INCITE

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Cook-Cole College of Arts & Sciences
Longwood University

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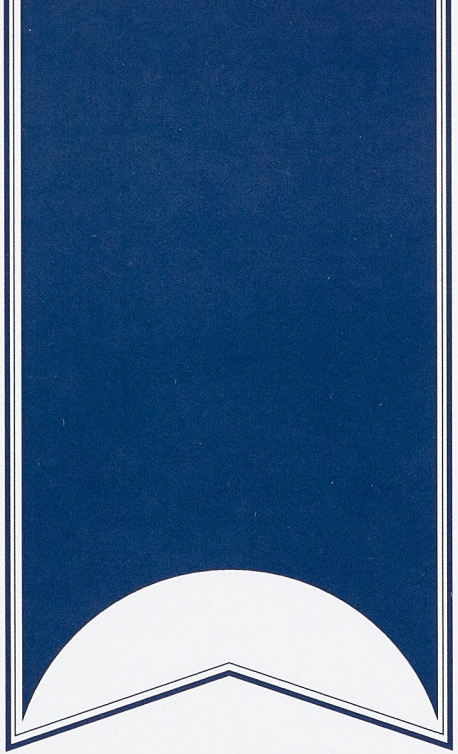

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Dr. Charles Ross, Dean, Cook-Cole College of Arts and Sciences

Introduction from the Dean

It is my pleasure to welcome you to the fifth edition of *Incite*. In this journal you will find wonderful examples of the undergraduate research and creative activity in the Cook-Cole College of Arts and Sciences at Longwood University. The faculty of the college and I are extremely pleased to be able share the work of our students with you.

Longwood University has a tradition of cultivating a stimulating and effective learning environment through the dedication of our faculty and the close personal attention they give each student. This tradition is amplified and enhanced by the scholarly and creative work of our faculty as they explore new ideas and techniques in their disciplines.

In *Incite* you will find some of the results of our efforts to give our students the opportunity to become scholars in their disciplines. In our college, we are making an effort to give as many students as possible the chance to experience the excitement of generating ideas and creative works that are not only new to the student involved but to the discipline as well. We feel that when a student has the chance to stretch his or her abilities by working closely with a faculty member on a rigorous project, it is the perfect complement to the college's excellent classroom instruction.

Our mission is to provide our students with both a solid liberal arts foundation and a deep understanding of their chosen discipline. I believe that *Incite* provides solid evidence that we are achieving our mission. We also hope that our students and faculty find a love of learning that lasts a lifetime and that the collaborations highlighted in these pages are just first of many such explorations to come for all involved.

Thank you for your interest in our students and for taking the time to investigate what they have created. In addition to thanking the student authors and artists, our faculty advisory board and our editors, I must express extreme gratitude to the students of the Design Lab who crafted and produced the beautiful work that you now hold in your hands.

The Tallis House as an Extension of Emily Tallis in McEwan's *Atonement*

Ian Karamarkovich

Dr. Gordon Van Ness, faculty advisor

Homes speak volumes about their occupants. Individuals bleed their qualities into their homes through conscious or subliminal choices: Architectural style and location "symbolically suggest [...] social class, personality, [...] and personal background" (Aragonés et al). The same osmotic process occurs in reverse, however; the house rubs off on its inhabitants just as noticeably. In Ian McEwan's 2001 novel Atonement, Emily Tallis, an upper-middle class mother of three, living in rural, World War II-era England, experiences these interactions. Her home, a "bright orange brick, squat, lead-paned baronial Gothic," is not just a reflection of Mrs. Tallis, but is also an extension of herself that she uses in her husband's absence to further her own interests and ideals (McEwan 18). McEwan uses Emily's relationship with the house to demonstrate that the histories of habitations and people regularly amalgamate to create new incarnations of each that significantly affect the outcome of events in which they are involved.

Inherited from the paternal side of the family, the Tallis property was originally purchased by Jack's grandfather, who "made the family fortune with a series of patents on padlocks, bolts, latches and hasps" (McEwan 18). The wealth of the family was recently accumulated in a sudden burst of mobility not uncharacteristic in Victorian-era England, where "'the newer individualism, stressing risk-taking, free choice, rewards to the enterprising and sharp, and devil take the hindmost'" had risen to prominence in the wake of the industrial revolution (Johnson 148). Prior to opening "his humble hardware shop," however, the Tallis family had been "irretrievably sunk in a bog of farm laboring" (McEwan 20). Despite escaping his proletariat roots, the hardships and instability of farming remained too fresh with him to allow him to lower his defenses. This is evident in how he "imposed on the new house his taste for all things solid, secure, and functional" (McEwan 18). Jack's grandfather fears regressing to an impoverished state. He set out to fortify his new estate against the hardships of his old life. Aside from its structural stoutness, the "relative isolation of the Tallis house" protects future generations from hazardous social interactions (McEwan 5). For those who did venture into the country to visit the Tallis family, an "artificial lake and island with its two stone bridges supporting the driveway" greeted them, evoking images of an imposing medieval fortress complete with mote and drawbridge (McEwan 18).

Like the lake, however, the Tallis family is posturing. Sarah Green, production designer for the film adaptation of Atonement, interprets the Tallises as, "second or third generation new money, so their home is not a [sic] historically beautiful or important house; it is mass produced, a reinterpretation of a classic form. The family had enough money but not that much style" (Bowen).

Jack's grandfather opted for privacy and endurance to keep something at bay rather than to place status and entrepreneurial success on a pedestal. He sought to combine these qualities with the fashionable Gothic revival architecture of the nineteenth century in Victorian England. Nevertheless, the fact remains that his wealth could have bought the Tallises an established, prestigious estate or at least prevented it from becoming a "tragedy of wasted chances" (McEwan 18). Victorian architectural theorists, who "believed that buildings not only embodied meanings, but also communicated them with precision" (Kaufman 30),

help us to understand that this was a deliberate decision made by Jack's grandfather: "the choice of style [...] was not the architect's but the patron's" (Lang 241). Its construction suggests a conflict of interests only insofar as an obligation to keep up a pretense of worldliness goes. Gothic architecture (and, therefore, Gothic revival architecture) is medieval in origin. While it appears that Jack's grandfather is paying homage to a medieval-inspired style of architecture representative of the same oppression that stifled his peasant ancestors, the choice was not self-deprecatory, insensitive, or ill-informed, but utilitarian. Realistically, a degree of conformity was more advantageous. Symbolically, the Tallis house is furnished to withstand the relentless onslaught of fortune-ruining forces; it is soundly outfitted against the elements and places distance between itself and prospective enemies of the family. To rely exclusively on static defensive measures implemented at a fixed moment in time ignores the fluidness and aggressive adaptability of society—in this case its elite, with whom the Tallises would ordinarily hobnob. Jack's grandfather's blueprint sans aesthetic tribute to the wealthy would have been interpreted as an attack on his wealthy contemporaries liable to ignite hostility between the involved parties. "There was a deeply entrenched middle-class mid-Victorian prejudice against the character and behavior of manual workers as a class" (Johnson 147). Failing to fully embrace the lifestyle of the wealthy, whose "latent industry and honesty" starkly contrasted the "latent recklessness and immorality" of manual workers (both common perceptions at the time), implied a mindset more contiguous with the latter (Johnson 147). By making minor concessions to placate the status quo, the house effectively "induc[es] positive reactions in others [...] change[s] others' views or behaviors in desired directions," and enables the Tallises "to adapt to, or feel comfortable in, a wide range of social situations" (Baror 17). In spite of his efforts to implement techniques that would improve the odds that his family would not descend back into poverty, Jack's grandfather "could not conceal the ugliness of the Tallis home," the transparency that the Victorian architectural theorists pointed to in architecture prevailing (McEwan 18). While the house succeeds in communicating that the Tallises are of high rank to their McEwan-created potential critics, its lack of traditional, dignified elegance indicates to the reader, armed with more intimate knowledge of the family's dynamics, that the family's concern is not status, but holding off history.

Emily's upbringing appears to be one generated by more privileged pedigree than the Tallises, though likely not graced with exorbitant wealth or status: "she had been educated at home until the age of sixteen, and was sent to Switzerland for two years which were shortened to one for economy" (McEwan 61). Her parents' frugality functions not only to suggest a shortage of resources, but, implicitly, that they also imparted on Emily traditional assumptions about gender and societal roles. These are most evident in her attitudes regarding Cecilia, her eldest daughter. Although Cecilia was educated at Girton, a constituent college of Cambridge University, her degree is unsatisfactory to her mother, who argues that "[Cecilia] had no job or skill and still had a husband to find and motherhood to confront" (McEwan 62). Emily disregards her daughter's intellectual pursuit as "at best an innocent

lark" (McEwan 61), one that violates women's traditional role even in the wake of an era when "the boundaries between public and private were continually being tested and renegotiated" (Morgan). While this nineteenth-century expansion of women's freedom enabled Cecilia to explore affairs outside of the home, Emily's assumptions are not replaced or forgotten upon marrying Jack and being assimilated into the Tallis family culture. Instead, she cherishes them as personal tenets that amicably collide with the values of Jack's grandfather to yield a mutually beneficial relationship. Rooted in stability and manifested in the Tallis house, his peasant-inspired sensibilities and the social order endorsed by Emily are staunchly opposed to change and, thus, complementary. "A sixth sense, a tentacular awareness that reached out from the dimness [of Emily's bedroom] and moved through the house, unseen and all-knowing," is the product of their compatibility (McEwan 63).

