolate their research and apply it to the stories of war veterans.

These two types are defined by Patricia O'Connor as the self-indexing "you" and the involving "you". The self-indexing "you" works as a way of interpolating a personal experience and applying it to a wider subgroup of people, embedding the speaker and his experiences into a broader context or class of people who share similar circumstances. The involving "you" is used to speak of experiences unique to the *speaker* and foreign to the *addressee*, with "the speaker us[ing] *you*, not I" to describe the experience.³ The easiest way to understand the nuances of these various forms of "you" in war narratives is through example.

The following is an excerpt from an interview I conducted with a Marine named John*:

"What I felt was in, you know, looking back I

don't know if it was wrong or right to feel this way or if it's what they train **you** to feel, I felt **you** felt—adrenaline, but at the same time **you** felt more excitement than fear, and **you** felt...I was excited yet calm...**you** didn't know what was going to happen...**you** could hear better, **you** could see farther, **you** just felt, **you** know... **you** would say it's part of the training, but **you** looked, obviously couldn't see, but **you** looked for the bullets, **you** wanted to go towards the action...**you** looked for the action [emphasis added]."

This repeated use of second-person in describing a personal experience may be read as O'Connor's involving "you"—giving audience members concrete details and lending them the ability to see through John's eyes ("you looked, obviously you couldn't see, but you looked for bullets") and feel the physicality of combat through his body ("you felt adrenaline"). John is bridging the gap between his experience and those of civilians by verbally placing them into his body and allowing them access to his experiences. However, since the various "you" forms are not mutually exclusive and often overlap, another analysis might view the several instances of this "you" as self-indexing, a rather complex form of the second person. When John wonders if the adrenaline felt during combat is just "the way they train you to feel," we have to ask ourselves who the "you" is in this sentence. The way they train who to feel? Not the audience—not the civilians listening to, or reading, his account of war. Instead, this "you" refers to a purely military audience—only those who have been trained for combat and are taught to feel a certain way. This use of second-person places John within a larger subgroup and works to project his own feelings of combat onto the group of military personnel as a whole. According to O'Connor, this allows him to claim that all soldiers trained for combat likely feel the same way that he does, effectively making him the mouthpiece for an entire membership category of people.

When this use of involving and self-indexing "you" overlap, analysis becomes extremely interesting. If the self-indexing "you" allows John to place his personal experiences as representative of the entire subgroup, while the involving "you" allows the audience to temporarily own John's point of view, then the conjunction of both together serves to completely break down the walls between civilian reader and military personnel. By allowing his audience to take on his perspective, then placing his perspective within the larger subgroup of the military, John is effectively moving his audience members from their own subjectivities and placing them—through their involvement in *his* subjective position—into the military subgroup as a whole. The lines between civilian

and military subgroups, then, are broken down and the audience allowed access to the military membership category through John. This works as an effective way to allow audience members more complete access to a world and an experience completely foreign to them.

However, when used in certain ways, the secondperson may act as a distancing mechanism rather than a means of connecting speaker and audience; it may point out the differences between the narrator and the reader. Another young soldier I was able to interview, Michael*, offers several examples of this distancing "you" in his oral narrative. When discussing the struggles many veterans face returning back to civilian life, particularly concerning the stigma of PTSD, he said:

> "It's —it's hard to fight that stereotype when that's all **you** hear about. **You** don't hear about the guys who deal with it on a daily basis, and we don't do anything."

Unlike the previous instance, in which the secondperson "you" was manipulated to allow the audience into the subjectivity of a soldier, this form of "you" actually distances the audience. Michael is drawing a clear line between the audience, who only hears about the sensationalized, stereotypical war veteran suffering from PTSD, and the men and women (himself included) who suffer from PTSD every day. Instead of working to draw the audience into his point of view, Michael is emphasizing the fundamental difference between himself (as a soldier) and the civilian population. This has the exact opposite effect as O'Connor's involving "you"—rather than lending the reader a specific experience, Michael asks him or her to become aware of the chasm of experience and knowledge that separates them. To even further delineate these two positions, Michael uses the pronoun "we" to describe himself and his fellow soldiers. As a plural, first-person noun, this "we" only includes men and women of the military, and very clearly excludes the rest of his audience lacking military experience.

As you can see, through analysis of a mere two examples of the pronoun "you" in the war narrative, pronouns tell a story far more complex than the average reader might recognize. Aside from their various tasks as grammatical units, pronouns have interesting implications for the process of narrative

"Whether it teaches soldiers responsibility and courage or leaves them suffering from insomnia and blackouts, the experience of combat is *transformative*." positioning. By paying close attention to intent of the speaker, particularly noting the position to which the audience is being relegated, listeners may become more effective witnesses.

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HOW BATS AVOID INTERFERING WITH EACH OTHER'S SONAR

KAYLEE DAVIS

INTRODUCTION

Bats are one of the most diverse and widely distributed groups of mammals in the world. This is likely due to the fact that they can fly, making them the only mammal capable of true flight.¹ They will roost just about anywhere they can hide, such as caves, hollow trees, and man-made structures. Some bats live solitary lives but most are highly social, roosting and foraging in large groups. Free-tailed bats [FIGURE 1] are on the far end of the social spectrum, forming massive congregations with numbers reaching into the millions in a single cave.^{2,3} At dusk, the bats leave the roost en masse to forage, flying in tight groups to reduce the risk of predation.

Bats in the suborder *microchiroptera* are known for their ability to navigate and hunt by echolocation, a behavior in which bats perceive their world by emitting sounds and listening to returning echoes.⁴ When two or more bats echolocate in the same area, it becomes difficult for a bat to tell its own echoes from those of its neighbors. This problem of bats interfering with each other's sonar becomes more daunting when bats fly in swarms or within densely packed caves.

This research explores how bats overcome the interference problem

"When two or more bats echolocate in the same area, it becomes difficult for a bat to tell its own echoes from those of its neighbors."



[FIGURE 1] A clump of Mexican Free-Tailed bats (Tadarida brasiliensis).

by investigating what behaviors bats use when echolocating in groups. Similar problems arise in many artificial systems such as sonar/ radar, computer networks, and wireless communication networks. When cell phone or internet users try to transmit signals over a single, shared channel they often interfere with one another, leading to signal loss. Computer networking engineers recognized this problem and developed strategies to improve the speed and efficiency of these communications networks. These strategies were based on simple rules guiding when and how often users transmitted and re-transmitted their signals.

> It was recently discovered that bats delayed the timing of echolocation pulses upon hearing emissions from nearby bats.⁵ I hypothesized that this behavior may lead to slower pulse emissions but better overall

> > 39

signaling for bats echolocating in groups. My project tests this hypothesis by measuring whether bats slow down their pulse emissions in groups following rules analogous to artificial networks.

METHODS

Three experiments were used to test my hypothesis. First, I tested how hearing recorded sonar emissions influenced a bat's own sonar emissions in flight. Secondly, I tested how hearing artificial pulses impacted a bat's ability to fly, and thirdly, I compared how bats performed alone versus flying alongside real bats.

Experiment 1: Measuring changes in sonar emissions

This experiment was used to see how hearing sonar from other bats affects a bat's own sonar emission. First, ten solitary bats were flown back and forth through a tunnel under two conditions: an open condition (no obstacles) and a



[FIGURE 2] Effect of playback stimulus on pulse emission rate (a) and maze performance (b). As stimulus rate increased, the number of pulses emitted decreased and the number of ropes hit increased.

maze comprised of 24 evenly to artificial stimuli accurately spaced one-fourth of an inch nylon ropes hanging from the ceiling. The mean pulse emission rates of ten individual bats were recorded under both conditions.

Next, ten bats were flown under both the open and maze conditions while hearing a recording that mimicked the sonar of one or two additional bats, and changes in mean emission rates of the bats were quantified.

Experiment 2: Measuring changes in navigation performance

To ask if the sonar of other bats caused a bat to have difficulty with their own sonar-guided navigated flight, we flew solitary bats through the maze and counted the number of ropes hit per flight. Each of the 24 ropes had a vibration sensor on the end that would go off every time a bat touched a rope allowing easy measurements of which and how many ropes were hit on each flight. The solitary bats flew through the maze under three experimental conditions: no recording, a recording mimicking one bat, and a recording mimicking two bats.

Experiment 3: Measuring changes in emissions with two bats flying

A third experiment was performed to tie together the two experiments and confirm that the bats' responses

reflect their response to real bats. Two bats were flown first alone and then side by side through the tunnel while their pulse emissions were recorded. This allowed us to measure if bats consider other bats as obstacles, and how they respond to each other's pulses in order to optimize their own sonar.

RESULTS

Experiment 1:

Prior to initiating the playback experiments I measured the effect of adding the maze on the bat's sonar behavior. Increasing the number and density of ropes in the maze caused a progressive increase in each bat's emission rates, confirming that the maze created a challenging sonar task. The playback recordings revealed that 1) the playback recording reduced the mean pulse rate of the tested bat under every condition and 2) increasing the number of bats being mimicked, resulted in proportionally greater decreases in emission rates by the bat in every condition [FIGURE 2-a].

Experiment 2:

In silence, most bats were able to pass through the maze hitting very few ropes (1.85±0.20 hits). When the recordings were played, the higher the number of bats

being mimicked, the worse the bats performed in the maze, i.e. the more ropes they hit **[FIGURE** 2-b]. This indicates that acoustic interference strongly degrades sonar performance and thus flying ability.

Experiment 3:

Trials with bats flying side-by-side through the tunnel revealed that the bats increase the emission rate in the presence of another bat as if it were an obstacle (i.e. like the ropes in the maze), but the mean emission rates indicated that they also reduced emission rates (dropped pulses) when hearing the other bats sonar, similar to the experiments with bats flying with recorded sonar playing.

DISCUSSION

These experiments allowed us to see how bats modify their echolocation rate in the presence of other bats. If all bats in a swarm echolocated at their maximum rate, it would be hard to distinguish one's echoes from another's which could cause confusion and decrease in navigational abilities. As shown in the first experiment, the more obstacles encountered (measured by the rope density of the tunnel), the more the bat will respond by increasing its echolocation rate until it reaches its maximum at about 42

"...the bats increase the emission rate in the presence of another bat as if it were an obstacle..."

pulses per second **[FIGURE 3-a]**. On the other hand, when a bat hears another bat's emissions, it responds by decreasing the rate of its own emissions, presumably to minimize instances of mutual interference. The bats appear to drop pulses in order to let the other call as a way to avoid interference, similar to computer networks taking turns sending information instead of trying to send it all at once.

The third experiment ties the first two experiments together by flying two bats alongside each other instead of using a stimulus. Surprisingly, each bat viewed the other as an obstacle, raising their pulse emission slightly below their maximum rate [FIGURE 3-a]. It was hypothesized that the reason for why they were not calling at their maximum rate was due to the bats dropping pulses to compensate for the other bat calling at the same time. This was confirmed by examining their pulse emission rate [FIGURE 3-b].

CONCLUSION

In conclusion, these experiments found that bats slow their pulse emissions when echolocating in groups following strategies similar to ones commonly used to coordinate users sharing computer networks. These results provide the first cohesive explanation for how groups of bats adapt their echolocation behavior to accommodate the emissions of their neighbors. Future experiments will explore details about how similar the bat's behavioral algorithm is to the ones currently used in artificial communication networks.

ACKNOWLEDGMENTS

I would like to thank Samantha Trent and Alyssa York for helping



(a) AVERAGE PULSE RATE WITH INCREASE IN

[FIGURE 3] (a) As two bats fly side-by-side, they produce slightly less pulses per second (represented by the red X) than their max most likely due to **(b)** dropped pulses between the arrows to compensate for another bat calling at the same time.

me fly and train the bats during the experiments. I would also like to thank Dr. Michael Smotherman for helping me come up with the thesis idea, planning, and setting up the experiment and providing me with his knowledge and expertise.

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JJJ JONATHAN MARTINEZ

I believe music is expressed by individuality and identified by the music background and experiences each person possesses. Everyone is unique and so is the definition and experience of music. In my opinion, music is a journey through life and it creates an individual experience for each of us. Once the journey comes into full bloom or an experience is created, the understanding of music becomes meaningful to the soul and it will become an expression of who we are as individuals.

My expression and definition of my music makes me a musician. I did not experience the benefit of having a mentor, professional musicians in my family, music lessons, or natural talent. My influence and experience was limited to listening to vinyl records with my parents. I listened to what they grew up listening to, such as the song "Jump" by Van Halen. I remember jumping off the furniture when the song was playing and that created an experience for me that I would revisit later in life. You see, since music was not my true talent at the time, it was dormant within me. Joining the 8th grade school band reignited my interest in music. It also created

"Together, the listeners and I are able to create a new music experience." an unexpected challenge and a realization that I could not read music. My determination to learn music was high and I found an alternative. My saxophone and I became true partners as I explored playing music by ear. It was a success! Once, my mastery of playing by ear was enhanced, my passion for music was at an all-time high. On to high school I went with my new found talent. Playing by ear was my talent and I achieved the highest level of recognition in a state competition.



[FIGURE 1] A screen capture of Garage Band, a music creation application for the iPad.

My previous experience brings passion and dedication to my world of music today. In the last few years, I have experimented with today's technology to create music. My song is called "My Blank Song Sheet" and was created on my iPad tablet. The song title encourages the listener to respond to the music and pay attention to the emotions generated by the song, therefore, allowing listeners to fill in the "blank song sheet" and create their own title. The template I created allows the listener to express their feelings for the song. This song helps me to read my music through others' emotions, and it contributes to my goal of enhancing music appreciation for all. Together, the listeners and I are able to create a new music experience. Enjoying music "This song helps me to read my music through others' emotions, and it contributes to my goal of enhancing music appreciation for all."

alone as a musician or a listener is one thing, but experiencing music together is something far more unique.