The deterioration of Emily and Jack's marriage produces an imbalance in the relationship between them and the house that benefits her radical agenda. Jack's extended absence from the family is work-related and extramarital in nature: "that he worked late she did not doubt, but she knew he did not sleep at his club, and he knew that she knew this" (McEwan 139). In either case, his clout in family affairs as a crucial moderating component diminishes. Jack has departed from the core values endorsed by his father and with which the house was built, taking a less cautionary approach to preserving the family's wealth and reputation. His rapport with and support of Robbie Turner, the son of the family's charwoman, is exemplary of this rift. Robbie is the intellectual progeny of Jack, the "living proof of some leveling principle he had pursued throughout the years" (142), whose college tuition at Cambridge he had financed. Jack's intent to provide Robbie with an escape clause from poverty is diametrically opposed to the house's "ambience of solidity and family tradition" (136). Robbie shows promising prospects for upward mobility and other successes that threaten to undermine the Tallises and their established status. Yet, Emily, whose ideals are intertwined with the house, is powerless to act out defensively against him in Jack's presence. Before their marriage became dysfunctional, she assumed the traditional domestic role of mother. The "late and unexpected appearance" of her youngest daughter Briony "had kept [childhood sacraments] alive in the household well into Emily's forties," in turn enabling Emily to cooperate and avoid confrontation with Jack after their de facto separation and Briony had outgrown the attentions of her mother (McEwan 64). Eventually, however, the "sources of contentment in her life—the house, the park, and, above all, the children"—overcome her commitment to her husband (McEwan 139). Emily concludes that "it was her own peace of mind she strove for; self-interest and kindness were best not separated" (McEwan 67). Only after assuming the role of head of household can she repurpose her "tentacular awareness" into a weapon suitable for indirectly solving the problem of Robbie (McEwan 63). Prior to Emily's uncontested coup, her wifely obligations prevent her from taking action using that awareness: the house functions as a mental appendage through which Emily channels and enhances her maternal instincts. "Like the cat's whiskers of an old wireless," it collects on Emily's behalf information

regarding the family's goings-on that she ordinarily would not have the sensitivity or capacity to collect (McEwan 63). Her awareness is innate, becoming tentacular only when coupled with an external actor. While her mechanics are unchanging, Emily applies them not to maternal betterment after ousting Jack, but to the preservation of common ideals that she and the house jointly embody.

Despite access to an endless flow of accurate, intimate information about the conflicts and happenings within the house—"only the truth came back to her, for what she knew, she knew" (63)—Emily rarely serves as an arbiter. Although conscious of the multiple, escalating plots whose development she is surrounded by, Emily assumes a policy of inaction, taking no initiative to intervene and perhaps defuse the novel's mounting tension. Doing so is crucial to succeeding in her campaign to de-liberalize the Tallis household and substantiates her deliberate use of the house as an extension of herself to eliminate Robbie. This is no more evident than in the nursery. This room is the proverbial powder keg of the novel's inciting incident, in which Briony misinterprets a sexually charged scene between Cecilia and Robbie from her vantage point as onlooker. Briony draws the conclusion that Robbie is a predator "issuing a command which Cecilia dared not disobey" as she denudes to underwear to retrieve a broken vase from the fountain, and her suspicions consequently evolve so virulently that she falsely accuses him of rape (McEwan 36). Briony is unexpectedly plucked from her waning, but still incomplete, childhood and granted "privileged access across the years to adult behavior, to rites and conventions she knew nothing about, as yet" (McEwan 37). Her imagination is stimulated by the incident without adult restraint, prompting not only her costly exaggeration but also a redirection of her literary mind from fairy tales to "the adult world in which frogs did not address princesses" (McEwan 37). In doing so, Briony is denied "access to deeper meaning and that which is meaningful to her at [her] stage of development" that "the child finds [...] through fairy tales" (Bettelheim 4-5). The rapid succession of life and plot-altering events in the nursery scene spawns a climate of instability and manifolds potentially disastrous outcomes. While "she could not send [her tendrils] into the future," Emily can see the plots gradually converge (McEwan 67). At the expense of Briony's healthy transition into adulthood, Emily withholds her guidance to protect her own interests, two of which she gambles will be addressed by unleashing her daughter: the realignment of Briony's values, which led her to accept that "leaps across [socioeconomic] boundaries were the stuff of daily romance." with her own, and the elimination of Robbie Turner's threat to the family (McEwan 36). Arguably, Emily has no say in the matter. McEwan emphasizes that "though she sometimes longed to rise up and intervene [,]" the fear of pain from debilitating migraines "kept her in place" (63). Her medical condition, however, has little bearing on how she deals with each situation. Emily is only intermittently bedridden, her migraines being triggered by stimuli such as "the white glare of the afternoon's heat" (McEwan 60). "Emily stood at the head of the table placing diners as they came in," for instance, completely lucid and without difficulty during the dinner preceding Robbie's arrest (McEwan

118). Thus, her ailment is more of a convincing alibi than a retardant hampering the performance of her essential motherly duties.

Briony herself, albeit as the elderly narrator of *Atonement* that she is revealed to be at the novel's conclusion, "London, 1999," is aware of her mother's iniquities and the symbiotic relationship with the house from which her present-confined omniscience sprang. Returning to her former home twenty-five years after her mother's death, she "turn[s] into the drive of Tilney's Hotel," not of the Tallis house (McEwan 342). The Tallis house, like all others, is subject to its occupants, constantly undergoing transformations in the push and pull of human life; births, deaths, marriages, and moving on all affect the personality of habitations, if only fractionally. Without Emily, the bond between her and the house was broken. Even so, the legacy of that bond plunged blindly into the future, the actions, or lack thereof, taken under its influence resulting in "the moment when [Briony] became recognizably herself" (McEwan 39). Ironic though it may be that Emily sets the atrocities of *Atonement* into motion in the nursery, it is also appropriate. What should have served as a sanctuary for Briony in conjunction with the nurturing affections of her mother and father declines into a theatre for "wickedness and scheming [...] confusion and misunderstanding;" and "above all, [...] the failure to grasp the simple truth that other people are as real as you" (McEwan 38). The impetus for the ultimate destruction of the Tallis estate, either by financial ruin or the estrangement of the remaining children, is issued forth from the room most affected by the broken marriage of Emily and Jack. Overlooked by Emily in her conniving, the ultimate outcome of *Atonement*, beyond her control and foresight, is the product of the same force that facilitated her appropriation of the Tallis house for selfish means. Tilney's Hotel, though "stark and unprotected" by Jack's grandfather's standards, persistently outlives its past inhabitants, nonetheless immortalizing them and their deeds in its aura (McEwan 343).

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Incorporating Original Research in the Classroom: A Case Study Analyzing the Influence of the Chesapeake Bay on Local Temperatures

Katlin M. Major, Carrie A. Dunham, and Dr. Kelsey N. Scheitlin

Abstract

Maritime climates experience moderate temperatures due to the specific heat of the nearby water. The first objective of this study is to analyze the relationship between temperature (maximum, minimum, and range) and proximity to the Chesapeake Bay and Atlantic Ocean. Results show that the annual T_{min} (T_{max}) means are smaller (greater) at the most continental locations, while the maritime locations experience cooler days and warmer nights. This results in a smaller DTR in maritime locations. The most notable seasonal differences in the variables occur during the transitional seasons of spring and fall when the lag time of the water temperature change is more. It is difficult to discern whether the temperature of the bay-side localities is being influenced by the bay or the ocean, but the authors speculate that it is a combination thereof. The second objective of this study is to incorporate this research into the middle school classroom using an inquiry-based approach. This approach allows students to practice real-world science through a guided experiment that encourages critical thinking and lays the foundation for successful thinkers.

1. Introduction

As a dynamic system, the Earth is constantly changing. One change that is currently being discussed is climate change. But what is climate? As defined by NASA, climate is the long-standing weather patterns in a specific area (Gutro, 2005). While weather changes daily, climate is more stable, as it is an average of the weather that occurs over a number of years. When determining climate, surface temperature and precipitation for a certain area over a certain period of time, often 30 years, are taken into consideration (Glossary of Meteorology, 2012). As a general rule, climate is what you expect and weather is what you get.

There are many factors that govern the climate of an area, including latitude, land features such as water and mountains, winds, and ocean currents (Carbone, 2012). Latitude has a large effect on climate, as the angles of the sun will be different at different latitudes. This results in a variation of temperature and precipitation, among other features. The latitude of a place will not change, nor will the angle of the sun, so this is one of the more stable factors affecting climate. The currents of warm and cold water in the ocean are another factor, as warmer water results in warmer air temperatures. This work focuses on a third major factor, which is proximity to water (Carbone, 2012). A more "maritime" climate (one near water) will differ in precipitation and temperature when compared to a more "continental" climate (one more centralized on a continent). The maritime effect on precipitation is obvious, as an area near a large water source will generally have more evaporation and precipitation. The temperature of a coastal locality differs for a more complex reason, which is referred to as specific heat.

Specific heat is the amount of heat required to change a unit quantity of a substance by one degree in temperature (Weisstein, 2007). While one degree may not seem like a lot, it is quite a feat when one considers how much energy is required in order to obtain that raise. For water, it requires 4.186 joule/gram °C to raise it one degree Celsius, which is the highest specific heat of common substances (Nave, 2012). At 20°C, the specific heat of air is 1.01 joule/gram °C (Nave, 2012). This difference in specific heat between water and air has a large effect on climate. The specific heat of water is much greater than the specific heat of air.

Specific heat affects the climate of maritime locations because it takes longer for the water to heat up and longer for it to cool down (Science Encyclopedia). This in turn affects the air temperature above and around bodies of water, so that their highs and lows are more moderate than those of locations not near water. Continental climates have more fluctuation because they have no water to stabilize the temperatures. In theory, maritime locations have cooler (warmer) summer (winter) days, as the water remains cooler (warmer) than land. This will in turn affect the diurnal temperature range (DTR), or the difference between the daily maximum temperature (T_{max}) and daily minimum temperature (T_{min}), with maritime locations having a smaller DTR due to the moderating effect that water has on temperature.

The type of water body near a maritime location also has an effect on temperature. Impurities, such as salt, in the water affect the specific heat slightly, making different bodies of water heat and cool at different rates. Another aspect of bodies of water that affects coastal temperatures is the depth of the water. For example, the Atlantic Ocean is 12, 881 feet deep on average (Enchanted Learning, 2010), while the Chesapeake Bay has an average depth of 21 feet. This means the water of the Chesapeake should be heated and cooled more quickly, and therefore the coastal temperatures should fluctuate more than a coastal area along the ocean.

The purpose of this research is twofold. First, we analyze the influence of the Atlantic Ocean and Chesapeake Bay on the temperature of adjacent locations. Second, we demonstrate how original research can be used to enrich the middle school science classroom by creating a meaningful lesson plan that incorporates the physical principles underlying this study.

2. Methods

The study analyzes the impact of the Chesapeake Bay and the Atlantic Ocean on the temperature of nearby locations by comparing temperature data from weather stations located across the area. Figure 1 shows the stations used in this study. The stations meet the following criteria:

- have data available for January 1–December 31, 2011
- are less than 150 m above sea level in order to account for elevation bias
- are located in an area with <30,000 people and a population density of <3,000pp/sq mi (according to 2010 census data) in order to account for urban bias

The stations are divided into four location categories.

A."Near **A**tlantic"

This includes all stations on the Delmarva Peninsula due to their proximity to the ocean. While these stations are also near the bay, the physical properties discussed in the previous chapter suggest that the ocean should have a stronger

influence on these stations than the bay. 8 stations.

B."Near Chesapeake Bay"

This includes stations nearest the western shore of the bay. 7 stations.

C."Continental"

This includes locations relatively removed from either water source, as shown by the figure. 6 stations.

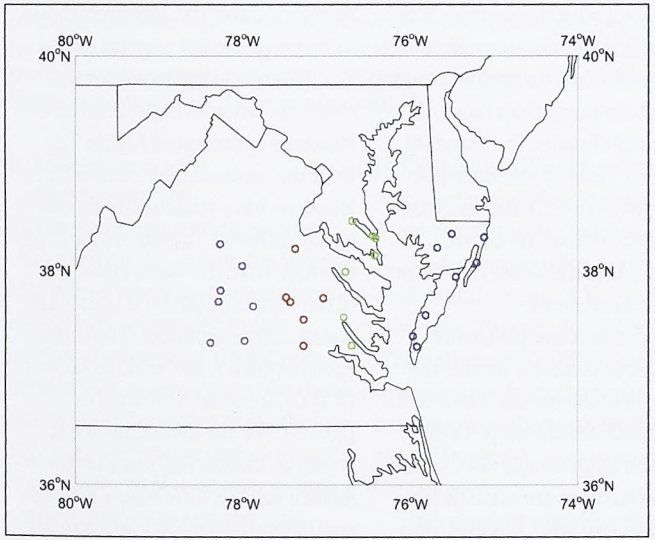

Figure 1. Location of weather stations used in the study. Near-Atlantic (A) stations are shown in blue, Near-Bay (B) in green, Continental (C) in red, and Distant-Continental (D) in purple.

Station Type	mean T_{max}	sd T_{max}	mean T_{min}	sd T_{min}	mean DTR	sd DTR
A	20.5	9.1	10.4	9.2	10	3.7
B	20.3	9.4	9.7	9.3	10.6	3.8
C	21.5	9.1	9.7	9.1	11.7	3.8
D	21.4	9.1	8.2	9.2	13.2	4.4

Table 1: The station type (A–D) and corresponding annual temperature values (°C) for 2011, including means and standard deviations (sd) of T_{max}, T_{min}, and DTR.

D."Distant Continental"

This includes locations farther removed from either water source, as shown by the figure. 7 stations.

While the climate of locations C and D is still likely influenced by the water sources, the effect should be less so than those in closer proximity. Stations farther west are not included because this will increase elevation differences between localities and introduce additional biases.

Daily T_{max} and T_{min} were acquired from the National Climatic Data Center for the year 2011 for the 28 stations and were used to calculate the DTR (T_{max}–T_{min}). Descriptive statistics and t-tests were used to analyze the differences between A, B, C, and D temperatures (T_{max}, T_{min}, and DTR) on an annual and seasonal basis.

3. Results

A. Mean annual temperatures

In this section the annual mean temperatures (T_{max}, T_{min}, and DTR) are compared between locations. The descriptive statistics of the temperature data are summarized

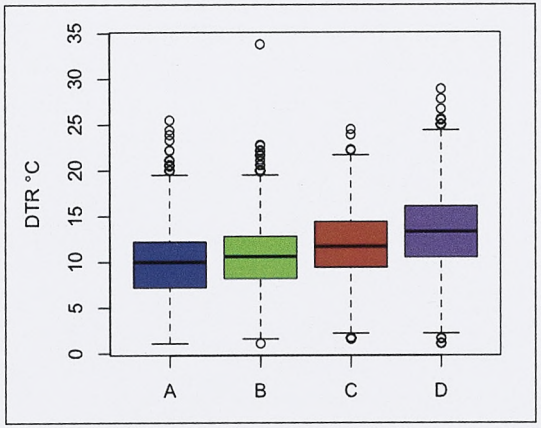

Figure 2: Boxplots of annual DTR values (°C) for each station type (A–D).

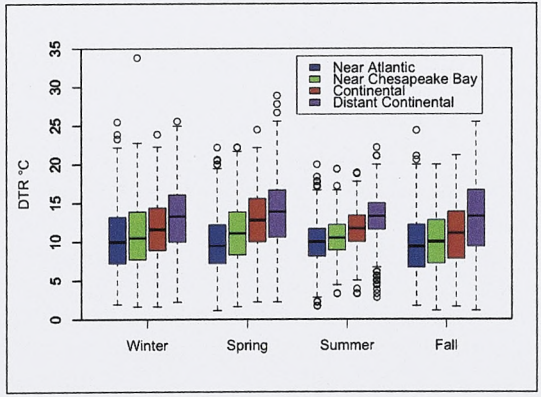

Figure 3: Boxplots of seasonal DTR values (°C) for each location type.

in Table 1 and DTR values are displayed as boxplots in Figure 2. T_{max} is greater in continental locations while T_{min} is smaller, causing the greatest DTR in the D locations and the smallest in the A locations. This is consistent with the premise that the specific heat of water will cause maritime climates to have a smaller temperature range than those of continental climate. The standard deviation (Table 1) and interquartile range (Figure 2) also increase with distance from the ocean, showing more variability in DTR in continental climates.

Independent sample t-tests were used to test for a significant difference in the means. The results of the t-tests are shown in Table 2. Due to the large sample size, many of the differences are statistically significant ($p<0.02$); however, only some of those differences are large enough to consider notable. T_{max} of the maritime locations (A and B) are not different from each other, but are significantly smaller than T_{max} at the continental (C and D) locations, which are not different from each other. Thus, the locations farther from the water are slightly warmer on average. However, these differences are not as great as the T_{min} differences, which in several cases are twice as large. Maritime locations experienced higher T_{min} than the continental locations. All locations have statistically significantly different T_{min} except for B and C, which have the same value. All of the results of the DTR t-tests are statistically significant. The difference between A and D is the largest (3.2° C), followed by B and D (2.6° C). For the annual means it seems as though T_{min} has a larger influence on DTR differences between continental and maritime locations, while T_{max} is not as important.

	T_{max}				T_{min}				DRT			
	A	B	C	D	A	B	C	D	A	B	C	D
A		0.2	-1.0*	-0.9*		0.7*	0.7*	2.2*		-0.6*	-1.7*	-3.2*
B	-0.2		-1.2*	-1.1*	-0.7*		0	1.5*	0.6*		-1.1*	-2.6*
C	1.0*	1.2*		0.1	-0.7*	0		1.5*	1.7*	1.1*		-2.5*
D	0.9*	1.1*	-0.1		-2.2	-1.5*	-1.5*		3.2*	2.6*	2.5*	

Table 2: T-test results comparing T_{max}, T_{min}, and DTR between station types (A–D). The numbers are the difference in the means (°C), with a negative (positive) number indicating that the station listed in the row is less (greater) than the station listed in the column. A number marked with a * indicates a statistically significant difference ($p<0.02$).

B. Mean seasonal temperatures

As the water temperature slowly changes with the season, the impact of water on maritime temperatures should vary seasonally. In this section, the temperature data are divided into seasons to test for these differences. December through February are categorized as winter, March through May as spring, June through August as summer, and September through November as fall. The descriptive statistics of the temperature data are summarized in Table 3 and DTR values are displayed as boxplots in Figure 3. As we saw in the annual means, T_{max} is generally higher in the continental areas and T_{min} is generally lower. This results in the same DTR pattern, with DTR increasing with distance from the ocean. The boxplots show the smallest DTR range for every location occurs in the summer.

Independent sample t-tests were used to test for a significant difference in the means. The results of the t-tests are shown in Tables 4 through 7. The largest differences in T_{min} and DTR occur between A and D locations in every season, with A locations being consistently warmer at night, regardless of season. The largest T_{max} differences occur between A and C locations (spring and summer) or B and C locations (winter and fall).

There are more significant differences ($p<0.02$) in T_{min} than T_{max} in every season except spring, which is when the greatest DTR differences occurred. The T_{min} differences were, on average, larger than the T_{max} differences except for the spring season, as well. While the annual means show T_{min} has a larger overall influence on DTR differences in the area, it is evident that T_{max} plays a larger role in spring DTR differences. This could be due to the increased solar radiation in the spring causing T_{max} to gradually increase throughout the season, making the lag between the water and air evident. This shines an interesting light on the "transitional seasons," i.e., spring and fall. The opposite relationship is shown in the fall, where there are the greatest differences in T_{min} between locations. Here the land is cooling quickly with the diminishing solar radiation and longer nights, causing a quick decline in T_{min} over the

Station	Winter			Spring			Summer			Fall		
Type	T_{max}	T_{min}	DTR	T_{max}	T_{min}	DTR	T_{max}	T_{min}	DTR	T_{max}	T_{min}	DTR
A	10.1	-0.3	10.4	19.0	9.2	9.8	30.6	20.4	10.1	21.4	11.7	9.7
B	9.7	-1.0	10.7	19.8	8.8	11.0	30.7	20.1	10.6	21.0	10.9	10.2
C	11.1	-0.9	11.4	21.7	9.0	12.7	31.6	19.8	11.7	21.8	10.8	11.1
D	10.4	-2.6	13.0	20.9	7.2	13.8	31.3	18.2	13.0	21.3	8.4	12.9

Table 3: Location type (A–D) and corresponding seasonal temperature means (°C).

	T_{max}				T_{min}				DTR			
	A	B	C	D	A	B	C	D	A	B	C	D
A		0.4	-1.0*	-0.3		0.7*	0.6	2.3*		-0.3	-1.0*	-2.6*
B	-0.4		-1.4*	-0.7	-0.7*		-0.1	1.6*	0.3		-0.7*	-2.3*
C	1.0*	1.4*		0.7	-0.6	0.1		1.7*	1.0*	0.7*		-1.6*
D	0.3	0.7	-0.7		-2.3*	-1.6*	-1.7*		2.6*	2.3*	1.6*	

Table 4: T-test results comparing T_{max}, T_{min}, and DTR between station types (A–D) during winter. The numbers are the difference in the means (°C), with a negative (positive) number indicating that the station listed in the row is less (greater) than the station listed in the column. A number marked with a * indicates a statistically significant difference (P<0.02).

	Tmax				Tmin				DTR			
	A	B	C	D	A	B	C	D	A	B	C	D
A		-0.8	-2.7*	-1.9*		0.4	0.2	2.0*		-1.2*	-2.9*	-4.0*
B	0.8		-1.9*	-1.1*	-0.4		-0.2	1.6*	1.2*		-1.7*	-2.8*
C	2.7*	1.9*		-0.8	-0.2	0.2		1.8*	2.9*	1.7*		-1.1*
D	1.9*	1.1*	-0.8		-2.0*	-1.6*	-1.8*		4.0*	2.8*	1.1*	

Table 5: The same as Table 4 but for spring.

land and making the cooling lag over the water more evident. This results in the transitional seasons having greater DTR differences between continental and maritime locations than during summer and winter, on average.