My creation began with an iPad and it was used as a vehicle to show others that music making does not require expensive instruments or a large music studio. Only one application, Garage Band, made my creation possible. First, I started out with a simple chord progression on a synthesizer. I looped the progression and listened to it for a while in its simple form. By playing something so simple, it was obvious what would fit perfectly with this chord progression. Next, the progression was played again, but this time, I played along with my Yamaha Keyboard to produce some possible melodies. This brainstorming process also occurred on other instruments such as my Ibanez ukulele and my Korg synthesizer. The next process included moving newly created melodies into the application on the iPad. Virtual instruments were added to emulate the ideal instrument for my melodies. Many other instruments were added to enhance the existing instruments. After the last instrument was added, the editing process began. Effects were added and specific notes were edited to make certain melodies sound livelier. Once the prototype was complete, I shared my music with others and asked for feedback. The feedback from others was also used in the final music piece. Finally, after all of my work, I was able to listen to my created song and finally confirm that it was finished.

I developed an unorthodox method to make music enjoyable, and it worked. When listening to the song, listen for the different sounds that were used. Towards the end, you will hear a build-up of variety of instruments to draw out emotions. Enjoy the music and let your emotions generate.

Scan the QR code, or visit soundcloud.com/explorationstexasam to listen to the song, "My Blank Song Sheet" by Jonathan Martinez.



CREATING A REACH-SPECIFIC BALANCE CONFIDENCE SCALE TO IDENTIFY AND REDUCE FALL RISK

ASHLEY FOX

INTRODUCTION

According to the Center for Disease Control and Prevention, "one out of three older adults (those aged 65 or older) fall each year."1 Falls contribute to the highest number of unintentional injuries experienced by the elderly aged 65 years and older. Furthermore, in the next 17 seconds, an older adult will be treated for fall-related injuries. and in the next 30 minutes, an older adult will die from fallrelated injuries.² Clearly, falling has significant implications for quality of life in our aging population. Research findings tell us that the elderly lack efficient action planning and that the most common reason for falls in the elderly is incorrect transfer or shift of bodyweight, like leaning too far from one's base of support.² From these reports, we can conclude that reaching, especially inefficient reach planning such as over- or underestimation. can cause one to lean too far from their base of support, therefore increasing risk of falling. In other words, many falls in the elderly can be directly linked to reaching.

Previously established scales, like the *Activities-specific Balance* Confidence (ABC) Scale and the Falls Efficiency Scale International (FES-I) have been used to determine one's confidence in balance while performing various daily activities. But, among these scales, few reach-specific questions are

"...incorrect transfer or shift of bodyweight was the most frequent cause of falling..."

provided. Therefore, the purpose causing the center of gravity to of this research was to develop a *Reach-Specific Balance Confidence* (RBC) Scale self-report to assess individuals' balance confidence with daily activity items that pertain to reaching. This instrument is then to be used in clinical settings and as a research tool.

BACKGROUND

Research tells us that as one ages, one's mental representation for action planning become less accurate and effective. For example, Gabbard and Cordova³ discovered that the relationship between planned (simulated) reach distance and actual functional reach was weak. That is, their intentions did not match their actual capabilities. Also, others have reported that the elderly experience significant difficulties with the ability to mentally plan and simulate simple and complex, sequential whole body movements such as walking.^{4,5} Taken together, these reports suggest that weak motor planning can prevent a person from determining actions their body needs in order to perform a motor task correctly and safely. Gabbard et al.⁶ and Noel et al.⁷ reported that overestimation of action capabilities in the context of reaching was a common observation among older adults. Both studies also noted how overestimation of actions could be a major fall risk. Furthermore, a recent review study that looked at the circumstances of falls in elderly people, determined that incorrect transfer or shift of bodyweight was the most frequent cause of falling (41%).² Incorrect transfer or shift of body weight is defined as "selfinduced shifting of bodyweight,

move outside the base of support" with the "imbalance [as an] internal rather than eternal [like a slip, trip, or stumble] perturbation."² A specific example provided from the study is leaning too far from one's base of support.

METHODS

The first phase of developing the Reach-Specific Balance Confidence (RBC) Scale involved reviewing and evaluating current existing questionnaires that are widely used to measure a person's concern/ confidence that they will or will not fall (e.g., Activities-specific Balance Confidence (ABC) Scale and the Falls Efficiency Scale International (FES-I). The questionnaires' wording of items, the types of reach-specific items used, and their rating scales were evaluated. The item evaluation criteria included: the height/level the activity was performed at (i.e. above head, on



[FIGURE 1] An elderly person going down stairs, an activity that can involve shifting bodyweight and reaching, and therefore a potential for fall risk.

"...falling has significant implications for quality of life in our aging population."

ground, etc.), the actions required of the activity (i.e. walking, standing, sitting, turning, etc.), the context of the activity (i.e. inside, outside, stairs, etc.), the frequency of the activity's occurrence for a majority of elderly people (i.e. every day, hardly ever, etc.), the activity's impact on daily living (whether or not it related to independent daily tasks), and the activity's ease to mentally visualize.

Four reach-specific items from an existing questionnaire, the ABC Scale, were used with modifications, along with 12 created questions, resulting in a 16-item initial RBC Scale. In addition to the development of activity items, the rating scale and wording of the scale needed to be determined. The classic and well-known ABC Scale evaluates one's **confidence** of not losing their balance on a scale of 0% to 100% with 0% being "no confidence" to 100% being "completely confident." On the other hand, the *Falls Efficiency* Scale International (FES-I) evaluates one's concern of falling on a 4-point Likert scale with 1 being "not at all concerned" to 4 being "very concerned." After reviewing a study done on the effectiveness of various rating scales, it was determined that the ABC Scale's 0% to 100% rating scale was not as reliable or effective as the FES-I's 4-point Likert rating scale—hence our adoption of the 4-point Likert rating system.⁸ The challenge then was to determine the wording used on the rating scale. Whereas a *fall* is defined as unintentionally coming to rest on the ground, floor, or other lower level, a *near fall*, or loss of balance, is when you are able to catch yourself (like a slip or trip). Therefore using the words "losing

balance" and "falling" virtually have two different meanings that needed to be contemplated. The use of the word "concerned" versus "confident," or even other words like "worried" or "likely," and their connotations also needed to be considered. Finally, the words used to explain what each number meant on the rating scale needed to be determined. For example, 1 should mean "none" or "not at all," 2 should mean "little" or "somewhat," etc.

In the second phase of the project, the initial 16-item scale was sent, along with a cover letter, to 35 experts in the fields of clinical and research geriatrics. These participants were asked to provide feedback including, but not limited to, modifications of item(s), wording of item(s)/scale, deletion of item(s), addition of item(s), and overall evaluation of the instrument and its potential. The responses were reviewed, and upon further deliberation and assessment of suggestions with the above item evaluation criteria, numerous changes and modifications were made to the initial scale.

RESULTS

Several drafts of the *RBC Scale* were developed, with the final result consisting of 14 items, most of which were modified items, and some completely different/new items, from the initial scale. These items include a variety of heights/ levels, surfaces, contexts, and activities in a domestic setting. The scale uses a 4-point Likert rating of confidence on a range of "will not lose my balance" to "will lose my balance" **[FIGURE 2]**.

DISCUSSION AND APPLICATION

The next step is to test the instrument in the field with participants ages 65 to 80 that have and have not fallen over the past 12 months. We will check the validity and reliability of our scale by having participants answer

the self-report *RBC Scale*, then placing them in some of the actual situations (like standing at the top of stairs looking down), and finally asking the participant to re-answer their balance confidence rating. We could then compare their original rating to their situational rating to see how reliable our scale is.

In order to evaluate the sensitivity of our scale, we are going to give the self-report RBC Scale to an elderly population, along with a pre-screening instrument. This pre-screening instrument will ask participants to identify how many times they have fallen in the past 12 months. We will then compare the results from the *RBC Scale* of people who have fallen in the past 12 months to the balance confidence results of people who have not fallen in the past 12 months. This will allow us to determine if our scale is sensitive enough to detect changes in balance confidence due to falls, like we have hoped.

Furthermore, this instrument has both clinical contexts and research potential. It can be used to examine confidence at different points after fall incidence. This instrument could also be used before and after specific training periods. For example, we could use the RBC Scale along with the popular Functional *Reach Test*, as a pre- and post-test paired up with a mental imagery training program. This kind of program tests imagery strategies to be used in planning effective motor (reach-related) actions, and subsequently reduce the loss of balance and the risk of falls. This motor imagery program will last 15-60 minutes, 3 times per a week for 4 weeks and will follow previously researched recommendations and strategies from Gabbard and Fox.9 These suggestions include: clear and effective script instructions, goal-setting, first person internalizing, concentrating on the effectors (body parts performing the action), focus on the visual cues,

INSTRUCTIONS:

For each of the following situations, please indicate how confident you are that you will or will not lose your balance. To help with your decision, image actually doing the activity. Check the box that is closest to your decision based on the scale of 1-4. If you have any questions, please feel free to ask the administrator.

Item	How confident are you that you will or will	1	2	3	4
Number	not loso your balanco while	Very	Fairly	Fairly	Very
, itumber	<u>not</u> lose your balance white	Confident	Confident	Confident	Confident
		that I Will	that I Will	that I	that I
		NOT Lose	NOT Lose	WILL Lose	WILL Lose
		My	My	My	My
		Balance	Balance	Balance	Balance
1	Standing on a step stool to reach for a book	1 🗆	2 🗆	3 🗆	4 🗆
	on a shelf above your head.				
2	Reaching for a railing to support yourself as	1 🗆	2 🗆	3 🗆	4 🗆
	you go <u>down</u> stairs.				
3	Sitting on the edge of a chair and reaching	1 🗆	2 🗆	3 🗆	4 🗆
	down to fasten/tie your shoe.				
4	Reaching for a railing to support yourself as	1 🗆	2 🗆	3 🗆	4 🗆
	you go up stairs.				
5	Reaching down to pick up a newspaper off	1 🗆	2 🗆	3 🗆	4 🗆
	the ground.				
6	Reaching for a bowl from a cabinet that is at	1 🗆	2 🗆	3 🗆	4 🗆
	eye-level.				
7	Reaching to open a knee-high drawer in	1 🗆	2 🗆	3 🗆	4 🗆
	front of you.				
8	Sitting on the edge of your bed and reaching	1 🗆	2 🗆	3 🗆	4 🗆
	for a glass of water on a nightstand.				
9	Reaching for a railing while walking on a	1 🗆	2 🗆	3 🗆	4 🗆
	flat surface.				
10	Standing on your tip-toes to reach for a	1 🗆	2 🗆	3 🗆	4 🗆
	cup/plate on the top shelf.				
11	Reaching while getting into a car.	1	2 🗆	3 🗆	4 🗆
12	Reaching in the dark to turn a light switch	1	2	3 🗆	4
	on/off.				
13	Reaching to the back of a refrigerator to get	1 🗆	2 🗆	3 🗆	4 🗆
	milk/juice.				
14	Reaching to open a car door in wet or icy	1 🗆	2 🗆	3 🗆	4 🗆
	conditions.				

[[]FIGURE 2] Final Reach-Specific Balance Confidence (RBC) Scale self-report to be used in research, clinical, and therapeutic settings to assess individuals' balance confidence with daily activity items that pertain to reaching.

reinforcement on kinesthetically **REFERENCES** "feeling" execution of movement, combining physiotherapy (actually performing the movements) with mental practice, and progressing from simple to more complex. These strategies, along with the developed *RBC Scale,* will help to support the effects of motor imagery practice and programs, as well as benefit therapy practices to prevent falls.

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불DISENCHANTED LIFE

CHRISTOPHER BLACK

THE QUESTION

Do emotion, respect for the intrinsic value of human life, love, or any other such personal sentiment have a place in our technologically and scientifically hyperdeveloped Western culture anymore? Or has the illuminating power of science and reason pushed such experiences out into the realm of the irrational? Is there still space remaining in our lives for mystery and spirituality to be valued and even nurtured, and if such a space remains, is it the goal of science to remove it?

THE MODERN CONTEXT

This modern age of science and technology that we find ourselves in has been passed down to us by generations of exceptional thinkers. Many of these thinkers were part of the 17th and 18th century Age of Enlightenment who were driven by a desire to break with the traditional power of the church and government and encourage human freedom by harnessing the power of reason. They were rational revolutionaries that

hoped to free people from the constraints of the physical world, scarcity, disease, and other such human struggles. Their extraordinary idea was that instead of relying

upon ideas inherited by power structures which had an interest in suppressing the intellectual growth of the masses in order to maintain supreme authority, people should be free to learn and make decisions themselves. In effect embracing what Kant called "the freedom to use one's own intelligence." The key idea of this new philosophy was that reason and science would guide humankind along a trajectory that would lead towards a never-before-seen liberation of the masses and the development of individuals as a free, rational beings.

THE RATIONAL ABSURDITY OF THE MODERN CONDITION

Now this age of scientific rationality in which we live brings with it its own exclusive language and framework of thought which has in many ways turned into a monologue. Our modern scientific story has largely excluded personal aspects of the human experience from acceptable intellectual conversation. Modern science stands at the center of a lonely stage and delivers universal and utterly impersonal truths

into the world. This corrupted science then looks out and sneers at those who think that they have individual experiences. For example, one does not have to have had the personal experience of "being in love" to know all there is to know about it because it is *merely* serotonin and oxytocin (and whatever other chemicals) flooding the brain in certain quantities and locations. That's all love is, right? Nor must one have to have a child in order to speak dismissively about how it is no more than a natural experience in line with the principles of evolutionary biology. I can imagine such a person with their arm around their selected mate or perhaps the mate determined for them by those chemicals and principles?—saying, "Yes, my love, we have such chemistry! Let us procreate and thus account for the perpetuation of our species." The romance and beautiful transparency of the exchange would be simply unbearable. Now of course not all and probably not even most self-identified scientists think this way, but the fact that this is a kind of thinking that does

exist (whether explicit or implicit) should be addressed and critiqued.