The differences between maritime locations (A and B) are minimal. A and B locations show no significant difference in T_{max}, and they have no T_{max} or T_{min} difference greater than 1° C. The differences between the two continental stations (C and D) are greater. This leads to speculation that while A is influenced greatly by the ocean, B may be influenced slightly by the ocean in combination with the bay. This in turn kept the B locations similar to the A locations in temperature, as compared to the differences between the other locations. However, this is only speculation based off of the results presented here, and to further analyze the

impact of the bay on temperature, data from a larger number of stations between the bay and the ocean would be needed in order to analyze the microclimate of the peninsula.

4. Implementation in the Classroom

This lesson uses an inquiry-based project approach to science learning. Not only are students doing an experiment, but they also are using their critical thinking skills in order to hypothesize and make conclusion. They are able to use the information they already know as well as information they learn through the lab time. Inquiry-based project learning creates a learning environment where students gain a better understanding of science concepts and skills along with learning cognitive, social, and communication skills (Kolodner et al., 2003). By incorporating inquiry-based project learning, teachers are "laying the foundation in middle school for students to be successful thinkers, learners, and decision makers throughout their lives and... learn the science they need to know to thrive in the modern world" (Kolodner et al., 2003).

	Tmax				Tmin				DTR			
	A	B	C	D	A	B	C	D	A	B	C	D
A		-0.1	-1.0*	-0.7*		0.3*	0.6*	2.2*		-0.5*	-1.6*	-2.9*
B	0.1		-0.9*	-0.6*	-0.3*		0.3*	1.9*	0.5*		-0.9*	-2.4*
C	1.0*	0.9*		0.3	-0.6*	-0.3*		0.4*	1.6*	0.9*		-1.3*
D	0.7*	0.6*	-0.3		-2.2*	-1.9*	-0.4*		2.9*	2.4*	1.3*	

Table 6: The same as Table 4 but for summer.

	Tmax				Tmin				DTR			
	A	B	C	D	A	B	C	D	A	B	C	D
A		0.4	-0.4*	0.1		0.8	0.9*	3.3*		-0.5*	-1.4*	-3.2*
B	-0.4		-0.8*	-0.3	-0.8		0.1	2.5*	0.5*		-0.9*	-2.7*
C	0.4*	0.8*		0.5*	-0.9*	-0.1		2.4*	1.4*	0.9*		-1.8*
D	-0.1	0.3	-0.5*		-3.3*	-2.5*	-2.4*		3.2*	2.7*	1.8*	

Table 7: The same as Table 4 but for fall.

Lesson plan begins on next spread.

Time	0	5	10	15	20	25	30	35	40	45	50	55	60	65
Water Temperature														
Light Sand Temperature														
Dark Sand Temperature														

Table 8: Sample table for students to record observations.

Teacher(s):
Subject: *Science*
Grade: *6th*
SOL(s):
6.1 The student will plan and conduct investigations in which
h) *data are collected, recorded, analyzed, and reported using appropriate metric measurements;*
i) *data are organized and communicated through graphical representation (graphs, charts, and diagrams);*

6.5 The student will investigate and understand the unique properties and characteristics of water and its roles in the natural and human-made environment. Key concepts include
d) *the ability of large bodies of water to store heat and moderate climate;*

General Objective(s):
Students will:
- *Create a hypothesis based off of previous knowledge.*
- *Follow instructions and conduct research about the given topic.*
- *Interpret their results.*

Introduction: *The teacher will explain to the students that today we are going to be discovering how land and water are different. We will be conducting an experiment to see which heats up faster and which cools slower (water or land). We will also be making a hypothesis about how that affects the land around it. Does anybody have an idea on what will happen?*

Specific Objectives: Students will:
- *Hypothesize with their groups on whether land or water heats up fastest.*
- *Conduct an experiment to test their hypothesis.*
- *Record the results of the experiment.*
- *Work as a group to graph their results and create a conclusion.*
- *Discuss as a class how they believe water temperature*

affects the surrounding areas and why.

Procedures: The teacher will:

- *Introduce the lesson and review the lab procedure and rules.*
- *Break the students into lab groups of 4 that will work well together.*
- *Describe to the students how the lab is going to run and explain where they can find all the materials they need in order to complete the lab.*
- *Circulate around the classroom to make sure all the students are on task while completing the experiment.*
- *Engage the students in conversation about their hypothesis while they are waiting for the water to warm up and cool down.*
- *Bring the students back and lead a discussion on how a water source will affect the temperature near it.*

Closing: *The teacher will bring the students back together and have them share their results. The teacher will then have the students hypothesize on how a water source will affect the temperature around it. The teacher should have the students focus in on the fact that since water takes longer to warm up and longer to cool down, the temperature in the surrounding areas will do the same.*

Evaluation: *The students will turn in a lab report and graph that they created during the lab time. The teacher will also ask questions throughout the entire lab and closing in order to ensure student understanding.*

Materials:

- *Lab report sheet for each student*
- *Group paper for each student*
- *3 identical waterproof containers per group (Large Styrofoam cups or plastic containers)*
- *3 thermometers per group*
- *1 heat lamp with at least 100-w bulb per group*
- *Black or very dark sand*
- *White sand*
- *Water*
- *Stopwatches*
- *Colored pencils*

Assignments:
Using the internet or news, find one place near the Atlantic Ocean in Virginia and one in the middle of the state and compare and contrast the high and low temperatures for the day. (Finding the temperatures can happen before the students leave school if needed.) Write a paragraph using the information you gained from today's lab to explain why the temperatures are the way they are.

Extenders/Back-Up Activities:

- *Have the students use the internet to look up temperatures across the state and have them look to see if the temperature is varying based on how far a place is from a body of water. (This can also be done as the students are working on their lab during their down time.)*
- *For gifted students, have them design their own experiment.*

Lab instructions:
Before you start: Fill one container about half-full with light sand, another with the dark sand, and the last with water. All of the containers should be filled to the same level. Place the thermometers upright in the sand and water. Make sure the ball of the thermometers is submerged in the sand or water.

Getting started: *Place the containers under the light source so that they are all receiving equal amounts of rays.*
Take the initial temperature of each material. If your sand and water temperatures are not the same, let the teacher know.
Turn on the light source and start your stopwatch. Record the temperature of each material in Celsius every 5 minutes and record your data in the table.
After 40 minutes, turn off the light and let the water cool for the next 30 minutes while still recoding the temperature every 5 minutes. (The times can be adjusted based on the amount of class time.)
Conclusion: Use your table to create a graph based on your results. Graph the water, light sand, and dark sand temperatures on the same graph using different colors.

This lesson allows students to use their critical-thinking skills in order to discover that the temperature surrounding a water source will heat up and cool down slower than the temperature of an area farther from the same water source. It also incorporates math by having the students create and interpret a graph. Since this lesson is inquiry-based project learning, students are gaining more skills than just science—they are also gaining life skills.

5. Conclusion

In this study, we compared the T_{min}, T_{max}, and DTR of four location groups: Near Atlantic, Near Chesapeake Bay, Continental, and Distant Continental. We found that annual DTR mean and standard deviation increase as you move away from the water sources. This is consistent with the premise of specific heat and the ability for water to moderate nearby temperatures.

The same general pattern is seen seasonally, but there are variations between seasons. The transitional seasons (fall and spring) seem to highlight the lag time between the temperature changes of water and land. Spring is the season with the greatest DTR differences. Annually, T_{min} has a larger overall influence on DTR differences in the area; however, T_{max} differences are greater in the spring when the water is warming up. This is the opposite in the fall, when the greatest T_{min} differences occur most likely because the water is still warm from its summertime heating. It is not obvious if the bay is able to moderate temperatures significantly on its own, or if the near-bay localities are being affected by their proximity to the ocean.

Original investigations such as this provide a unique opportunity to demonstrate real-world examples of classroom material. Creating an inquiry-based lesson plan based on research findings allows students to explore the world around them through guided, yet autonomous, investigations.

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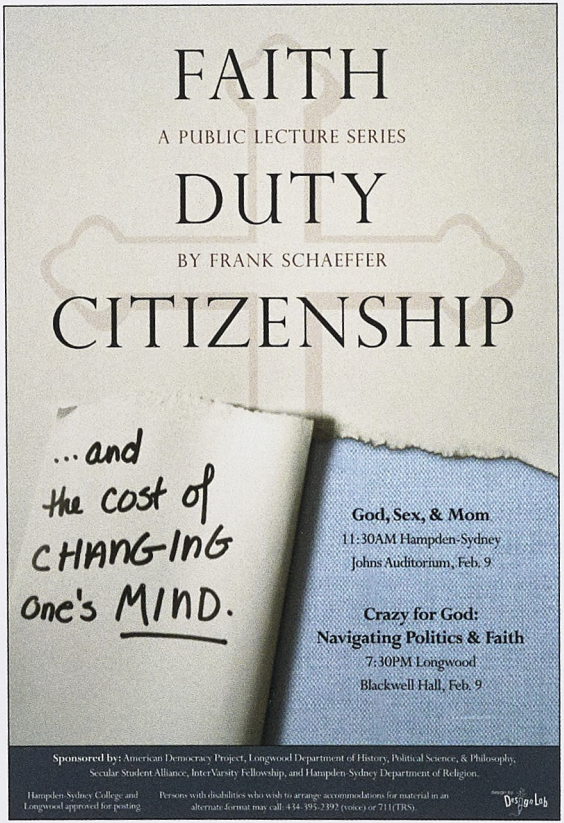
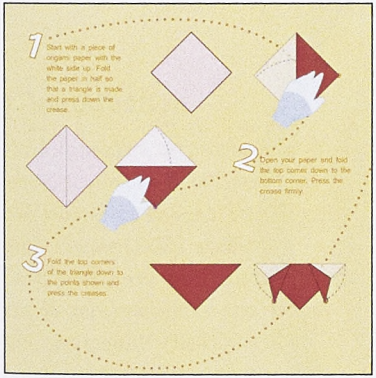
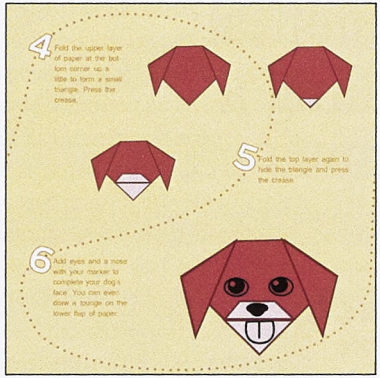
poster for a talk by Frank Schaeffer,

2012







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2012

Facing the Music: Environmental Impact Assessment of Building a Concert Hall on North Campus

Jennifer Nehrt, Kelsey Stolzenbach, and Dr. Kelsey Scheitlin

1. Introduction

For this project, we propose the construction of a 10,000-seat concert venue, the fictional Farmvegas Civic Center (FCC), at North Campus (Lancer Park). Lancer Park is a 50-acre residential and recreation community. The FCC will be erected at the current apartment construction at Lancer Park. Two sports fields will be replaced with parking lots (Figure 1).