It appears as if the scientific drive to reduce everything to its component parts has

in some cases lost sight of its noble goals of human liberation and become no more than an unreflective habit. The scientific revolution which laid the basis of the "Enlightenment" now results in the dismissal of emotion and experience from our world in its unrelenting attempt to remove all unreason from the community of modern men and women by way of explaining and dissecting all that there is. Those who do not communicate in terms of empirical universals and vacuum-packed laws of reason are rejected by the modern knowledge oversight committee. As Foucault said, "Modern man no longer communicates with the madman...There is no common language."

REMOVING THE SPIRIT

Scientific thinking requires a reduction of the world to its component parts as well as requiring repeatability in order to be considered scientifically "valid." However, the world we (or at least I) live in is one of unsharable emotions, complex tensions, passions conflicting with reason, and personal preferences.

"The enchantment of life is replaced

by a scientific model oriented around

a reductive paradigm."

Such private life experiences have no place in the reductive, reproducible, and universalizing monologue that science has with itself. Our life itself is becoming demystified, and the intimate privacy of one's own consciousness is even being invaded so as to be investigated and understood. A scientist might smugly and fatalistically imagine himself as lifting a veil so as to reveal that there is actually no one behind it. When people are converted from a subject into an object of study he or she becomes an "it" in the dispassionate pursuit of scientific knowledge. The scientifically understood person is incapable of original expression and self-determination, they become merely a piece of data in an infinitely interrelated system of predictable processes. Rather than being understood as a unique individual, he or she is viewed as an amalgamation of distinct parts and processes.

The absurdity of the modern condition is that in the massive project of improving and understanding human life those experiences by which life is constituted are removed from the equation. The enchantment of life is replaced by a scientific model oriented around a reductive paradigm. This social condition in which scientific understanding is more highly valued than mystery and belief is what Weber called "disenchantment with the world." One might say that the mystery of life is gone, and "the spirit" behind the action of a person becomes a taboo or useless topic because it is outside of the parameters of that which can be understood and dissected scientifically.

While humans used to stand above "nature" as beings with spiritual qualities, the new scientific man is just another piece of organic machinery with nothing admirable about him save the complexity of his or her biological circumstance. This view of a person as yet another biological device does not lead to a strong sense of interpersonal respect; I have never valued a machine as a meaningful in itself, I have only ever valued a machine instrumentally in terms of what it can do for me. This conception of meaningfulness, when applied to others, is obviously shallow and flawed.

To bring it closer to home via an everyday example: What does someone who buys into this scientific way of thinking see when they look into the eyes of the one they claim to love? Does nothing but complex and agreeable biological machinery return their gaze, or is there room for something more, some ineffable consciousness and value? Are they merely "made for one another" as interchangeable organisms in

an exchange of pheromones or are they—dare I say it?—kindred spirits? If the experience of being human is treated as valuable in itself then such disheartening situations would not occur. When people start to view one another as no more than resources to be exploited, what Heidegger would call "standing reserve," is when the greatest instances of disrespect towards humankind have taken place. Once human life has no fundamental worth it is more easily acceptable to wantonly slaughter a mass of people for an advantage, or to simply shun another because they are worthless to you. The connection between people becomes no more than a reciprocal exchange of benefits. Such thinking would suggest that when one is no longer useful one is unnecessary and should be removed as a broken part that no longer serves its purpose. Many contemporary social attributes, such as the massive divorce rate, speak to this socially internalized way of thinking.

EVERYDAY SYMPTOMS

Because the world we live in has been reshaped at a psychological and a physical level, we have a fundamentally new way of living. It is a symptom of our age that many experiences have become disembodied. One can "access" just about any experience without ever leaving their computer desk, and "share" any bit of relevant data through a plethora of cyber forums. Pop culture emphasizes massive communion around common entertainment demigods. Even when people do go out physically into the world and actually do activities such as attending concerts it seems as if they now feel some overwhelming desire to validate their experience by recording it on their phone or camera. Do remember what we have been trained to think: if it's not repeatable it's not real. Pics or it didn't happen.

CONCLUSION

Now science is much more than just a source of dehumanization. It also cannot be dismissed as a fundamentally negative force in the world. It is clearly preferable to get a toothache or a stomach infection in the 21st century, and before the telegraph in 1837 information could travel no faster than a man on horseback. However, as with any powerful force, it has the potential to be misapplied and used for negative purposes. The intrusion of scientific thinking into any and all personal and public arenas of life is something that we should be careful about, so that the pursuit of understanding itself does not blind us from being able to see the objective: an increase in the quality and respect for the human experience, rather than distancing ourselves by turning the human experience into no more than a scientifically reducible process.

"...the new scientific man is just another piece of organic machinery."

Communited and a second second

BASEBALL: A REFUGE DURING JAPANESE AMERICAN CONFINEMENT

BRETT WASHBURN

On March 7, 1943, the first baseball to maintain a sense of community. game was played on Zenimura field at the Gila River War Relocation Camp in Arizona and for the first time since the outbreak of the Second World War, Japanese Americans felt a sense of relief. Here, surrounded by nothing except scorched lands and barbed wire, internee Kenichi Zenimura built a diamond in the desert. With help from his two sons, he borrowed wood and swiped fence posts to build a backstop, dugouts, and even a grandstand complete with a reserved seating section. Zenimura planted castor bean plants to serve as the outfield fence and convinced a plumber to reroute waterlines in order to keep the grass from withering under the Arizona sun. Originally donning homemade uniforms, sewn together out of mattress ticking, using rice bags for bases, and marking the foul lines with flour from the mess hall, thirtytwo teams played almost every evening on the makeshift field. However primitive Zenimura's field might have been, it quickly became a social hot spot for thousands of internees who crammed into the bleachers and filled the foul lines for each evening's games. What Zenimura had created was not just some makeshift baseball field—the former all-star catcher and pitcher from Fresno, California had built a sanctuary.¹ During internment, baseball was more than just a game; the sport provided a refuge from the reality of internment and an opportunity for Japanese Americans

For Japanese Americans, baseball did not begin during confinement. Baseball was already deeply entrenched in Japanese culture well before the outbreak of World War II. When the first generation of Japanese immigrants migrated from their native country, they brought with them as much of their heritage as they could, including their love of baseball. However, the love of the game that they carried across the Pacific, the same love that was shared by Japanese and Americans alike, and the same love the first generation of immigrants would pass to their children did very little to ease the already present anti-Asian sentiments in the minds of the West Coast's white population. Tensions along racial lines created a segregated culture for the Japanese in the United States, a segregated culture that included segregated baseball diamonds.²

Undeterred by racial tensions, however, baseball thrived in Japanese American communities. In 1903, the first all-Japanese baseball club was formed in San Francisco, and by the onset of World War II. Japanese baseball teams, clubs, and leagues had sprouted up in every Japanese community around the country. Through baseball, Japanese Americans were able to demonstrate their competitiveness and abilities to the "Caucasian baseball hierarchy and city leaders."3 Kenichi Zenimura's baseball activism in Fresno, California as well as his talent on the field earned him

"Playing and watching baseball almost instantly boosted community morale and brought distancing generations closer."

the opportunity to be one of only four Japanese American players to participate in an exhibition game when Babe Ruth and Lou Gehrig came through Fresno in 1927. At only five feet tall, Zenimura singled and stole a base for Gehrig's team, the Larrupin' Lou's.4

Zenimura may have been the most renowned Japanese American baseball pioneer before World War II. but baseball was at the heartbeat of all Japanese Americans. "Sundays became exciting during the summer. Baseball was not only fun, but it was a way of bonding," Jerry Inouye recalled about his Oregon summers.⁵ To other Japanese Americans living in the United States, baseball was not only a way to bond with other Japanese; according to historian Samuel Regalado, first generation immigrants used baseball to "shape their American identity," while their children began to use the sport to "build global and cultural bridges on several fronts."6 Baseball also provided a potential path for Japanese immigrants to assimilate into American life. Although largely unnoticed by "mainstream" baseball fans, Japanese American players and fans exhibited tremendous

competitiveness, which produced fierce rivalries between community teams and an unshakable devotion to the game. This devotion allowed baseball to serve as an "important vehicle for recreation, community cohesion, and boosting of morale" during some of the darkest days in American history.7

In 1942, just months after the bombing of Pearl Harbor, President Franklin Delano Roosevelt signed Executive Order 9066 which led to the relocation of tens of thousands of Japanese Americans. Deemed a "military necessity" by Colonel Karl Bendesten, the relocation process spared few to none, and no matter how loval to America, Bendesten claimed that all Japanese Americans "must be regarded as potential enemies" and therefore subject to evacuation.⁸ People had few options to escape the mandatory relocation. They could either move to regions in which the anti-Japanese hysteria was limited or, for men, they could join the military. If neither route was chosen, then relocation was virtually inevitable. In the panic caused by the evacuations, many families sold their belongings at a fraction of their actual worth. Even if families decided not to sell their possessions, they could not take all of their things with them. Once relocated, much of their property was at the mercy of looters.⁹ Leaving their homes or selling their belongings was just the beginning of the four-year journey Japanese Americans were forced to endure.

Before their incarceration in more permanent camps, Japanese Americans were moved to assembly centers run by the United States Army and the Wartime Civil Control Administrations (WCCA). The centers were crudely constructed on county fairgrounds and racetracks. For several months in 1942, while the War Relocation Authority (WRA) selected sites and built concentration camps that would house Japanese Americans



[FIGURE1] Arcadia, California. An impromptu baseball game is held by young evacuees of Japanese ancestry at Santa Anita Assembly center. Image in the Public Domain. Source: National Archives. Identifier: 537447

until the end of World War II. inmates suffered overcrowding, miserable sanitary conditions, and "sweltered in the stables and livestock exposition centers."¹⁰ The trauma of the assembly centers and the evacuation process itself significantly affected Japanese Americans. Children began to resent their parents for their heritage, which had caused their incarceration. As community morale fell and a "generation gap" began to grow, baseball became more important than ever.¹¹

In assembly centers such as Fresno and Merced County, baseball provided residents an opportunity to relieve stress built up from relocation. Playing and watching baseball almost instantly boosted community morale and brought distancing generations closer. In reference to elderly Japanese Americans in his assembly center, inmate Yok Yotsuya said, "They didn't care who was playing as long as they could watch the games."¹² However the solace residents found wire fences of concentration camps in baseball soon ended as they were was harsh, but baseball was a bright

informed of the locations of their more permanent "homes."

Located on desolate and worthless lands, Japanese Americans moved to one of ten concentration camps and were confronted by many of the same trials and tribulations as before. Overcrowding and poor sanitary conditions were typical of all camps, and entire families were crammed into "one-room 'apartments' in hastily constructed tar-paper barracks that offered very little privacy."13 Along with the dehumanization of Japanese Americans, Mother Nature also took a toll on inmates. In some camps, residents battled swarms of mosquitoes and dust storms or other severe weather. The burdensome hardships placed on detainees were not always physical either. Psychological challenges such as the stress of captivity, the uncertainty of the future, and the loss of property, livelihood, and freedom all added to the list of miseries.¹⁴ Life behind the barbed

"Of the ten concentration camps, not a single one was without some form of a baseball league."

spot for Japanese Americans in internment. Providing internees an escape from the realities of their forced confinement, the sport was an opportunity to maintain the sense of community that was present before the war.

at the Gila River Relocation Camp in Arizona, Kenichi Zenimura brought the community closer and helped thousands of internees cope with life in the camp. Pat Although historian David Vaught Morita remembers, "The teenagers and the adults would gather every night to watch the games...this was my introduction to baseball sitting and cheering with a couple thousand rabid fans," and Howard Zenimura, Kenichi's son recalls, "Baseball was the only thing that kept us going. If we didn't play baseball camp life would've been unbearable."¹⁵ Although not as captivating as the field Zenimura built in Gila River, internees at Amache, Colorado promptly built Japanese American concentration a baseball field upon their arrival. Former Merced Assembly Center resident and Amache inmate Fred Kishi remembered, "We had to make the baseball diamond, and there were no stands, no seats, no nothing, so the crowd just stood around the field and watched the games."¹⁶ Of the ten concentration camps, not a single one was without some form of a baseball league.¹⁷ The game offered an outlet for the tensions of camp life while boosting morale and stimulating community cohesion, just as it had done before World War II and while in the assembly centers. Baseball also allowed younger generations to grow closer to their elders during a time when "cohesion was vital."18 Former internee George Omachi said, "The baseball experience

was one of those elements that allowed me to develop as a person and an individual, plus it gave me 6. opportunities."19 The ball fields, however primitive, became havens for thousands of internees trying to forget, even if just for a few moments, the barbed wire, the heat of the Arizona deserts, and any other stresses the internment camps created.

A love for baseball was part of a culture passed down from By completing his baseball field the first generation Japanese Americans to their children and their children's children, allowing all three generations to cope with the involuntary life in confinement. did not address baseball in Japanese American concentration camps in The Farmer's Game, he observed that "Baseball offered not only an outlet for the tensions of rural life but also a means of translating a core set of values, which they inherited from their fathers, into practice."20 Vaught's words about rural baseball could easily be used to describe Japanese American confinement baseball as well. Baseball behind the barbed wire of camps was a refuge, a sanctuary. and an escape for thousands. Baseball behind the barbed wire was home.

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WATER USE AND VALUE RELATED TO HYDRAULIC FRACTURING: TEXAS EAGLE FORD SHALE

INTRODUCTION

Hydraulic fracturing (also known as fracking) is a process that involves drilling vertically into shale formation (followed by drilling through the rock horizontally), then pumping a water and chemical mixture into the drill sites at high pressures. The high pressure causes the shale to crack (fracture) allowing the extraction of natural gas and oil. There is an abundance of shale in the United States and hydraulic fracturing has grown substantially over the past decade alone.¹

The development of hydraulic fracturing technology has opened vast regions to production of oil and natural gas. There were more than 45,000 gas wells completed in the United States in 2012,² with almost 11,000 of those wells being completed in Texas.³ With this boom in production comes a high demand for water in order to fracture the wells.

The high water demand for fracking has created controversy, especially in more arid parts of the United States, which struggle with the issue of continuing drought. This article examines the Eagle Ford Shale in Texas, a region of limited water supply. We will compare the value of water used in fracking and in alternative uses. The results will be largely based on the acre-foot unit of measurement which is the equivalent of 325,851 gallons.

METHODOLOGY

Water is a tricky commodity to value, in part because in its purest form (not including substances dissolved in the water such as salt and other minerals) water is fairly uniform throughout the earth. Water value does differ, however, based on availability and location. as well as on the opinions of those who make use of water in their everyday activities. These groups include city water suppliers, farmers, hydraulic fracturing companies, and environmentalists. With the exception of values determined by environmentalists, water values are determined by the total revenues generated from the use of the water. The determination of water values necessarily includes consideration of production costs

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"The high water demand for fracking has created controversy, especially in more arid parts of the United States..."

such as the costs of distilling the water for drinking, pumping the water out of wells, and shipping the water to the appropriate sites. This analysis observes these differences among three basic water stakeholders: municipal and industrial (M&I) users, agricultural users, and fracking users.

For M&I use, the prices and quantities presented by the Texas Municipal League⁴ served as an estimate of value while a residual value approach was applied for agricultural use. A residual value approach involves comparing irrigated (land that water is pumped onto in addition to rainfall) returns to net dryland (land that only uses rainfall; no additional water is added) returns with a charge to all inputs including land. The only difference is that there is an implied value of water

					1									
Municipal and Industrial			Agriculture ³											
					Cotton			Sorghum			Bermuda Pasture			
	\$ per Th	nousand						Returns			Returns			Returns
Classification	Gallons		\$ per Acre-Foot			Dry	Irrigated	to Water	Dry	Irrigated	to Water	Dry	Irrigated	to Water
Residential	Low	High	Low	High	Yield	1,320 lbs.	2,272 lbs.	-	22 cwt	43 cwt	-	140 lbs.	600 lbs.	-
5,000 Gallons	2.62	6.7	855	2,185	Total Revenue (\$)	493.00	826.00	-	187.00	366.00	-	55.00	270.00	-
10,000 Gallons	2.17	5.05	708	1,647	Land Charge (\$)	123.00	207.00	84.00	62.00	121.00	59.00	25.00	100.00	75.00
					Water Charge (\$)	-	16.00	(16.00)	-	8.00	(8.00)	-	84.00	(84.00)
					Irrigated (ac.in.)	-	14.00	-	-	14.00	-	-	12.00	-
					Net Returns (\$)	(77.00)	(28.00)	49.00	(49.00)	17.00	66.00	(26.00)	(102.00)	(76.00)
Commercial	Low	High	Low	High	Net Returns to Irrigation (\$)	-	-	117.00	-	-	117.00	-	-	(85.00)
50,000 Gallons	2.29	4.21	747	1,373	Value (ac.in.) (\$)	-	-	8.36	-	-	8.36	-	-	-
200,000 Gallons	2.31	4.05	753	1,321	Value (ac.ift.) (\$)	-	-	100.29	-	-	100.29	-	-	-

[TABLE 1] M&I and Agriculture Water Values

WATER VALUE PER ACRE-FOOT



[FIGURE 1] M&I Water Values

for irrigated land. In order to gain a strong idea of what these returns were, three crops were used to conduct this analysis, including cotton, sorghum, and bermuda pasture. Examples of both the M&I and agricultural approaches to determining the value of water are shown in **[TABLE 1]**.

The value of water in fracking was derived in a slightly different manner. This analysis assumes that a typical well is capable of being productive for 20 years.⁵ Thus, the revenues (based on the prices and quantities of oil and gas extracted) and costs of the well were projected each year using an equation⁶ that predicted the production cycle of a well. Then, capital budgeting techniques were applied to estimate the initial investment, annual costs related to production, and revenues generated from the use of the well. Next, the present value of the well was calculated by discounting the revenues and costs each year back to the present period using the projected economy discount rates.⁵ Discounting values simply involves taking future values and converting those values back to a current value. Discount rates take into account projected inflation and risk. By comparing the present value of revenue to the present value of costs, an approximation of water value was estimated. This value was then divided by the water used in fracking to calculate approximate value per acre-foot, per acre-inch, and for every 1,000 gallons.

RESULTS

First, M&I and agriculture water value were examined. Water prices were obtained from the Texas Municipal League (mentioned in the methodology) and the agriculture data were obtained from crop enterprise budgets presented by the Texas A&M AgriLife Extension Service.⁷ For M&I, water rates (prices/costs) are reported for two water use levels, including residential (5,000 and 10,000 gallons per month) and commercial (50,000 and 200,000 gallons per month) customers, without reference to average typical quantities of water consumed by those users **[TABLE 1]**. Because of limited resources, it is assumed that M&I companies have set prices that reflect what they believe the value of their water is. Therefore, the prices from the Texas Municipal league are deemed appropriate for this analysis. For agriculture, three crops being observed are shown from both a dryland and an irrigated perspective **[TABLE 1]**. Visual examples of **[TABLE 1]** are shown in **[FIGURES 1 AND 2]**.

The value for M&I water use has an estimated low value of \$708 per acre-foot and a high value of \$2,185 per acre-foot. In agriculture, estimated water value stays at slightly more than \$100 per acrefoot for both cotton and sorghum. For bermuda pasture, no value is shown in the "Value per Acre-Foot" row because it assumed that ranchers will not choose to irrigate bermuda pasture if the returns to the irrigation are less than the returns to dryland methods.

Chesapeake Energy⁸ and Dr. Stephen Holditch⁹ provided the information for the initial investments in drilling, fracking, and operating wells as well as the elements (and their associated



WATER VALUE PER ACRE-FOOT

[FIGURE 2] Agriculture Water Values

	\$ per Well				
Returns to Gas Returns to Oil	\$	6,058,814 17,541,265			
Total Returns			\$ 23,600,079		
Operating Costs to Gas Operating Costs to Oil Royalty Payments (25% of the Total Revenue)	\$	1,211,763 5,847,088 5 900 020			
Total Variable Costs		0,000,020	\$12,958,871		
Drilling and Fracking Costs			\$ 6,343,000		
Net Returns per Well			\$ 4,298,208		
Net Returns per Acre-Foot		:	\$ 291,800		
Net Returns per Acre-Inch		:	\$ 24,317		
Net Returns per Thousands Gallons			\$ 896		

[TABLE 2] Hydraulic Fracturing Water Values

costs) contributing to the fracking process. They also provided most of the following facts aside from the calculations. Fracturing a typical well in the Eagle Ford Shale requires approximately 4.8 million gallons (14.73 acre feet) of water. Drilling a well, including set-up costs, transportation, casing, contingencies, completion of the well, among other expenses totals \$6.3 million. A royalty payment worth 25% of the total revenue is included with the operating costs. Also included in the operating costs are the daily fracking expenses. Shown in **[TABLE 2]** are the values of the revenues, operating costs (variable costs and 25% royalty payments), and the fixed costs (represented drilling costs previously discussed). The revenues and variable costs are separated into two components, oil and gas, because a typical well is assumed to produce both oil and gas. The fixed costs are lumped together because those represent the costs that are spread over both oil and gas extraction. The table is also separated into values per acrefoot, per acre-inch, and per 1,000 gallons. The values presented in the table represent the value

per well. Therefore, the net returns are divided by the 14.73 acre feet needed to fracture the well.

Based on the estimated oil and gas prices applied, water value in hydraulic fracturing is nearly \$300,000 per acre-foot. Water, therefore, is far more valuable to the fracturing users than it is to agriculture and M&I users. Return on investment and risk management was not included in this analysis, creating the possibility that this result is high. However, sensitivity analysis would reveal that the value of water in fracking would not go below \$35,000 and would not exceed \$570,000 per acre-foot. Shown in **[FIGURE 3]** is a comparison of the water values for the three water users discussed in this report. For M&I, the value shown is a simple average of the four values listed in **[TABLE 1]**.

CONCLUSIONS

With reasonable oil and gas prices, it is clear that the value of water used for hydraulic fracturing exceeds the value of water used in M&I and agriculture. This scenario is probably because the oil and gas industry is very lucrative despite attempts to move to alternative sources of fuel such as biofuels, hydrogen or electricity. Public knowledge of the large difference in these water values could have considerable implications for how water is distributed in the near future.

To begin, economics assumes that a person is rational above all else. Realizing that water is far more valuable in hydraulic fracturing than it is in agriculture and in M&I, water owners would look to sell their water to fracking companies as soon as possible to make a profit. This stems from the fact that people need to make money to support themselves and their families. As such, could knowing this value cause a shift in water usage from, say, agriculture to hydraulic fracturing in Texas?



[FIGURE 3] Water Value Comparison

"...could knowing this value cause a shift in water usage from, say, agriculture to hydraulic fracturing in Texas?"

Now consider the other side of the argument. Obviously the drought in Texas has been making agriculture and some M&I activity more difficult. Assuming that ownership of water falls largely in the hands of farmers, would money alone be enough of an incentive for Texas farmers to let go of their water? Farmers seem to understand better than most that water holds the key to life, and without the food it produces, abundant oil and gas has no value. Would knowing this longer-term value of water cause farmers in Texas to keep their water at all costs? In addition. Texas cities are growing at phenomenal rates, and without water that growth is problematic. Does the indirect value of water through municipal growth and development outweigh the immediate value of water for fracking? The fact that this research indicates that water is currently more valuable in fracking opens the door to numerous questions that will need to be addressed in the coming years.

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"I DON'T DO LABELS" EXPLORING IDENTITY WITH SHAHZIA SIKANDER

SAAD DAWOODI

INTRODUCTION

Shahzia Sikander is a Pakistani-born artist who began her career in the miniature painting tradition. Studying at the National College of Art in Lahore, Pakistan during the late 1980's, Sikander chose the miniature to explore its limitations and relevance as an art form in the 20th century (extending to 21st). Moving to the United States, Sikander enrolled at the Rhode Island School of Design to earn a Masters of Fine Arts and followed with a fellowship at the Glassell School of Art in Houston, Texas. She has been the recipient of numerous awards, including the prestigious MacArthur Foundation "genius" Fellowship in 2006.¹

Sikander is well known for exploring and playing with the traditional art form of miniature paintings, examining its artistic limits and, as many would argue, setting a precedent for bringing the miniature painting into the modern era. Expanding from the miniature, Sikander has branched out to various media including videos, animations, installations and even performance art collaborations.¹

CHOOSING SHAHZIA SIKANDER AND IDENTITY

The beginnings of this project came from a desire to understand what exactly "identity" is and how an individual goes about exploring and establishing his/ her identity. More specifically, this project hoped to address interactions between different identities and examine the acute, confusing and sometimes violent tension that exists between two (or more) identities. Speaking honestly, this project stemmed from a personal struggle to pin down my identity as an individual, an identity that encompasses all aspects of my life. During the conception of the idea for this project, I was struggling to juggle my (trans)national, (multi)cultural, gender and religious identities. The last of which was giving me the most grief. Growing up as a Muslim in the United States and experiencing Islamophobia, both internal and external, this portion of my identity seemed to be the least developed and most neglected. I wanted to explore the Islamic world from an artistic and art historical perspective in order to discover the side of Islam that is little



[FIGURE 1] Museum of Modern Art (MoMA) banner for Shahzia Sikander. Photograph used with permission from Shahzia Sikander.

appreciated in mainstream news and understanding. By exploring, analyzing and experiencing the works of contemporary Muslim artists, this project aimed to understand how Muslim artists explored and expressed their identities (not necessarily just Muslim identity) in their works. Sikander was chosen as the focus of this project since she, like myself, has a transnational identity. I had hoped this added layer of similarity would increase or at least clarify my understanding of identity formation. In addition, from previous knowledge of Sikander and her work. Sikander expressed a very fluid understanding of identity which seemed to be an interesting concept to explore. Indeed, this persistence on viewing identity as a fluid entity is the basis for analyzing the presentation of identity in Sikander's work as a continual process rather than a collection of innate characteristics.

IDENTITY PORTRAYED THROUGH SIKANDER'S WORKS

At the beginning of the project, and in my naivety and ignorance, I had chosen to explore Sikander and her work because she was a) an individual from a Muslim country and b) a Pakistani living primarily in the States. Not realizing it at the time, I had boxed in Sikander to two portions of her identity. The



[FIGURE 2] A Kind of Slight and Pleasing Dislocation, 1995 by Shahzia Sikander. Photograph used with permission from Shahzia Sikander.

same "boxing" in process I had been subjecting myself to and causing myself all sorts of grief. It was with this state of mind; to peg down, label and control the meaning/significance of identity that this project was approached. Such a frame of mind, whether conscious or subconscious, is the basis for the formation of generalizations and perpetuates the "boxing" in of individuals.