It is important to note that we are not building on an unaltered landscape, so we are analyzing additional impact from FCC construction and utilization. We used an environmental impact assessment (EIA) to analyze possible impact on the following components of Lancer Park: physical resources, ecological resources, human use values and quality of life values. EIAs are documents that are used to inform the public as well as interest groups of what damages and benefits could possibly incur from a project. EIAs outline possible alternatives to the proposed project, provide a baseline evaluation of the area, and summarize how a project would affect the environment in which it takes place. They are primarily used to support environmental protection and sustainable development; protect the environmental, economic, and social health of surrounding communities; and prevent environmental problems before they occur.

The four impact areas listed above are analyzed using different techniques, such as a thermal imaging camera in order to assess climate impacts, biodiversity studies to understand the plant and animal populations, water and soil testing, etc. Each of these is discussed in more detail in the following sections. Within each section is a current assessment of the status of these resources, followed by the possible impact from the FCC use and construction. This is followed by a discussion of possible mitigation techniques to keep the area healthy, and finally a summary and conclusion.

2. Current and projected status of physical resources

The first-step EIA is to analyze the current status of physical resources in the study area and the potential impact on them. The physical resources we researched include climate, soil, and water.

A. Current status

The climate is already being affected by the land use at Lancer Park. Currently, there are apartment buildings and roads that create an urban heat island. Urban heat islands are further discussed in the next section, as they are expected to be even stronger due to the construction of more roads and buildings. Figure 2 shows the current heat production by anthropogenic surfaces at Lancer Park as seen by a thermal imaging camera in March 2012.

The water in the stream located in the northern end of Lancer Park (see Figure 1) is beginning to see some effects from human impact as well. A water sample taken in March 2012 shows good phosphate levels (2ppm), excellent nitrate levels (0ppm), excellent dissolved oxygen levels (92%), fair turbidity (20 JTU), and the presence of coliform bacteria. Overall, this is a fairly healthy report for the stream, outside of the turbidity and bacteria.

Figure 1. Digitized maps of Lancer Park before and after the building of FCC (purple). There will also be two additional parking lots (green) that replace the current sports fields.

Figure 2. Roads and built surfaces at Lancer Park are giving off heat (as shown by the brighter colors), showing the effect of urbanization on climate. The grass and trees are naturally cooler (darker colors).

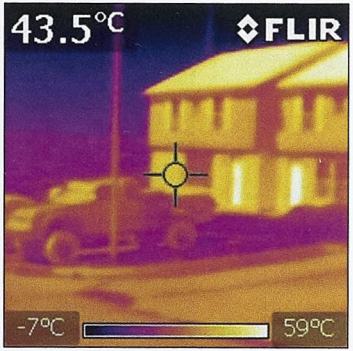

Figure 3. Soil samples from Lancer Park. One sample is from the woodland area (top) ,while the other sample is from near the parking lot (bottom).

Soil samples were compared from two different locations in Lancer Park, one in the woodland area north of the construction and the other near the current parking lot (Figure 3). Both soil samples had more than 200ppm of lead, adequate phosphorous levels, surplus potassium, and nitrogen depletion. The woodland soil proved slightly acidic (pH of 6.5), and the sample near the parking lot was found to be alkaline (pH of 7.5).

B. Projected impacts

The projected impacts on the physical resources of Lancer Park include alterations to the current climate, soil, and water health of the area.

Water health

Runoff from both the construction and utilization of FCC will affect water quality. Mahler et al. (2005) found that the sealcoat applied to parking lots every two to three years contains polycydic aromatic hydrocarbons (PAHs). PAHs run off into the water and inhibit reproduction and delay the emergence of mammals. Additional impact on water health could include increased pollution from human litter, oil from cars, and an increase in the number of serious events such as sewage system failure.

Climate

The FCC will cause an increase in the urban heat island at Lancer Park. An urban heat island is the characteristic of a city that causes it to be warmer than surrounding areas. During construction of the FCC, there will be removal of vegetation, which will increase the urban heat island effect. Vegetation provides shade and reduces urban heat release by trapping moisture in itself as well as the soil (Arrau and Peña, 2011). There will also be a general increase in albedo as more

of the environment becomes built and paved. The albedo of asphalt is 0.04, versus the 0.25 albedo of grass. This means that asphalt absorbs 21% more of the sun's energy than grass, which is more reflective. More absorption of the energy will cause an increase in temperature.

Soil

The soil will likely be impacted by the new construction. Overuse of land creates surface compaction, decreasing the amount of silt and clay in soil. Land use commonly deteriorates the quality of the soil, up to 44% in some areas (Islam and Weil, 2000). Removal of vegetation will increase soil erosion and lessen nutrients from organic debris.

3. Current and projected human use values

Next, we assessed the human use values of the area as they are currently, and how we anticipate the FCC will affect them. The human use values include the recreational use of the area, living space, and employment.

A. Current status

Much of the area in Lancer Park is currently used for recreation. This includes the baseball field, the turf field, disc golf, and several trails in the woodland area. The club sports teams use the baseball and turf fields to practice as well as for games. Other students are also allowed to use the fields for recreational use with their friends. Club teams that use Lancer Park include soccer, field hockey, lacrosse, and rugby. There are also parking lots for the sports fields and residents.

Living space is obviously a large use of Lancer Park as well. Longwood students live in the apartments available for housing in Lancer Park. In 2010, a pedestrian bridge was built to give residents easy access to campus. While there are currently more apartments being built, we are proposing to use that area for the FCC instead.

Currently there are only a few jobs at Lancer Park, and most of them are jobs that would be at Longwood regardless of the existence of Lancer Park.

B. Projected impacts

The level of recreation will decrease in relation to sports activities because both the turf field and baseball field will be eliminated, but it will increase entertainment for residents of the Farmville area, including Longwood University students. The FCC will create a safe, enclosed environment for college students around the area, but students will have to look elsewhere for physical fitness.

The FCC will increase parking due to added parking lots. When there is an event, however, the residents of Lancer Park will have trouble finding parking. Events will cause an increase in traffic in the Lancer Park area. People around the area of Lancer Park will also be affected by the noise pollution produced by the FCC. This may cause a decrease in sleep and an increase in frustration, resulting in more stress and perhaps lower grades. The residents of Lancer Park will also be affected by additional litter from the FCC, including increased cigarette trash as well as copious amounts of plastic and paper trash.

4. Current and projected status of ecological resources

Next, we looked at the current and future status of the ecological resources at Lancer Park. This includes the impact of the construction on species diversity, and the plants and animals in the study area.

A. Current status

First, we evaluated the current status of the ecological resources at Lancer Park. The developed area already contains a lot of concrete and housing, as well as small areas of aesthetically pleasing shrubbery. These small areas contain little vegetation and a depleted bug population. A biodiversity study was performed in order to compare a 10x10 foot area of the woodland versus near the parking lot. The different types of vegetation were counted in the area, as well as the number of insects seen within five minutes. The more natural woodland area is fairly large and dappled with various different types of vegetation throughout. The woodland is also home to more insects. The woodland area contained 25 total trees and 17 insects during the study period. This included 4 different insect species and 7 different plant species. The developed area near the parking lot contained 10 trees and 12 insects, 4 different species of each. This small study begins to show that the area of Lancer Park that is not as developed has a larger number of plant and animal species and individuals.

B. Projected impacts

Aquatic Biology

Next, we assessed the potential environmental impact that building FCC could have on Lancer Park. The first area that we assessed was the aquatic biology. Our research included a study that indicated "extensive use of bulldozers on steep slopes for road building and in-stream channels during debris removal caused excessive streambed sedimentation in narrow streams" (Burns, 1972). The adversities to the fish due to this increase in sedimentation would vary by species, as sediment sensitivity varies with size, morphology, and behavior (Brusven and Mcclelland and Brusven, 1980). Also, the temperature of the water will rise with the absence of trees to catch sunlight. The bugs may grow bigger and multiply more frequently, which would allow for the fish to eat more and populate as well. Logging has also been proven to increase stream flow in the summertime, which would allow a higher number of fish to coexist. In one study, some populations of fish suffered as well, with a decrease of 85% in young of the year in steelhead trout populations and an 84% decrease in steelheads over a year old, accumulating to an 82% decrease overall (Burns, 1972).

Birds

The construction of the stadium could also potentially affect the bird population of Lancer Park. Currently, there is construction to expand the student apartments. The construction, while necessary for Longwood's expansion, is impacting the natural world. A killdeer has nested in the gravel on the construction site, in the way of the workers (Figure 4). In order to continue construction, the workers will have to either move the nest, which will disturb and/or incidentally destroy the un-hatched eggs, or simply destroy the nest where it stands. Our research also concluded that the breeding potential

Figure 4. A killdeer has nested in the construction gravel at Lancer Park.

of birds in the area will be affected, as male-female bird bonding has been known to be complicated by environmental noise (Swaddle, 2007). This would cause a decline in the population and overall biodiversity over time.

Vegetation

Finally, we assessed how the vegetation of the area could be affected by our construction. Biodiversity would decrease because trees would have to be cleared in order to construct the FCC. Many areas of rich biodiversity would be replaced with low biodiversity similar to the current apartment complex. This can further impact the status of insects and other animals in the area.

5. Current and projected quality of life values

In this section of an EIA, the quality of life values are analyzed. Here, we briefly discuss the current quality of life in Lancer Park, and the projected impacts of building the FCC. This includes how the FCC will impact public safety, the culture of the area, the aesthetics, and the economy.

A. Current status

Lancer Park currently houses 258 Longwood students in an apartment/townhouse complex. The buildings are plain and unaesthetic. The townhouses are squat, two-level structures and the area is dominated by parking. A beautification attempt has been made on the grounds. Shrubs and trees have been planted in the common areas that are clearly regularly landscaped. To the west, a large construction project is underway for new housing, currently marring the scenery. Beyond the occasional public intoxication arrest, public safety is not a great concern and campus police regularly patrol the area

B. Projected impacts

Public Safety

We have concluded that the FCC will impact the Farmville community in a number of ways, both harmful and beneficial. The stadium could be a threat to public safety. It would increase noise pollution in the area, which would be harmful to the residents' overall health. Studies have shown that exposure to loud music can lead to tinnitus, or hearing loss (Chung et al., 2005). To prevent permanent impairment, it would be beneficial for residents to use noise-cancelling earplugs, which many residents might find to be a nuisance. It could also cause sleep deprivation for Lancer Park residents, many of whom already suffer from limited hours of sleep.