Through the analysis of Sikander's work, this framework was deconstructed, dissected and exposed in its inadequacies and fallacies. Sikander approaches this problematic way of thinking ingeniously: She does not approach it at all. Instead, the deconstruction and challenging of fixed, seemingly concrete meanings is left to the audience. By creating works of art that serve as spaces of exploration, for herself as well as her audience, Sikander evades the *label* of being a teacher or a presenter of an idea. She does not dictate a message nor does she have an agenda. Instead she leaves her works as spaces of exploration to question, explore and formulate new understandings (or even to bolster older understandings). Sikander's work

"...this project came from a desire to understand what exactly "identity" is and how an individual goes about exploring and establishing his/her identity."

begins with drawing and the drawings serve as spaces for exploration of the process, the relationship of materials and the relationships of images (separate and together).² The images used in Sikander's works are taken from various artistic and cultural traditions. For example, her works have included images from Hindu mythology, the Mannerism movement as well as symbols from Buddhism [FIGURE 1].¹ Although such images are assigned certain meanings from the cultural/artistic traditions from which they arise, the interest here is not in these pre-assigned meanings. Rather, the interest is on the recreation of meaning through transformation. Through these images, Sikander explores the meaning, sentiments and significance that arise from manipulating the figures. An excellent example of this transformative process is through the use of an image from Sikander's own visual repertoire, the hairdo of the Gopi women. The Gopi women are devout followers of the Hindu God Krishna and the figure of the Gopi carries with it associated power dynamics and gender hierarchies that arise from the relationship between Krishna and the Gopi.¹ In Sikander's work SpiNN, the hairdo of the Gopi women dissociate from the body of the women (symbolic of dissociation of meaning from an image) and become bird-like figures [FIGURES 2 &3].¹ Use of the Gopi hairdo motif transform the hairdo as a representation of the Gopi (and their associated meanings) to an image that takes on a meanings of its own. Thus, when the Gopi hairdo is viewed in a later work it is successfully dissociated from its original associations with the Gopi, Krishna, and





[FIGURE 3] Singing Circles as seen in Parallax by Shahzia Sikander. Photograph used with permission from Shahzia Sikander.

Hinduism. Therefore, Sikander's works are not only the intersection of visual images that come from various traditions, but also the intersection of meanings, prejudices and ignorance. The tension Sikander's works create are the same tensions that arise when an individual's identity groups rub against each other and create friction. Sikander's works reveal that meaning is NOT concrete and that it changes with context. If identity is viewed as a collection of attributes, each of these attributes carries with it certain standards, expectations and meanings. However, as evidenced by Sikander's work, meaning is fluid. Therefore a model in which identity is segmented into various categories is not adequate to describe one's identity. Instead, identity must be viewed as a fluid entity that is under continual change, transformed by personal histories and experiences.

RELEVANCE/CONCLUSION

Art works hold the special status of being spaces where ideas can be problematized and tension created. However, what about outside the realm of art works? It is easy to keep such a discussion to academia or to the world of books and theses. Nonetheless, the rigid classification of identity that we subject ourselves and one another to, is very much a real phenomenon. For me, the most striking lesson I learned from researching Sikander was the inadequacy of the labels I originally used to select Sikander as the subject of this study. Categories, such as "Muslim" or "Pakistani" have no meaning by themselves but get their meanings from the definitions I have personally cultivated and assigned to them. The meanings these words carry are reflective of *my* experiences, not Sikander's (or any other Muslim and/or Pakistani). Thus, Sikander's work serves as a superb platform for discussion of the origins of meanings and how they apply to individuals in the process of identity formation.

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MYSTERIOUS FUNGI: INVESTIGATING THE GROWTH OF FILAMENTOUS FUNGI

INTRODUCTION

What are Fungi?

Despite popular belief, fungi are not just mushrooms or molds, and they are certainly unique from other microorganisms such as bacteria. Fungi are multicellular organisms, eukaryotes, which are more like humans than plants or most other microorganisms. In fact, fungi are so much like us that their similarities make them difficult to treat when they become pathogenic. Fungi are well known for their role as primary decomposers of organic matter, recycling crucial nutrients for use by new forms of life. They are also highly regarded for their role in alcohol fermentation, the production of useful chemicals such as antibiotics, and even as a biological means of pest control. Any way you look at it, fungi are a crucial and inescapable part of the natural world. Understanding these unique and mysterious organisms is the first step in employing them

"These unique and yet, diverse eukaryotes have established themselves as a fundamental part of life on earth."

to improve life around the world.

What are mushrooms and molds?

Mushrooms are actually the reproductive structure or fruiting body of the fungus. Mushrooms are unique to the phyla Basidiomycota, often referred to as the "higher" fungi. Basidiomycota includes the

most common mushrooms such as Mario's familiar fly amanita, shiitake, white button, and in general, the ones that appear in your yard after a heavy rain. Ascomycetes, another group of "higher" fungi, are more often considered the molds of the world, but do produce some large and edible fruiting bodies such as morels and the renowned truffle. Some examples of ascomycetes, or molds, include members of the Aspergillus and Fusarium genera. Aspergillus flavus, as well as members of the genus *Fusarium*. are most notable for their production of deadly mycotoxins such as alfatoxins and fumonisins, respectively, which can cause irreversible damage to mammalian organs¹. Aspergillus fumigatus is commonly found to cause respiratory damage by infecting the lungs, Aspergillus terreus is used in the production of drugs for combating heart disease and high cholesterol, and Aspergillus oryzae is an integral part in the production of rice wine and sake.¹ These are just a few of the world's most important ascomycetes. In addition to human-fungal relations, fungi are the most common pathogens of plants. Members of the genus Puccinia, often called rusts, include some of the most virulent plant pathogens. For instance, P. graminis causes stem rust, a disease of wheat that is cited throughout recorded history, including biblical and ancient Egyptian references to the devastation it caused. Stem rust is a significant disease that affects cereal crops and can lead to massive yield loss resulting in food shortages throughout the

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world.¹ On the flip side, there are mycorrhizal fungi that exist in symbiotic relations with thousands of plant species, and many species of fungi that can help combat pathogens rather than being pathogens. Some of these beneficial fungi have been used as biological pest control, in the production of antibiotics, and even to boost one's immune system. These unique and yet, diverse eukaryotes have established themselves as a fundamental part of life on earth. Fungi provide the world with both essential benefits and damaging impacts, and they can no longer be ignored or misunderstood. To understand these unique organisms is to be one step closer to uncovering the delicate and intricately woven processes of the natural world.

How do Fungi Grow and Develop?

There are many amazing characteristics that set fungi apart, but by far the most important aspect of filamentous fungi is what makes them similar to each other. Filamentous fungi have a very unique pattern of growth in which they grow by means of polarized extension at the cell tip.² This mode of growth produces long thread-like, filamentous cells called hyphae. In other words, fungi grow at only a small portion of the cell and growth in any other region is scarce and subsidiary [FIGURE 1]. All organisms present some form of polarization during growth. For example, when our cells divide through mitosis the two daughter cells become polarized away from each other during their division. Fungi, however, exhibit an extreme



[FIGURE 1] MODEL DEPICTION OF APICAL-RECYCLING AND CLATHRIN BUDDING. (a) The localization of clathrin and Golgi equivalents is shown. The cell is thought to grow at the tip via polarized extension; the polar molecules will be forced back away from the site of active growth. These polar molecules are maintained at the tip by endocytosis. **(b)** Clathrin first coats the surface of the membrane. A membrane invagination begins to form with the aid of other cellular proteins. Clathrin continues to aid in shaping the membrane invagination while other proteins apply pressure at the membrane, behind the invagination. The invagination is sliced from the membrane and becomes an intracellular vesicle, and then the clathrin dissipates.

form of polarized growth that confines all growth to the tip of the cell. It is hypothesized that this type of growth is the result of polar molecules directing exocytosis, secretion outside of the cell, and cell wall production at the cell tip. But how is this system maintained? As the cell expands during growth, would not these molecules be carried away from the tip? In addition to exocytosis, most fungal biologists agree that endocytosis, the uptake of external substances and the recycling of membrane into the cell, of these polar molecules must occur in order to maintain the cell's polarity and thus its distinctive method of growth³. Understanding the functionality of hyphal growth could prove valuable in controlling disease, improving health, and advancing industrial processes such as fermentation.

In my research, I work with a filamentous fungus known as *Aspergillus nidulans*, and I manipulated the organism's genetic makeup in order to help elucidate the growth and development of the fungus. Specifically, I have been working to better comprehend the process of endocytosis in fungi. A greater understanding of the mechanisms behind fungal growth will not only provide ways to better control and manipulate fungi, but will also provide insight into the cell biology of similar organisms such as humans. Although we do not grow via hyphal elongation, cellular processes such as exo- and endocytosis are certainly conserved and fundamental within human biology.

METHODS

I choose to work with clathrin. which is a protein complex that coats vesicles within the cell.4 Vesicles are small components of cells that resemble thousands of tiny bubbles surrounded by lipids (i.e. fats) that float around the cytoplasm or cell body. It is expected that clathrin coats endocytic vesicles, vesicles that carry molecular cargo absorbed from outside of the cell, and would work well for the visualization and characterization of endocytosis. In order to set up the experiment, mutants (*chcA::GFP*) were created using Fusion Polymerase Chain Reactions (PCR) and genetic transformation. This process takes artificial DNA constructs and stitches them into the desired genetic construct. Transformation then inserts the desired genes into the organism. The first mutant (chcA) is essentially the wild type that is found in nature, A. nidulans, with a marker attached to the cell's clathrin gene. This makes it fluoresce green under a particular wavelength of light provided by a florescence microscope [FIGURE 2].

"Fungi, however, exhibit an extreme form of polarized growth that confines all growth to the tip of the cell."



[FIGURE 2-a] LOCALIZATION OF CLATHRIN WITHIN THE CELL. This is a time-lapse imaging of a growing hypha. Clathrin can be seen as green fluorescent structures, and Golgi equivalents are the red fluorescent circles/rings. In the frame marked 1:03, the two white arrows are pointing at two small clathrin-coated vesicles. Scale bar = $2\mu m$

The clathrin mutants were used to characterize the localization of clathrin throughout the cell.

The main tool used in uncovering the characteristics of clathrin and endocytosis within the cell was the laboratory's microscope. A complete list of specifications for this microscope was previously published.⁵ Green (GFP) and red (mCherry, FM4-64, mRFP) compatible florescence filter sets were utilized. Images were collected via time-lapse with a variety of time-delay ranges from 1, 2, 5, 10, 30 seconds, and several minutes. Localization of clathrin was simply observing the various locations where green and/or red fluorescence was observed. All images were acquired using a computer controlled microscope and camera that utilized Slidebook (version 5.0) imaging software.

OBSERVATIONS

Clathrin localized to three different forms within the cell: a cytoplasmic haze, small vesicles, and ring structures. The cytoplasmic haze likely represents very small structures that cannot be resolved by the fluorescence microscope. The haze was present throughout the cell, but was excluded from the tip of the hyphae and enriched in the region just behind the tip that is known to be the site of endocytosis [FIGURE 2-c]. Clathrin small vesicles were distributed relatively evenly throughout the cell [FIGURE 2-a], but were also excluded from the tip. The movement of these vesicles was observed over long distances both towards and away from the cell's tip, and at velocities between 1-3 μ m/s. The ring structures were characterized by a diffuse ring of clathrin localization that was pronounced in several punctate points on each ring [FIGURE 2-b]. Co-localization with a Golgi marker (red fluorescence) confirmed that these structures

were Golgi equivalents (the fungal analog of our Golgi apparatus) and dispersed when the Golgi dissembled. Golgi equivalents can be considered the post-office of the cell, organizing and shipping vesicles throughout the cell. These clathrin structures were also most prevalent just behind the tip of the cell, but were entirely excluded from the tip. It is also worth noting that when the fungal cell was dead or stopped growing, clathrin localization did not follow these patterns and often was located within the cell's tip.



[FIGURE 2-b] Colocalization of clathrin (green) and the cells' Golgi equivalents (red) is depicted here. These frames show close-ups of the Golgi equivalents and clathrin, respectively. The ring structure of both clathrin and the Golgi equivalents are clearly visible. Scale bar = $0.5\mu m$



[FIGURE 2-c] The cytoplasmic-collar 'haze'

DISCUSSION

The characterization of clathrin within the cell is incomplete. These observations do, however, provide some insight. For instance in a healthy and growing fungal cell. all of the cell's clathrin is excluded from the cell's tip or area of polarized growth. In addition, most of the clathrin within the cell is concentrated just behind the cell's tip, at or near the suspected site of endocytosis, known as the sub-apical collar. Clathrin was also observed moving long and short distances throughout the cell, both towards and way from the tip of the cell. This would suggest that clathrin is a fundamental protein during endocytosis and intracellular transport. In other words, clathrin fluorescence has proven to be an outstanding marker for intracellular transport by which integral cellular mechanisms might be observed and/or characterized.

The next step in my research is taking this knowledge and producing strains that are both repressed in endocytosis as well as having a fluorescent marker on an important cellular protein such as clathrin. This will allow for more visualization of endocytosis, and for the characterization of various proteins that are the cargo of endocytic vesicles.

Understanding endocytosis in

these organisms will allow for the development of a more complete insight of fungal growth and development. This knowledge could also be applied towards the disclosure of the mechanisms behind cellular polarity in other living organisms. If the mechanisms behind fungal growth are elucidated, this could mean great things for the control of pathogenic fungi, and in utilizing fungi for the improvement of bioproduct (e.g. pharmaceuticals) and biofuel production as well as other industrial processes.