The development also contains many sports fields. The loss of recreational activities for Farmville's youth could lead to an increase in the crime rate. Our research indicates that communities with recreational activities for children have decreased rates of drug and alcohol abuse (California State Parks, 2005). The most immediate consequence would be the increased foot traffic, which could also raise the crime rate.

Cultural Impacts

The cultural impact of the FCC appears to be positive. Music has been shown to improve people's general outlook on life. It enhances quality of life by improving a person's social relationships, environment, and even their physical well-being (Coffman, 2002). It is also valuable in building a stronger Longwood community. Studies show that people with a diverse taste in music will seek out others with similar preferences (Kruse, 1994). This

connection would create a sense of cohesion throughout the different groups on campus.

Aesthetics

Aesthetically, the area would most likely suffer. The FCC would increase the influx of out-of-towners, with the likely creation of a parking overspill. The added visitors would also increase the litter in the area. Trash such as broken bottles and small pieces of plastic could be hazardous for small children and pets. However, if enough care is taken with the appearance of the FCC, then it could improve the overall aesthetic value of the area.

Economic Impacts

The economic impact would be mostly nonexistent to the Farmville community. Currently, the unemployment rate in Farmville is above average at 19.1% (Citydata.com). The introduction of the FCC would create some low-wage jobs, mostly pertaining to landscaping, security, and food service. However, in a study by Robert Baade, findings show that stadiums rarely introduce either positive or negative economic benefit to their surrounding community. In fact, Baade suggested that in 36 cities he studied from 1958 to 1967, over 60% of the stadiums tended "to push rates of economic growth below the average" (Jones et al., 2007).

6. Impact reduction and monitoring

The FCC will be joining a movement sweeping throughout the entertainment industry. Locally, Wolf Trap National Park for the Performing Arts, a busy summer spot in Northern Virginia, is attempting to become "a zero waste organization and carbon neutral" by transitioning to high-efficiency vehicles and alternative fuel, becoming paperless, and buying wind credits in addition to their previous efforts at using biodegradable products and subsidizing public transportation.

A number of tactics need to be adapted in order to mitigate the negative environmental impacts of the FCC. A stadium will incur a large carbon footprint. In order to offset the negative impact, the stadium can focus on using green energy sources or purchase carbon offsets for energy used. Generators and vehicles used on behalf of the stadium can use biodiesel. On-site recycling in conjunction with biodegradable food service materials is an important element in keeping the stadium as green as possible, and any compostable refuse can be sent to local farms for use.

It is important that the FCC maintain or improve the local area's landscape. By hiring a local botanist, a diverse group of local plant species can be planted around the buildings, which will maintain biodiversity, decrease the runoff from the increased parking, and help aesthetics. Native plant species need less water during planting and the stadium can use high-efficiency irrigation systems with a 95% efficiency rate compared to the 60% efficiency-rated irrigation systems. Optimally, this can save 700,000 gallons of water every year. Porous pavement can be used to manage the increased run-off from the additional parking and walkways. Porous pavement consists of crushed granite stone material instead of plantings or concrete medians. It allows rainwater to recharge groundwater and reduces the amount of storm water that flows into the surrounding environment (MetLifestadium.com).

The impact of the construction and use of the FCC on Lancer Park residents must be constantly evaluated. We suggest noise ordinances, such as only weekend

concerts during the school year, in order to avoid sleep deprivation on weeknights for college students. Complimentary earplugs should be provided to drown out the noise pollution when the students need to concentrate. It is also suggested that public safety officials be placed on duty during times of FCC usage, ensuring the safety of the college students. These officers can also be in charge of litter control and have the ability to fine people who do not follow the rules. This will assist in maintaining an environmentally friendly production. The concerns of residents should be continually assessed and addressed to reduce any negative impact on their lives.

7. Summary and Conclusions

This project used an EIA in order to evaluate the impact of building a concert hall (FCC) at Lancer Park in Farmville, Virginia. The EIA evaluated the FCC's impact in four different areas: physical resources, ecological resources, human use values, and quality of life values. For each area, the current status of Lancer Park was assessed, and then the probable impacts of the FCC were discussed based on other research.

The current use of Lancer Park mainly includes living facilities and physical recreation. It is obvious that the area is already being impacted by the presence of people and the built environment. A thermal image of the area shows the heat production of the apartment complexes. The species diversity of the area is decreased near the apartments as well. There are currently few jobs at Lancer Park.

The building of the FCC will have an inconsequential economic effect on the area and will likely have some negative impact on the human and natural environments. The soil, water, and air are sure to be polluted with the presence of more people. This will affect Lancer Park residents, as well as the natural environment. In general, the ecological and physical impact will likely be an increase of the current impact by Lancer Park. Some individual organisms will be more affected, such as the killdeer as shown in Figure 4. However, the positive cultural impacts that it can serve cannot be negated. This development could lead to a higher sense of community bonds and socialization.

It is our conclusion that the most impacted areas from the construction and utilization of the FCC on North Campus are likely the human-use values and quality of life values resulting from the influx of concert-goers and new buildings. The lives of Lancer Park residents will be severely impacted, as discussed through much of this article. It is important to consider the impact reduction suggestions in Section 6 in order to make the impact of the FCC more positive on the environment. If the correct impact reduction techniques are used, the area will benefit from the cultural impact of the FCC.

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Artist:

Kristin McQuarrie

"Directions"
2013

The work is a woodblock print on Mohawk lightweight paper.

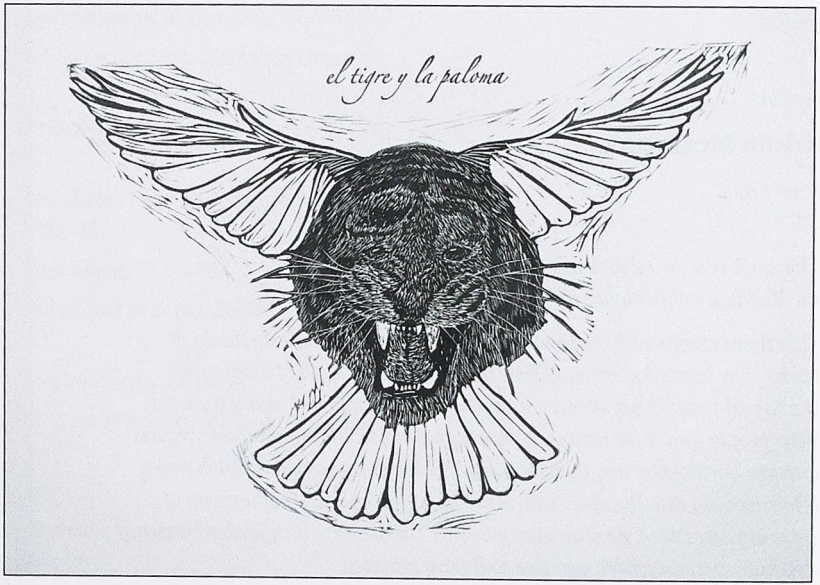
This print stemmed from the theme of cairns, or man-made stacks of rocks. For North America, cairns are largely a method of displaying the literal meaning of direction, as they are often found along trails to help people find their way in a geographic sense. However, if one travels outside North America, the meaning of cairns encompasses much more, often moving into the spiritual, thereby giving cairns another way of showing direction. As with many things, cairns have a different meaning depending upon where you live and have traveled.

Artist:

Sara Nelson

"Evita"
2013

"Evita" is a four-print edition that was originally solely based on my research on modern screen printer Phineas X. Jones. Since the project had to be in relief, I decided to transfer my subject matter to linocut with photopolymer text to fulfill the project's parameters. The subject is based on Jones's gig poster "Elephant Six," an image of his ionic elephant's head, but with crow's wings and tail feathers growing out of the sides. My subject matter was inspired from my Latin American Culture and Civilizations class, where I learned about Eva Perón—iconic political and spiritual leader, activist for the working class, and former Argentinean President Juan Perón's wife and First Lady. Inspired by her successes and passion, I decided to create a tribute to her. A close friend described her in a documentary interview as a "tiger mixed with a dove," having a balance of a bad temper and unmeasured compassion. To tie my image to Jones's screen print work, I illustrated a tiger head with a dove's wings and tail feathers. Above the image are the words "el tigre y la paloma," Spanish for "the tiger and the dove."



Artist:

Melisa Michelle

"Untitled"
2013
Medium: Trace Monotype
Size: 9˝ X 12˝

Everyone wears shoes. They are associated to a lot of different styles, and they are shared by the people of that community. I have made many friends just by wearing my Dr. Marten boots. I first discovered them from this punk I met at radio. He told me the how they were made in England with bouncing soles, and that they became very popular during the punk scene in the late 80s. Metal was always more my style, but I did like a few punk bands. I figured it wouldn't be too bad if I bought a pair. A couple of months later, I started to realize that these boots were more than just music. I noticed that the love for "docs" was shared within street fashion. Not only did I meet many musicians because of these boots, but I also met many artists. I never thought that a shoe could have so much impact on my life. It has become the highlight piece in my wardrobe, and it seems the more scuffed up my boots get, the more compliments I get on them.

Prosocial Behavior as a Result of Prosocial Music

Jessica L. Sudlow

Abstract

Past research supports the notion that prosocial music can promote prosocial behavior and lower aggression. For this study, I tested how prosocial lyrics, relative to no lyrics and aggressive lyrics, affected prosocial behavior in college students. Participants listened to a song that was neutral, aggressive, or prosocial in content. A Likert scale questionnaire assessed the likelihood of prosocial behavior based on a scenario that involved an act of theft toward the participants. Study One did not support that prosocial lyrics affected prosocial behavior; a Mixed Model Analysis of Variance (ANOVA) showed main effects for Study Two. Participants who listened to a prosocial song while reading the lyrics were less likely to argue with their roommate than those who listened to a neutral song. Participants said they were more willing to let their roommate keep some money rather than all of the money. Participants also said they were less angry with their roommate after empathy was presented. The results suggested that prosocial lyrics can lower aggressive behaviors.
Keywords: prosocial music, prosocial lyrics, prosocial behavior, college students

Prosocial Behavior as a Result of Prosocial Music

The directly proportionate relationship between aggression in media and aggressive cognitions and behaviors is one that research repeatedly supports. After decades of exposure, there may be a new form of reversing or combating the effects of aggressive cognitions and behaviors. Researchers are turning to prosocial media: media that promote the welfare of others by emphasizing helping behaviors and positive emotions such as empathy. Prosocial media appear to be having the opposite effect of aggressive media in such a way that they may be lowering aggression and promoting prosocial behaviors and cognitions.

To determine how prosocial media can counteract aggressive media, the effects of aggressive media must be defined through research. Television was one of the first forms of media to be researched in relation to aggression. Certain television shows have been under scrutiny for the amount of gore and violence portrayed and how it affects the viewers in regards to imitation of what they see. Thomas, Horton, Lippincott, and Drabman (1977) found that more frequent exposure to aggressive acts in television desensitized the participant's emotional sensitivity to similar aggressive situations. When viewing real-life aggression in a film, children and adults were less likely to be emotionally responsive after viewing violence on a television drama program (Thomas et al., 1977).

Similarly, the violent content in many video games qualifies them for criticism of aggression and how they affect players. Participants who played a violent video game associated the outsiders of a group with more nonhuman than human

traits (Greitemeyer & McLatchie, 2011). The violent video game players also rated confederates as less likely to possess secondary emotions, such as hope. Participants who played a violent video game also rated themselves with less positive human-uniqueness qualities, such as broadmindedness (Greitemeyer & McLatchie, 2011). Violent video game play resulted in participants scoring higher on state hostility, having less positive affect, and having higher aggravation relative to those who played a neutral or prosocial game (Saleem, Anderson, & Gentile, 2012). These feelings increased in participants playing the violent game compared to participants who played the neutral game (Saleem, Anderson, & Gentile, 2012).

Overall, aggressive media increase desensitization and aggravation, and lower positive affect. Prosocial media are emerging as a counteractive approach to aggressive media by lowering aggressive behaviors and increasing helping behaviors. Television is one media type that can provide lessons of prosocial behaviors. Television that is prosocial in content can include a moral lesson; television that is not necessarily considered a prosocial show as a whole but still contains prosocial lessons can influence prosocial behavior in children. For example, Rosenkoetter (1999) found that children were able to understand and recall moral lessons in *The Cosby Show*, such as not stealing. Mothers rated their children who reportedly watched more prosocial sitcoms, such as *Full House,* to perform more prosocial behaviors, such as helping others (Rosenkoetter, 1999).

Video games centering on prosocial content typically target helping behaviors as the main objective of winning the game, unlike violent video games, which typically center on performing violent actions, such as killing, to win the game. Greitemeyer and Osswald (2009) conducted a study using two video games, one of which was pre-rated as significantly more prosocial than the other game that was considered neutral. Participants played one of the two games and then performed the task of completing a story or completing a word to assess their aggressive cognitions. Both tasks had the opportunity for neutral, aggressive, or prosocial responses. Participants who played the prosocial video game had a reduced hostile expectation bias, which is the players' expectation that the video game character would perform an aggressive act (Greitemeyer & Osswald, 2009). Participants in the prosocial group also had decreased accessibility of antisocial thoughts and reduced aggressive cognitions (Greitemeyer & Osswald, 2009).

Greitemeyer, Osswald, and Brauer (2010) conducted a follow-up study that addressed the relationship among prosocial video games, empathy, and *schadenfreude* (a person's pleasure at someone else's misfortune). Participants played one of two games that were previously rated as prosocial or neutral by Greitemeyer and Osswald (2009) and responded to short articles and essays after playing the games. Participants who played prosocial video games experienced increased empathy towards others and decreased pleasure at others' misfortune, or *schadenfreude* (Greitemeyer, Osswald, & Brauer, 2010). Participants in the prosocial group indicated feeling less of an antisocial affect and having an increased interpersonal empathy (Greitemeyer, Osswald, & Brauer, 2010).

Greitemeyer and Osswald (2010) found that participants

who played a prosocial video game were more likely to perform the following helping behaviors: picking up pencils, participating in other studies without compensation, and intervening in a situation where a woman was harassed (Greitemeyer & Osswald, 2010). Participants experienced more prosocial thoughts after playing the prosocial video game. The same participants were more likely to help pick up spilled pencils than participants in the neutral condition. This finding suggests a mediating mechanism that prosocial thoughts tend to result in prosocial behavior (Greitemeyer & Osswald, 2010).

Another study on prosocial video games provided evidence of lowered feelings of state hostility and aggravation in participants as opposed to those who played a neutral or violent video game (Saleem, Anderson, & Gentile, 2012). One of the most significant findings of this study was that high trait aggression participants experienced lower feelings of aggravation than participants in the violent and neutral game groups, suggesting that prosocial video games can positively affect people who possess higher traits of aggression (Saleem, Anderson, & Gentile, 2012),(Greitemeyer & Osswald, 2010).

Researchers have also examined whether prosocial music can lower aggression and raise prosocial tendencies. Greitemeyer (2009b) conducted one of the first studies in order to examine this relationship. He found that participants had higher prosocial word completion scores if they listened to a song with prosocial lyrics, compared to those who listened to the neutral song. Participants who listened to the prosocial song were more empathetic towards the authors of two essays who were experiencing recent life struggles (Greitemeyer, 2009b). Greitemeyer (2009b) also found that participants who listened to a prosocial song were more likely to donate money than those who listened to a neutral song. Overall, participants had higher accessibility to prosocial thought, showed more interpersonal empathy, and showed an increase in prosocial actions after listening to a song with prosocial lyrics (Greitemeyer, 2009b).

Greitemeyer (2011) also tested the relationship between prosocial lyrics and lowering aggression. Participants who listened to a song with neutral lyrics had a higher amount of aggressive words in a word completion task than those who listened to a song with prosocial lyrics, thus lowering accessibility of antisocial thoughts (Greitemeyer, 2011). Prosocial songs elicited negative attitudes toward war and lower acceptance of penal code violence from participants (Greitemeyer, 2011). Overall, music with prosocial lyrics decreased aggressive cognition, affect, and behavior in participants (Greitemeyer, 2011).

The previous researchers addressed prosocial music in a specifically controlled setting. Jacob, Guégen, and Boulbry (2010) observed how playing music in a restaurant affected the behavior of customers. Customers who listened to the prosocial music during their meal tipped the waitress more often than those in the neutral and baseline (music normally played in the restaurant) conditions (Jacob et al., 2010). The researchers concluded that songs with prosocial lyrics are associated with helping behavior, i.e. tipping a waitress (Jacob et al., 2010). This study is important to note because it includes participants who did not give sole attention to the music in the background, unlike the other studies. These findings start to define the relationship of

prosocial music and prosocial behaviors when the music is not the sole focus of attention.

The previously mentioned studies assessed how prosocial music made participants respond toward other peoples' unfortunate situations without including the participant in them directly. I wanted to see if music with prosocial lyrics could influence prosocial behavior and decrease aggression if a situation involved the participant first-hand—i.e., if the participant had an unfortunate event happen to him or her. Music is one of the most readily accessible and mobile forms of media, which is why I wanted to address that specific aspect of media rather than television or video games. The reasoning behind manipulating the lyrics comes from the notion that lyrics are the easiest aspect of prosocial music to examine, isolate, and portray prosocial messages. Increasing prosocial thoughts by exposure to prosocial music should lead to prosocial behavior by model of the mediating mechanism (Greitemeyer, 2009a). The hypothesis of the following studies was that prosocial lyrics would increase prosocial behavior by increasing empathy and lowering aggression.

Study One

The hypothesis was that the participants who listened to the song with prosocial lyrics would have higher levels of prosocial behavior in response to a scenario than participants who listened to the aggressive or neutral song.

Method: Participants

Participants consisted of 64 students from Longwood University (18 males, 46 females). Participants did not report age and class rank. Participants voluntarily signed up for the study through an online signup system. Participants earned one point of extra credit for various psychology classes, ranging from general education courses to specific psychology major courses, as incentive for participating in the study.

Materials and Procedure

Participants signed up for the study under a deceptive title of "Money and Associated Importance." Participants were assigned to one of three groups: no lyrics (control), prosocial lyrics, and aggressive lyrics. The songs were Michael Jackson's "Will You Be There (Instrumental)", "We Are the World," and "They Don't Care About Us" respectively. The prosocial song "We Are the World" was rated as prosocial in previous research (Greitemeyer, 2009a). Lyrics for the songs are listed in Appendices C and D. Participants heard instructions to listen to the song, as well as to pay attention to the lyrics if there were any. Participants received instructions to listen to the song in order to clear their heads before participating in the survey. These songs were played on a classroom sound system from YouTube.com without the video showing. The prosocial song was 4 min 51 s, the aggressive song was 4 min 44 s, and the neutral song was 3 min 48 s.

Once the song was over, the participants read a scenario that provided opportunities for empathy or aggressive behaviors (Appendix A). In the first part of the scenario, the participant's roommate was caught stealing $40 of hard-earned money from the participant's wallet. The participants then filled out a survey with a series of Likert scale statements ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). These statements addressed how important the money was to the

participant, how upset the participant was, if the participant would fight with his or her roommate, and if the participant would demand the money back (Appendix A). The second part of the scenario, on the opposite side of the paper, provided opportunities for empathy by explaining that the roommate's parents were laid off and the roommate needed the money for groceries and other necessities but was too embarrassed to ask. The participants then filled out a second series of Likert scale statements which readdressed how upset the participant was, if the participant thought the roommate needed the money more than the participant, if the participant would discuss the issue, and if the participant would let the roommate keep the money. Afterwards, participants were debriefed about the true nature of the study. I compared the participants' answers on the Likert scale survey from each song condition.

Results

A one-way Analysis of Variance (ANOVA) showed that there were no significant differences for the statement "I will have a fight with my roommate about this," $F(2,63) = 1.66, p = .198$. There were also no significant differences between groups for the statement "My roommate needs my money more than I do," $F(2,63) = 2.03, p = .141$. There were no significant differences between groups for any of the other statements.

Discussion:

Overall, the results were incongruent with the hypothesis. Prosocial lyrics did not have an effect on the likelihood of prosocial behaviors. Prosocial lyrics also did not lower aggressive behaviors and cognitions in the participants. There were several factors that may have led to these findings. Some participants seemed to not pay attention to the song while it was playing. Participants may have only paid attention to whether they knew the song or the beat, tempo, or melody. The lyrics of the aggressive song may have been hard to understand because they were sung faster than the prosocial song; the lyrics were also sung in an aggressive tone, which may have affected the enunciation of the words. In future research, if using an aggressive song, the lyrics should be available for both songs to truly measure how the lyrics affect prosocial behaviors and decreased aggression. A manipulation check would have addressed how aggressive or prosocial participants thought each song was in content.