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CREATION OF A KINETIC MODEL FOR LEARNING GROSS ANATOMY

ERICA MALONE

INTRODUCTION

From Charles F. Hoban Jr. and Samuel B Zisman's 1937 *Visualizing the Curriculum* to Edgar Dale's 1946 *Audio-Visual Methods in Teaching* and his Cone of Experience model, the ways in which people obtain and retain information have been consistently evaluated and ranked.¹ The above mentioned models were eventually merged to create "The Learning Pyramid." This educational model presents the ideas of active and passive learning. In the pyramid model, methods are ranked and arranged in the pyramid from the lowest percent of information retained to the highest. Learning by using passive methods means students retain far less information than when they use active learning methods [**FIGURE 1**].

This Learning Pyramid definitely applies to learning gross anatomy. While lectures and reading books may allow students to retain about 10% of the information, interacting with a kinetic model only once could allow them to simulate the real experience thereby retaining a much greater percentage of the information in one sitting.² A student who has fallen asleep on a book or in front of his computer is not a rare sight. Reading a text leaves a student open to distraction and, if the text is not of particular interest to the student, can easily put a student to sleep. Interacting with a model as well as interacting with other students can interest students



Adapted from: Edgar Dale Audio-Visual Methods in Teaching, Holt, Rinehart and Winston.

[FIGURE 1] The Learning Pyramid

and encourage comprehension.³ Providing resources which can serve as examples and comparisons can create a visual approach to aid in understanding abstract concepts such as schema of movement based on structural features.⁴

Why is movement such an important concept?

Anatomy is largely about structures—specifically, their location and relationship to other structures. Students are expected to identify bones, muscles, vessels, and organs. The practical application of this information to real-life situations, however, necessitates a basic understanding of how these individual structures cooperate to create physical movement and physiological functions.⁵ Often considered a "memorization course," full understanding and, thus, applicable knowledge of gross anatomy only comes after one is able to partner the name of a muscle with the movement produced. **[FIGURE 2]**

Let's use an example from veterinary medicine. Imagine that a client calls his veterinarian and explains that his dog is having trouble moving his front leg. The dog is able to stand on the leg and has some movement. The veterinarian needs to know which joint is affected (shoulder, elbow, digits) and if the dog is unable to flex or extend the joint. The veterinarian also needs to know which ligaments, blood vessels, nerves, and muscles are nearby in order to accurately diagnose and treat this pet.

Current visual aids used in teaching and learning gross anatomy

Understanding complex concepts such as the functional application of gross anatomy requires a student to visualize, mentally, what is being presented.⁶ Radiographs and the dissection of cadavers are two techniques frequently utilized in teaching and learning anatomy.³ To accompany dissection there are usually many diagrams and illustrations of what the structures should look like and where they should be in regard to other anatomical structures. All of these visual tools, (cadavers, radiographs and illustrations or diagrams), have been proven useful in learning anatomy.⁷ The main utility of these tools is often limited to identification. For the majority of students in a gross anatomy course the purpose of obtaining information
is to apply it to a living being. Cadavers, radiographs, illustrations, and diagrams lack the ability to convey many important aspects of working anatomy. While a living, breathing, animal or person is the best way to demonstrate the cooperative efforts anatomical structures, certain aspects of functional anatomy can be represented individually through kinetic models. [FIGURE 3 & 4]

METHODS

In order to create a working model of the canine thoracic limb which accurately demonstrates movement, basic structural components as well as supporting and moving elements of the limb had to be simulated. Being able to create what looks like an anatomical structure is not difficult as long as the model is not expected to work in *exactly* the same way as the real animal. Creating an anatomical model only on the basis of aesthetics is much less difficult than creating one which is also able to move. The material used to simulate bone must be able to withstand pressure from all angles while maintaining a small, delicate, appearance. Ligaments and tendons must also withstand pressure, but be able to give and stretch. Simulated muscles must allow for attachment of tendons, stretch and contract, and provide smooth, continuous motion. In order to meet these requirements, many materials had to be tested.

RESULTS

Following multiple tests for each component of the model the following materials were chosen:

- Bones: plastic casts made from Alumilite Super Plastic Casting resin and Alumilite "Quick Set" Mold Making Rubber
- 2. Ligaments: various widths and sizes of sewing elastic
- 3. Tendons: shoe laces dyed to match the color of the muscle and muscle group to which they correspond.
- 4. Muscles: latex balloons filled with a viscous compound made from glue, Borax and water.
- 5. Support: Sugru[®], a self-setting rubber; used to create origin and insertion points as well as hold some of the laces acting as tendons
- 6. Stand: plexiglass assembled by Acme Glass in College Station, Texas. The base of the stand was painted with acrylic paint and sealed. Magnets were affixed to the distal phalanges of two digits with super glue and epoxy in order to hold the limb in the proper position when it is not in motion.



[FIGURE 2] Diagram of the canine left pes. Original sketching by Erica Malone, vectorized by Annabelle Aymond.

Materials such as clay and plaster were tested for their ability to simulate bone, however they proved far too flimsy to withstand the necessary pushing, pulling, gluing, and drilling that the bones would have to endure. Furthermore these materials were not easily reproduced. If a portion of the model were to break or if the opportunity to replicate the model presented itself, we wanted to have an easy way to reproduce the different parts. Sand, flour and corn starch were among the materials tested in the balloon to act as the muscle body. While all of these materials would contract such as a muscle would, they held the contracted shape and did not relax back into the form a relaxed muscle would assume. These as well as the remainder of materials were chosen based on the least costly, but most effective simulation of the structure it was to represent [FIGURE 5].

"Learning by using passive methods means students retain far less information than when they use active learning methods."



[FIGURE 3] The model in action: cranial view of cubital joint flexion.

CONCLUSIONS

Careful design and many instances of trial and error were rewarded with the successful construction of a kinetic model of the canine thoracic limb. Upon interacting with the model proper movement could be simulated and concepts involving movement and gross anatomy could be illustrated. Functional success of the model was complemented by an accurate and aesthetically pleasing visual representation of the thoracic limb.

Future research involved with this model will include user studies in which students of many different backgrounds and levels of understanding in gross anatomy will interact

with the simulated limb. These user studies, both questionnaires and student interviews, will not only serve to demonstrate whether or not the visual and tactile representation of movement helps the students to understand and learn, but also provide us with information helpful in improving the model. Areas of the model where the physical construction or movement is problematic will become apparent following student use. As students who are already familiar with gross anatomy explore the movement of the model anatomical inaccuracies will also become apparent and be addressed in future models.

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[FIGURE 4] The model in action: lateral view of flexion of the digit.



[FIGURE 5] Students in VIBS 305 interacting with the model.

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SALINE IRRIGATION WATER IN URBAN AREAS POSES PROBLEMS FOR VEGETATION MANAGEMENT

INTRODUCTION

Soil salinization is often associated with water scarcity, an increasing problem affecting people around the world. Due to water shortages and high groundwater extraction rates in Texas, many municipalities have now resorted to using low quality, high sodium (saline) water in their water system, a practice which is discouraged worldwide.^{1,2} For example, College Station, Texas extracts groundwater from 8 wells in the Carrizo-Wilcox, an aquifer formed at the transition zone of the Gulf of Mexico in the Tertiary Period.³ As municipal water demands are projected to increase in Texas, the sodium concentration in aquifer water is also expected to increase with the need to explore deeper water sources in the future.

Unpredictable weather and inconsistent rainfall will impact our state as Texas wildlands and agricultural lands are urbanized. Increased urbanization is known to cause dramatic warming and drastic local temperature swings. Warmer temperatures cause plants to require more water, increase water consumption by cities, and increase reliance on sodium rich water sources. These factors increase stress on urban plants.

Application of highly saline water to any soil degrades structure, disperses particles, and can make a soil intolerable to many plants. This type of degradation is a growing global problem due to urbanization and irrigation.⁴ Sodium content of water is the most important predictor of exchangeable sodium accumulation in soil.^{2,5} Reversing the effects of high sodium irrigation water requires the application of clean water that washes the sodium from the soil. The adoption of alternative irrigation techniques to reduce soil sodium content at a large scale could assist in reducing landscape maintenance costs, assist in the creation of more attractive urban environments, and help maintain urban trees.

Watering techniques and engineering solutions exist to ameliorate these issues. Rain harvesting systems (RHS) offer an engineering solution that would mitigate the effects of long term usage of highly saline waters on our communities. RHS will reduce injury of urban trees and plants due to saline water and improve the soil environment.

BACKGROUND AND PROBLEM

To counteract the warming effect of urban sprawl, shade trees have been used to cool surrounding surfaces, remove carbon from the atmosphere, and improve human well-being. However, urbanized cityscapes irrigated with sodium laden water can be a difficult place for trees to survive. Lawns and shrubs are usually dependent on irrigation, but trees can tap into deeper water sources and survive on little to no irrigation. As urban

"Salt stress causes injury, reduced growth, and results in sparse, stunted or abnormal leaves and overall shape."

MARCO NEFTALI MINOR

areas generate and trap more heat and reflect more light than natural areas, moisture is lost more quickly in city environments than in forest or grassland due to the urban heat island effect. Urban plantings are often completely dependent on irrigation for water needs because urban hot spots encourage rapid evapotranspiration rates from vegetation and soil. Shallow rooted plants require high levels of irrigation in these environments to survive. Persistent irrigation techniques, though beneficial for shallow rooted vegetation, are applied at the expense of urban trees. In addition, large areas of impermeable surfaces cause rapid runoff of rainwater that would normally filter down through the soil.

Common watering techniques used to keep lawns green often lead to the formation of dispersed salt affected soil beneath the surface. Landscapers are forced to water continuously to leech out accumulated salts at the soil surface and allow grass to grow. The effect of repeated irrigation causes water logging in salt affected soils. Saturated soil conditions reduces shoot growth in ornamentals such as American elm (Ulmus americana L.), bur oak (Quercus macrocarpa Michx.), and winged elm (Ulmus alata Michx.).6

Although turfgrass can handle high levels of salinity, most urban trees cannot. Salt stress causes injury, reduced growth, and results in sparse, stunted or abnormal leaves and overall shape. Trees in salt affected soils showed deficiencies in essential nutrients such as iron and zinc. Salinity exposure has been shown to decrease growth in common Texas ornamental trees such as: bald cypress (*Taxodium distichum* (L.) Rich.), American sycamore (*Plantanus occidentalis* L.), and red maple (*Acer rubrum* L.).⁶

METHODS

GPS referenced soil samples were acquired during July 2013 and again in February 2014 in the middle of the day at the edge of the dripline of prominent live oak (*Quercus virginiana* Mill.).

Live oak is considered tolerant of salt spray and saline soils. It is one of the few species of oak that can grow well in our urban soils; thus a number of live oaks were chosen for soil data acquisition. A soil auger was used at each location [FIGURE 1] and samples were separated into 0-30cm, 30-60cm, and 60-90cm sample groups. Measurements of soil and water salinity/nutrients were performed by the Nutrient and Water Analysis Laboratory at Texas A&M soil laboratories. Soil pH, electrical conductivity, and SAR were measured in the summer group, but only soil pH and electrical conductivity were measured in the winter group. Electrical conductivity can be used as a measure of salinity. Solutions to mitigate the effects of soil salinity were then explored and water quality sources were compared.

RESULTS AND DISCUSSION

Irrigation water content has been measured in measured on the Texas A&M campus and compared to published water quality reports and typical rainwater chemistries. Sodium and calcium concentrations of water being applied in summer 2013 was



[FIGURE 1] A map of all locations where soil samples have been taken.

shown to be above 200mg/L and 2.24mg/L respectively. The College Station Utilities 2012 Drinking Water Quality Report shows concentrations of ~190mg/L and ~2.8mg/L which correspond with the levels of sodium and calcium in the water we have measured in irrigation water summer 2013.7 These measured levels are not extreme in comparison to West Texas counties where sodium concentrations reach beyond 1,000 mg/L in El Paso, Texas.³ However, they are an example of the higher sodium concentrations recorded in the state.² The National Atmospheric Deposition Program/ NTN measured precipitation chemistry at the nearby Attwater Prairie Chicken National Wildlife Refuge. The weighted mean concentration of seasonal precipitation of sodium and calcium concentrations was 0.307mg/L and 0.129mg/L in 2012.⁸ This data shows that sodium and calcium deposition from rain would be much lower than from irrigation water sources at the Texas A&M campus. Weather patterns during 2013 provided by the National Oceanic and Atmospheric Administration indicate below normal rainfall in the summer months and

record high temperatures, which had caused irrigation water to evaporate quickly and pull sodium upwards through the soil profile by capillary flow. Although extreme, these weather events illustrate the harshness of the urban environment that our trees must face.

Soil analysis of our samples underneath urban trees on the Texas A&M campus have indicated high levels of sodium in the soil in summer months due to extensive irrigation after and during Texas droughts. Each location measured in the summer had a measured pH of above 10.0 in the upper soil profile and moderate low to high electrical conductivity, indicating high sodium levels. A comparison of pH measurements between the Brazos County Soil Survey,⁹ unirrigated soil, soils near to irrigation, soils that are irrigated, and the average of soil samples collected in the summer can be seen in [FIGURE 2]. The application of sodium laden irrigation water to already alkali soils increased the pH dramatically, greater than 9.5, producing soil as basic as an antacid tablet. High soil pH also affects nutrient mobility to vegetation. The 2012 Drinking Water Quality Report measured a pH of 8.5 from samples in 2011. Rainwater generally has a pH less than or equal to 7 and contains only trace amounts of sodium. Measurements taken at the Attwater Prairie Chicken National Wildlife Refuge showed rainwater had a weighted average pH of 5.04 in 2012.⁸

Electrical conductivity measurements showed a dramatic difference between the heavily irrigated soil samples taken in the summer, compared to the samples taken in the winter [FIGURE 3]. Normal rainfall patterns coupled with low to zero irrigation had produced electrical conductivity far below that of the samples taken during the summer, where drought conditions and high irrigation had resulted in massive accumulation of sodium. The United States Department of Agriculture National Resources Conservation Service (NRCS) soil survey does not currently provide pH and electrical conductivity information for soils heavily influenced by urban irrigation due to urban soil characteristic variability; however, comparisons of historical and modern soil properties are possible.

How do we prevent sodium

"Increasingly toxic water sources are making it difficult for landscape managers to irrigate their lands."

build up in soils when watering is necessary during drought and periods of high temperatures? One possible solution is to minimize the amount of saline irrigation water that it directed towards the base of trees. Irrigation methods that are designed for maintenance of turfgrass are nearly always excessive relative to the amount needed to support nearby trees. Adjusting irrigation heads so that water is directed away from tree trunks is a simple method of reducing salt buildup in a rooting zone [FIGURE 3]. In addition, it would reduce the area covered by irrigation, potentially saving water and money.

Another solution to reduce stress on the trees and lawns, and also to save water is the installation of rainwater harvesting systems (RHS). As described by William Hall Saour's Undergraduate Research Scholar Senior Scholars Thesis, using RHS on 42 buildings on the Texas A&M University campus



[FIGURE 2] A comparison of pH values shows an increase with proximity to irrigation.

could save 60,850,000 gallons of water per year with a cost saving of over \$406,000 per year.⁴ In addition, RHS systems have a positive impact by reducing sodium laden runoff to nearby streams. His framework would allow for potable water to be pumped through the system once the rain water runs out. Although not a permanent solution, use of RHS when available would be a better alternative than not using it at all. During high rainfall years, RHS application could help wash out accumulated sodium, improving lawn and tree growth. Use of rainwater from RHS systems aims to reduce soil dispersion. encourage formation of structure, and leech out sodium from the soil profile. Technical guidance. descriptions of legal compliance, and descriptions of further benefits for RHS management are readily provided by the EPA.¹⁰

This is an opportunity to conserve water and reduce costs in the long run across the state, particularly in municipalities that pull groundwater from the Carrizo-Wilcox aquifer. By increasing the cooling effectiveness of shade trees by improving crown quality, the need to purchase new trees to replace salt damaged shade trees and tree-care costs are reduced.

Although harvested water may not be sufficient for summer usage, it would ameliorate some of the damage that soils have accumulated. With increasing urbanization across Texas, opportunities to maximize water use efficiency with Rainwater Harvesting Systems exist.

CONCLUSION

Irrigation with sodium-laden ground water is causing urban soils to accumulate sodium and become increasingly unsuitable for vegetation growth. It is critical that Texans adapt to changing climate and water availability by applying creative water usage techniques. Increasingly toxic water sources are making it difficult for landscape managers to irrigate their lands. With water scarcity commonplace, engineering solutions are available to mitigate the effects of water scarcity. Creation of a Rain Water Harvesting System would help us take advantage of high rainfall events and extend the application of rainwater to urban soils, thus improving the overall quality of water applied to the landscape.

Future projects would involve the creation of a complete map of the effects of irrigation on urban soil properties that would be updated vear after year. Municipalities that pull ground water from the Carrizo-Wilcox Aquifer would be of great interest to study as we move on into the future. Another project would be to prove that water usage of water from an RHS system is more beneficial to the landscape and is cost effective to maintain compared to standard ground water irrigation techniques. Other experiments would be able to quantify the beneficial environmental effects of water from rainwater harvesting systems.

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[FIGURE 3] Proximity to irrigation showed an increase in TDS in soil samples taken in February. Heavy irrigation coupled with little rainfall in summer months led to accumulated TDS up to four times the amounts measured in February.

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ALTERNATIVE CURES FOR A SILENT KILLER

RACHAEL MUSCHALEK

INTRODUCTION

A cerebral aneurysm is a weakening of a blood vessel wall in the brain that allows localized extension and ballooning of the blood vessel. Aneurysms are susceptible to rupturing, causing what is known as an intracranial hemorrhage, or bleeding in the brain. According to the National Institute of Neurological Diseases and Stroke, 30,000 aneurysms rupture in the United States every year¹ and approximately 3 to 5 million people in America have or will develop an aneurysm in their lifetime.²

Current aneurysm treatments include surgical clipping and the endovascular ("through the blood vessels") delivery of platinum coils to embolize, or "plug up" the aneurysm.¹ Surgical clipping is the primary treatment for aneurysms today and includes a craniotomy, or open brain surgery, and although proven effective, it is obviously extremely invasive.² Endovascular embolization involves introducing foreign material into the blood vessel, causing blood to clot in that area, thus filling the aneurysm site and restoring normal blood flow in the brain's blood vessels. The current standard for embolization utilizes platinum coils to obstruct the aneurysm and promote clotting within the ballooned vessel.³ Issues with platinum coils include material cost (platinum is extremely rare and very expensive) and a significant incidence of retreatments due to coil packing (or "shrinking of the plug") over time. Hydrogel coated platinum wires were developed to reduce aneurysm recurrence rates⁴ and are the intermediary device between the "old" platinum coils embolism treatments and the newly developed nickeltitanium (nitinol) alloy backbone with shape memory polymer coated treatment. Endovascular embolization is now the preferred treatment for many patients⁵ and the new device concept of the Biomedical Device Laboratory at Texas A&M University is attempting to optimize this treatment. This new aneurysm treatment, along with early detection methods, could decrease the rates of retreatment of an aneurysm and in doing so, save millions of lives.

The new endovascular embolism device uses ultra-low density polyurethane shape memory polymer (SMP) foams adhered to a nickel-titanium alloy (nitinol) backbone to occlude the aneurysm.⁶ SMPs are a class

of smart materials that are capable of deforming to a stable secondary shape and recovering to a primary form (hence "shape memory") when exposed to a particular stimulus, such as heat. This property allows for the delivery of a compressed foam to the aneurysm site via micro-catheterization and for consistent, high recovery rates once positioned. See [FIGURE 1] for a schematic representation.

The previous protocol for attaching the SMP foams to the backbone wire was to mechanically crimp and attach the foam directly to the wire at both ends using epoxy, thus setting the secondary shape of the SMP around the wire. Using this process, the foams had a tendency to slip along the wire and cause multiple problems during delivery of the device to the aneurysm site. For instance, epoxy could be detrimental to the device because of a lack of biocompatibility, which is an adverse response of the body to a foreign device being inserted that compromises the success of the device. Additionally, the use of adhesive increases the minimum compressed diameter of the foam over the wire, and within a micro catheter, space is key. This entire process of attaching foam to a wire was extremely tedious and required significant optimization. The method described hereafter is a significant improvement due to the creation of a seamless interface between the backbone wire and SMP foam.

"This new aneurysm treatment, along with early detection methods, could decrease the rates of retreatment of an aneurysm and in doing so, save millions of lives."

METHODS

The new process synthesizes the foams directly over the backbone wire, while maintaining the properties of the foams. Think of how rock candy is "grown" on the stick. If we "seed" a polymer similar to the foam onto the wire, we can "grow" SMP foams onto the backbone wire instead of attaching them later. The foam/wire



[FIGURE 1] Schematic representation of the shape memory behavior of our polymers.

complex would then be cut to the desired diameter using an Excimer Laser or biopsy punch, and crimped to the smallest possible diameter in order to be fed into the delivery catheter. This eliminates the need to optimize the process of attaching the foam to the wire and eliminates multiple issues within the device design and fabrication.

Foam/wire samples were created with a varying concentration of the base chemical in order to ensure consistency in the fabrication method across a range of SMP foam compositions. Once samples were created, microscope images were taken in order to determine the quality of foam adherence. Once a standard procedure was developed for foaming over wire (including optimization of a coating process, and a means of securing the wires within the foaming vessel) samples were created for further testing. To ensure the foam itself was not compromised by our process, three variables were tested to ensure homogenous foam surrounding the wire. Parameters tested were foam cell size, density, and dry volume expansion. Together these parameters would show that the foam "grown" on the wire was of equal quality as the previous standard. Also the maximum change in diameter added by the polymer coating on the wire was examined using Scanning Electron Microscopy techniques to ensure a sufficiently small diameter was still possible when crimping.

We calculated foam density to ensure production of the ultra-low densities seen in the previous foam compositions and protocols. We achieved this outcome by cutting small foam samples from the middle of the foam, far enough away from any backbone wires so that the properties might not be compromised (bulk foam), as well as foam within the vicinity of the wire (Foam over wire (FOW) samples). We found this volume as an average of three measurements for each dimension per sample. The samples were then massed, and the density was calculated. The bulk foam was then compared to the foam from the vicinity of the wire (within 2mm) and a ratio was calculated in order to quantify how similar/dissimilar the samples were. Cell images were taken using a microscope from a piece of foam approximately one cell thick cut transversely to the axis of foaming. The diameter of a specific cell was measured from the collected images, and the diameter of 15 cells/image was used for the analysis. For non-circular cells, diameters were taken at the longest point between two walls. Calculations assume perfectly circular cell sizes. Pore sizes were then calculated

To calculate the dry volume expansion, we cut wire samples from the foam, creating cylindrical samples having a diameter of 6mm and a height of 4cm. The foams were radially crimped using a stent crimper to the smallest possible diameter. This step was done by at 100°C while in the primary shape for 20 minutes, then crimping to the smallest possible diameter and cooling, thus setting the secondary morphology. An image was taken using the microscope and analyzed for the diameter using Image J software. The samples were then allowed to sit at 100°C for 20 minutes in an oven, and allowed to cool to room temperatures, thus providing the energy to transfer back into the primary shape. In this case, the foams expanded from the crimped diameter back into their original shape. Once cooled, the samples were again imaged and analyzed for the final diameter. Finally, the volume expansion was calculated.

RESULTS

Results have shown the maintenance of low-density foams within the vicinity of the wire, with an average foam-wire to bulk foam density ratio of 1.014 across the range of chemical compositions. This shows that there is a slight increase in the density of the foam surrounding the wire, but it is maintained acceptably low. Average Cell size data can be seen in **[FIGURE 2]**.

The figure above shows that, on average, the cell sizes of the foams are slightly smaller around the wire, but have maintained fairly similar size in most compositions. Results of the volume recovery tests





Compositions

[FIGURE 2] The results of the foam over wire pore size experiment separated by IPDI content, compared to the bulk pore size.

show that the process by which the specimens are cut out of the bulk foam may require some refining. Since the samples were cut using a biopsy punch, for simplicity, it was impossible to maintain the wire in the perfect center of the punch, thus changing the area of foam on either side of the wire, which also changes the crimped diameter.

CONCLUSIONS

In conclusion, we confirmed the ability to synthesize a variety of shape memory polymer (SMP) foams directly to a nitinol wire. A low foam density was attained and pore size was not significantly changed by the addition of a polymer-coated wire. More tests are required to precisely quantify the homogeneity of the foam/wire adherence, but this work was a successful change in the aneurysm occlusion device fabrication protocol.

The ability to synthesize SMP foams onto a nitinol wire without changing the qualities of the foam itself is a simple improvement that will affect millions of aneurysm patients by increasing the efficacy and safety of the SMP device, simplifying the production process and speeding the availability of this life-saving treatment. If the Aggies at the Biomedical Device Lab have their way, the world will soon have an improved weapon in its fight against the silent killers known as cerebral aneurysms.

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EXPLORATIONS BOARD MEMBERS



Michael Boachie-Mensah



Haleluya Chamiso



Aaron Griffin

Michael Boachie-Mensah is

a sophomore Biology major from Alexandria, Virginia. Boachie-Mensah plans to attend medical school and become a physician. Boachie-Mensah appreciates music, as it allows him to both express himself and understand the perspectives of others. Boachie-Mensah feels that getting involved in undergraduate research and scholarly work is a must, especially at an institution like Texas A&M, where countless opportunities are available.

interdisciplinary environment

is never seen more clearly

than in undergraduate

research and scholarly work.

Aaron Griffin is a senior

Biochemistry and Genetics major, with minors in

Chemistry and Mathematics,

from Missouri City, Texas.

After graduating, Griffin

plans to attend medical

school and graduate school to

study cancer cell biology and

pursue a career as a physician

scientist. Griffin is driven

by a passion for translating

simple scientific discoveries in a research setting into

advancements that can change

lives and make the world a

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better place.

Computer



Aida Guhlin



Teresa Hall



William Linz

Aida Guhlin is a junior Geography major, with minors in English and Sociology, from San Antonio, Texas. After graduating, Guhlin plans to pursue graduate studies in the field of medical geography, one day working at the CDC or WHO in the hopes of tracking and slowing the spread of epidemics across the globe. Guhlin is motivated by the desire to learn and make the world a better place, and feels that undergraduate research is one of the best ways to combine these two passions.

Teresa Hall is a junior **Biochemistry and Genetics** major from New Braunfels. Texas. Hall plans to attend medical school and pursue a career in obstetrics and gynecology. For Hall, serving as an editor for *Explorations* allows her to see what her fellow undergraduates are passionate about and the academic activities into which they pour their hearts.

William Linz is a senior Mathematics major, with a minor in German, from Temple, Texas. Linz plans to pursue graduate studies in pure mathematics and pursue a career in mathematical research. Linz is driven by a passion for knowledge and a desire to understand the inner workings of all things. Linz feels that undergraduate research and scholarly work provides students with a way communicate their knowledge on both a specialized and general level.



Connor McBroom

Connor McBroom is a senior Biochemistry, Genetics, and Chemistry major from Missouri City, Texas. McBroom plans to further his education with doctoral studies in either medicine or science. McBroom feels that undergraduate research and scholarly work involves not just drawing up a plan of action for investigating a particular scientific or academic concept. but involves developing a different way of looking at the problem, and can help people see life in new and exciting ways.



Corey Smith

Corey Smith is a junior Civil Engineering major, with a minor in French, from Friendswood, Texas. Smith plans to travel abroad to design infrastructure for disadvantaged communities. Smith hopes to one day combine his love for traveling, writing and engineering to make the world a better place. Smith believes that that everyone can benefit from the opportunities to learn, experience, and network that undergraduate research and



Matthew McMahon

Matthew McMahon is a senior Geology major, with a minor in Mathematics, from Chana, Illinois. McMahon plans to attend graduate school and earn his doctoral degree studying materials science. McMahon is passionate about chemistry and Earth science, especially with regard to how they relate to environmentalism and human health. McMahon believes that finding one's academic path is of utmost importance for an undergraduate, and that engaging in research and scholarly work can help students identify their passions.



Jason Szafron

scholarly work provides. Iason Szafron is a senior **Biomedical Engineering major** from Houston, Texas. After graduating, Szafron plans to attend graduate school and earn his doctoral degree, after which he will pursue a career as a research scientist. Szafran is passionate about taking an idea from the drawing board and seeing it brought to life, and believes that this "learning by doing" mentality is something undergraduates can embrace through undergraduate research and scholarly work.



Marc Rauckhorst

Marc Rauckhorst is a senior Economics major, with minors in English and History, from Silver Lake, Ohio. Rauckhorst hopes to eventually go to graduate school and obtain his Masters in Behavioral Economics. Rauckhorst believes that ambition, creativity, and empathy should be the goal of any world class education, and feels that undergraduate research is essential for training and inspiring the next generation of scientists, engineers, and researchers.



Bailey Woods

Bailey Woods is a sophomore English major from Fort Worth, Texas. Woods plans to attend graduate school and earn her Masters in Education, followed by a Doctorate of Philosophy in English. Woods finds inspiration for her writing during her time spent hiking and camping in nature. Woods believes that undergraduate research and scholarly work furthers students' ability to think creatively and critically, which will benefit them no matter where they find themselves.

EXPLORATIONS VOLUME 6 AUTHORS



Micaela Allen

Micaela Allen is a sophomore Environmental Design major from Round Rock. Texas. Allen's future plans include participating in an archaeological excavation on the island of Crete and continuing to feed her passion for architecture and history. Allen's inspiration for her project is derived from her fascination with the interplay between architectural wonders, like the Parthenon. and the people that occupy them.



Morganne Blackstock

Morganne Blackstock is a junior Kinesiology major from Flower Mound, Texas. Blackstock plans on attending Occupational Therapy school. Blackstock's article explores the link between an individual's psychological disposition and their cellular phone usage as a medium of interpersonal communication.



William Thomas Allen

William Thomas Allen is a senior Agricultural Economics major from Dalhart, Texas. After graduating, Allen plans to apply his agricultural education and work with the JBS Five Rivers Cattle Feeding LLC. Allen's article explores the value of water as it applies to applications such as agricultural development, hydraulic fracturing, and municipal use.



Jordan Cazamias

Jordan Cazamias is a junior Computer Science and Applied Mathematical Sciences double major from The Woodlands, Texas. Cazamias plans to pursue a Masters in Computer Science, followed by graduate studies or a career in Research and Development. Cazamias has a passion for studying Artificial Intelligence and Machine Learning, and believes that shape grammars hold promise for advancing these fields.



Christopher Black

Christopher Black is a senior Philosophy major from Irving, Texas. Black intends to pursue graduate work studying philosophy. Black wrote his piece to serve as a social critique, attempting to elucidate the way of thinking that defines a generation he feels has lost a sense of spirit and mystery in the asphyxiating cloud of scientific progress.



Julia Cisneros

Julia Cisneros is a junior Geology major from Pflugerville, Texas and plans to attend graduate school to pursue a doctorate. Cisneros' passion for astronomy is highlighted in her research, in which her connection with NASA through her research mentor allowed her to craft her own project, one which seeks to describe the parallels between the effect of wind flow on the geological features of Earth and Titan.



Kaylee Davis

Kaylee Davis is a senior Biology major from Stephenville, Texas. Following graduation, Davis plans to enter medical school. Davis has been working with bats for three years, stating that their graceful acts of group echolocation fascinate her. Davis is an Undergraduate Research Scholar.



Katherine Elmer

Katherine Elmer is a senior Health and Kinesiology major from Pleasanton, Texas. After graduating, Elmer plans to pursue a Doctorate of Physical Therapy at Texas State University. The inspiration for Elmer's article arises from a combination of her passion for the biomedical sciences and her fascination with the exploration of space by human beings.



Saad Dawoodi

Saad Dawoodi is a senior Architecture major from Hyderabad, Pakistan. After graduating, Dawoodi plans to enter medical school. Dawoodi's article uses the work of Shanzia Sikander as a platform to explore the concept that identity is more than simply a collection of innate attributes.



Ashley Fox

Ashley Fox is a junior Kinesiology major from Helotes, Texas. After graduating, Fox plans to attend graduate school where she will obtain a Masters in Occupational Therapy and a Doctorate in Physical Therapy. With her education, Fox plans to live out her dream of improving the lives of others as an Occupational and Physical Therapist.



Abigail Demiano

Abigail Demiano is a junior Health major from Houston, Texas. Demiano intends to pursue a career as a Physician Assistant after graduating. Demiano says the motivation for her research arose from the realization that cellular phones play a large role in the lives of teens today, representing an exciting new avenue of psychological study.



Neddie Ann French

Neddie Ann French is a senior English major from Katy, Texas. French's piece was inspired by her mentor, Dr. Marian Eide, and focuses on the ability of the second-person to manipulate the relationship between the reader and the narrator, which allows for a level of witnessing not usually accessible in trauma stories. French plans to pursue a Masters in Education so that she may start a career as a high school English teacher.



Alexandra Frenzel

Alexandra Frenzel is a junior Geology major from Sugar Land, Texas. Frenzel's motivation for her piece came from her dual interests in Baroque architecture and geological science, and more specifically how the two are intertwined. In the future, Frenzel plans to shift her research to focus on understanding other Baroque structures through symbolism and geology.



Alyssa Nicole Mangan-Reta

Alyssa Nicole Mangan-Reta is a senior Biology major from San Antonio, Texas. Mangan-Reta plans to pursue a medical degree and specialize in reconstructive orthopedics or plastic surgery. Mangan-Reta's creative piece utilizes fluorescence microscopy to unveil a complex microscopic world that is both intellectually interesting and beautiful.



Tyler Johnson

Tyler Johnson is a senior Microbiology and Biological and Agricultural Engineering major from Irving, Texas. After graduating, Johnson plans to pursue graduate studies in biology or environmental science. Johnson hopes to one day make a career in academia, teaching and performing research in areas such as biofuels, plant-microbe interactions, or climate change.



Jonathan Martinez

Jonathan Martinez is a junior Technology Management major from San Antonio, Texas. Following graduation, Martinez plans to pursue a degree in audio engineering and produce and sell a line of music production software and hardware. Martinez has a strong passion for music, and strives to assist others in truly enjoying the musical experience.



Erica Malone

Erica Malone is a senior Biomedical Science major from Waxahachie, Texas. Following graduation, Malone plans to pursue a Masters in Visualization in collaboration with the College of Veterinary Medicine. Malone has a passion for combining art, technology, and anatomical information to create tools for learning that engage the student in active education.



Marco Neftali Minor

Marco Neftali Minor is a senior Ecosystem Science Management major and from Harlingen, Texas. After graduating, Minor plans to pursue a career in forest ecology with the purpose of managing, conserving, and restoring forest ecosystems. Minor's article on the construction of rainwater harvesting systems may one day help to boost urban ecosystems and enrich the soil of cities.



Rachael Muschalek

Rachael Muschalek is a senior Biomedical Engineering major from New Braunfels, Texas. Muschalek plans to pursue a Master's degree in biomedical engineering and perform scientific research internationally. Muschalek's work with the **Biomedical Device Laboratory** at Texas A&M University focuses on streamlining the manufacturing process of an aneurysm-occlusion device, the employment of which may one day save numerous lives.



Jessica Smarr

Jessica Smarr is a senior Psychology major from Llano, Texas. Smarr plans to attend the Texas A&M School of Public Health and pursue a career in community health outreach, focusing specifically adolescent health on communication. Smarr's work explores the social connection between obesity and perceived immorality, and how it affects overweight individuals in America's justice system.



Nandini Patel

Nandini Patel is a junior Biology major from Allen, Texas. After graduating, Patel plans to pursue a graduate degree in the biological sciences and work in industry. Patel's creative piece combines her love of photography and life science as her use of fluorescence microscopy captures the intrinsic visual confection of the microscopic world



Zachary Steelman

Zachary Steelman is a senior Biomedical Engineering major from Clear Lake, Texas. Steelman plans to pursue graduate studies in biomedical engineering, with a special emphasis in biomedical optics. Steelman's article focuses on the use of Brillouin spectroscopy to detect bacterial meningitis, a technique that might one day aid doctors in the detection of this dangerous illness.



Manzil Quadir

Manzil Quadir is a senior Biomedical Sciences major and an Anthropology minor from Houston, Texas. Following graduation, Quadir plans to attend medical school and pursue a career in the field of cardiology. Quadir believes that the art of photography gracefully mirrors the gravity of natural beauty, the depth of human relationships, and the wisdom of moments. and has the power to bring people closer together as they share its beauty.



Brett Washburn

Brett Washburn is a senior History major from Montgomery, Texas. Washburn wishes to pursue graduate work in historical studies. Washburn's study into the role of baseball in the Japanese confinement camps during the WWII era was motivated by both his passion for the sport and a desire to accurately capture the experiences of the men and women who lived in the confinement camps during this period of history.

EXPLORATIONS ANNUAL COVER ART CONTEST

Each summer, typically beginning in June and spanning a month's time, *Explorations* hosts a cover art contest to challenge students to create the next volume's cover art. Based on certain colorful articles in the up-and-coming journal release, the contest participants are given a theme to base their submission on, and winners not only have their art displayed in the journal, but also receive monetary awards of either \$100, \$50, or \$25. Submissions go through rigorous review by the *Explorations* team and are tested for printability before winners are notified in late July or early August.

Congratulations to the Volume 6 Cover Art Contest Winners!

Rebekah Huerta, 1st place Shutong Liu, 2nd place Jo Chan Kim, 3rd place





Rebekah Huerta

Rebekah Huerta is a senior Visualization major from Round Rock, Texas. Huerta's inspiration stems from the article Sand Dunes: The Clue to Titan's Climate, as well as a child-like vision of descending into Titan's atmosphere. After graduation, Huerta hopes to work as a graphic designer and to continue her music studies.







Shutong Liu

Shutong Liu is a junior Civil Engineering major from Baoding, China. Liu's piece was inspired by the vastness and haziness of the moon, Titan, and how much Titan resembles the planet Earth. After graduation, Liu plans to pursue a graduate degree in Vizualization.





Jo Chan Kim

Jo Chan Kim is a sophomore Environmental Design major from Coppell, Texas. Kim's inspiration for his submission was the article, Sand Dunes: The Clue to Titan's Climate. Kim hopes to find a future career that he can truly enjoy.





GUIDELINES FOR SUBMISSIONS

WHO CAN SUBMIT A PROPOSAL?

Any undergraduate student currently enrolled at Texas A&M University who is actively pursuing research, creative, or scholarly work or has done so in the past can submit a proposal. All submissions must be sponsored or endorsed by a faculty member at Texas A&M University. *Explorations* publishes student research and scholarly work from all disciplines.



FORMAT FOR PROPOSALS

When submitting your proposal for consideration, please include the following:

- Name
- Email address
- Phone number
- Department
- Classification
- Area of research
- Name and contact information of your faculty advisor/mentor
- Title of the proposed project
- Your contribution or role in the research
- An abstract of no more than 250 words. The proposal should provide an overview of the project's objectives and methods. It should also include a description of the project's importance to the student's field of study and to others outside the field.

NOTE: Because *Explorations* is a multi-disciplinary journal targeting a general audience, please use non-technical language in your proposal. Necessary technical words must be defined.

The deadline for submissions is to be announced, however, submissions are typically welcome at the end of the fall semester. For more information, please visit **explorations.tamu.edu**.

FORMAT FOR CREATIVE WORKS

- Only one submission per student
- All creative work requires a faculty endorsement. A faculty member in the field of your work must approve your piece for publication in a serious scholarly journal. If you have difficulty locating a faculty member to review your work, *Explorations* may be able to provide suggestions.
- All genres of creative work are welcome, however, due to the requirement for faculty endorsement, please remember that your submission should relate to creative work currently being taught at the university.
- Your work must be accompanied by a descriptive sidebar of 500-700 words. The sidebar must include:
 - Why did you choose this topic?
 - Who are your creative influences?
 - How does this style or medium help you to communicate your idea?
 - What studies were done to develop your piece? How did they contribute to its persuasiveness, depth, vision or styling?
- Please limit prose and poetry submissions to 3500 words. This word limit includes your scholarly sidebar, a minimum of 500 words.



TO JOIN EXPLORATIONS

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If you are a freshman or sophomore, you are welcome to apply for consideration as an editorial board member, which is our first year member program that will teach editors the basics on what goes into creating a yearly journal such as *Explorations*. Exemplary members of the editorial board will be invited to join the executive board after their first year, or members can remain a part of the editorial board if they wish.

If you are an upperclassman, you are welcome to apply for an executive board position; be aware, however, that first priority is given to editorial board members in filling executive board positions.

Applications for the editorial board, executive board, and layout and design team are made available at the beginning of each fall semester.

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