Participants may have thought that $40 in the scenario was not a significant amount of money. If amount of money was not large enough to warrant aggressive behaviors and cognitions if stolen, then participants would not be more or less likely across conditions to let the roommate keep the money or to demand it back.

A larger underlying factor may be that the scenario did not include what type of relationship the roommate and the participant had. For some participants, they may have read the scenario with their own current roommate situations in mind. Participants may have thought of current roommates who are good friends, rather than someone they do not quite know or trust yet. As an observation, sometimes it may be easier to forgive or have empathy for a good friend versus a relative stranger. All of these factors contributed to the changes made in Study Two.

Study Two

Based on the limitations of Study One, Study Two included revisions to the materials used in the first study. The money in the scenario was raised from $40 to $80 in order to make the money have a higher impact on the participant. The scenario also included a short description that the participant and roommate had only known each other for two weeks prior to the incident. In order to accurately address whether it is the lyrics themselves that have an effect on prosocial behaviors, only prosocial and neutral songs were used. The independent variable was again the type of lyric, with one group reading the lyrics while listening to the prosocial song. I hypothesized that participants who listened to the prosocial song while reading the lyric sheet would have higher levels of prosocial behavior in response to a scenario, compared to those who listened to the neutral song.

Method: Participants

Participants consisted of 70 students from Longwood University (12 males, 58 females). The ages ranged from 18 to 27 years (M = 19, SD = 1.6). There were 33 freshmen, 18 sophomores, 11 juniors, and 8 seniors. Two participants' data were excluded because they had participated in Study One. Participants voluntarily signed up for the study through an online signup system. Participants earned one point of extra credit for various psychology classes, ranging from general education courses to specific psychology major courses, as incentive for participating in the study.

Materials and Procedure

Participants signed up for the study under a deceptive title of "Money and Associated Importance." Participants were randomly assigned to one of three groups: no lyrics (control), prosocial lyrics, and prosocial lyrics with a lyric sheet. The lyrics that the participants read are shown in Appendix C. The songs were the same prosocial and neutral song used in Study One. The procedure for the study remained the same as Study One with a few changes. The purpose of the song was portrayed as a way to ensure the same experience for all participants before the survey. Once the song was over, the participants read a scenario similar to the scenario used in Study One that provided opportunities for empathy or aggressive behaviors, with minor changes. In the first part of the scenario, the participant's roommate was caught stealing $80 of hard-earned money from the participant's wallet. The statements on the survey addressed anger, hitting, having an argument, and suspicion of previous theft as aggressive responses (Appendix B). A manipulation check was included to ensure that participants thought $80 was a significant amount of money. The participants then filled out a second series of Likert scale statements that reevaluated anger of the participant. The statements also provided opportunities for prosocial behavior such as letting the roommate keep all or part of the money, discussing the issue rather than arguing, and admitting that the roommate needed the money more.

Results

A one-way Analysis of Variance (ANOVA) showed the question "I will have an argument with my roommate about this" was approaching significance $F(2, 69) = 2.80$, $p = .068$. The participants who read the prosocial lyrics ($M = 3.92$, $SD = .93$) said they were less likely to have an argument with their

roommate than those who heard the song with no lyrics ($M = 4.48$, $SD = .90$).

To examine the changes between the three groups from the initial set of questions to the second set of question, I conducted a 2 (question: first question vs second question) x 3 (lyric type: no lyrics, prosocial lyrics, or prosocial lyrics with a lyric sheet) Mixed Model ANOVA for each set of questions that addressed aggressive and prosocial behaviors before and after the second part of the scenario. The question sets were the within-subjects variable and the lyric type was the between-subjects variable. There was a main effect for the lyric manipulation for the behavior of arguing $F(2, 67) = 4.61$, $p = .013$ (Figure 1). A Tukey post hoc revealed that those in the control group ($M = 3.11, SD = .88$) said that they were more likely to have an argument with their roommate, whereas those who read the lyrics while listening to the prosocial song ($M = 2.63$, SD = .72) said that they were less likely to have an argument with their roommate, $p = .014$. Participants in the group who heard the prosocial song but did not read the lyrics ($M = 3.00, SD = .82$) said they were more likely to argue with their roommate than those who did read the prosocial lyrics while listening to the song, $p = .072$.

One of the Mixed Model ANOVAs showed a main effect for being angry at the roommate for stealing the money regardless of lyric manipulation $F(1, 67) = 65.61, p < .001$ (Figure 2). The participants were angrier ($M = 4.84, SD = .40$) with their roommate while answering the first set of questions, whereas they showed less anger ($M = 3.94$, $SD = .99$) for the second set of questions after reading the reasoning. There was a similar main effect between the two sets of questions for the amount of money participants would let their roommate keep $F(1, 67) = 51.271, p < .001$ (Figure 3). Participants who said that they would not let their roommate keep all of the money ($M = 2.27, SD = 1.20$) said that they would let their roommate keep some of the money ($M = 3.20, SD = 1.35$). These two main effects support that participants were more likely to change their opinions toward their roommate once they learned why the roommate stole the participant's money.

Discussion:

Overall, the study showed that prosocial lyrics were helpful in lowering a participant's aggressive behavior of arguing. Participants were less angry and more willing to let the roommate keep a partial amount of the money once they understood why the roommate stole it. The findings parallel those of previous research (Greitemeyer, 2011) showing that prosocial lyrics lower rates of aggression. Prosocial lyrics can positively affect the behaviors and cognitions of people.

The scenario itself provided an explanation of the roommate's action that should have easily elicited empathy. A manipulation check for empathy toward the roommate would address differences in empathy across conditions. Further examination of the relationship between empathy and decreased aggression would help to explain why participants were less angry and more likely to let the roommate keep some of the money after learning the explanation, regardless of which song participants heard.

The questionnaire should have also included a manipulation check to ensure that the participants viewed the prosocial song as more prosocial in content than the

neutral song. The prosocial song was previously rated as prosocial in content (Greitemeyer, 2009a), but the song should have been rated again by this study's participants.

Similar to previous research on music with prosocial lyrics (Greitemeyer, 2009b; 2011; Jacob, Guégen, & Boulbry, 2010), this study observed short-term effects. Future research should address long-term effects on participants. This study also tested only for the lyrics of the song. While the artist was the same for each song, other aspects, such as tempo, were not controlled. Using the same song and changing the lyrics of that song would control for all assets of a song, providing more accurate representation of the effect of prosocial lyrics on prosocial behavior.

Defining the relationship between prosocial media and prosocial behavior is important because it could facilitate increased prosocial behavior in everyday situations. Further research could examine how prosocial music played in schools between class changes affects the moods and behaviors of students. Prosocial music on the radio may reduce aggression of drivers in heavy traffic areas. Research to this point showed that prosocial music can lower aggression and increase prosocial thoughts and behaviors. Emphasizing this type of prosocial media could effectively decrease the impact aggressive media have had on aggressive behaviors.

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Appendix A

Please read the following scenario carefully.

You have just finished working a shift of your 35-hour workweek to help pay for your college tuition. It is late at night and you still have to study for two tests tomorrow, so you decide to stop by a place where you can get food quickly and take it home. You realize before you order that you left your wallet at home before you left for work. You decide to drive home to get your wallet and then go back to get some food. When you walk into your room, you witness your roommate taking $40 out of your wallet.

Please read the following statements and circle only one number for each statement.

Please read the following statements and circle only one number for each statement.

1. I am upset with my roommate for stealing my money.

Strongly Disagree		*Neutral*		*Strongly Agree*
1	2	3	4	5

2. I worked hard for my money.

Strongly Disagree		*Neutral*		*Strongly Agree*
1	2	3	4	5

3. My money is worth a significant amount to me.

Strongly Disagree		*Neutral*		*Strongly Agree*
1	2	3	4	5

4. I will have a fight with my roommate about this.

Strongly Disagree		*Neutral*		*Strongly Agree*
1	2	3	4	5

5. I am wondering if my roommate has stolen my money in the past.

Strongly Disagree		*Neutral*		*Strongly Agree*
1	2	3	4	5

6. I will demand that my roommate give back my money.

Strongly Disagree		*Neutral*		*Strongly Agree*
1	2	3	4	5

Please turn over and complete the backside. It is a continuation of the scenario you just read.

Please read the following scenario carefully.

After witnessing your roommate take your money, they break down in front of you. They start to explain that their parents got laid off around the same time and the family is struggling for money. Your roommate was too embarrassed to tell you that they could not afford groceries and other necessities. They explain that they never meant to hurt you or to have to steal money from you.

Please read the following statements and circle only one number for each statement.

7. I am still upset with my roommate for stealing my money.

Strongly Disagree		*Neutral*		*Strongly Agree*
1	2	3	4	5

8. I will tell my roommate to keep the money.

Strongly Disagree		*Neutral*		*Strongly Agree*
1	2	3	4	5

9. My roommate needs my money more that I do.

Strongly Disagree		*Neutral*		*Strongly Agree*
1	2	3	4	5

10. I want to discuss this issue with my roommate, rather than fight about it.

Strongly Disagree		*Neutral*		*Strongly Agree*
1	2	3	4	5

11. Stealing my money was wrong.

Strongly Disagree		*Neutral*		*Strongly Agree*
1	2	3	4	5

Appendix B

Age: _____ Sex: _____

Class (Circle One):

Freshman Sophomore Junior Senior Graduate

Please read the following scenario carefully.

You have just finished working a shift of your 35-hour workweek to help pay for your college tuition. It is late at night and you still have to study for two tests tomorrow, so you decide to stop by a place where you can get food quickly and take it home. You realize before you order that you left your wallet at home before you left for work. You decide to drive home to get your wallet and then go back to get some food. When you walk into your room, you witness your roommate taking $80 out of your wallet without your permission. You and your roommate have known each other for only 2 weeks.

Please read the following statements and circle only one number for each statement.

Please read the following statements and circle only one number for each statement.

1. I am angry at my roommate for stealing my money.

Strongly Disagree *Neutral* *Strongly Agree*

1 ..... 2 ..... 3 ..... 4 5

2. Eighty dollars is a significant amount of money to have stolen.

Strongly Disagree *Neutral* *Strongly Agree*

1 ..... 2 ..... 3 ..... 4 5

3. I want to hit my roommate for stealing my money.

Strongly Disagree *Neutral* *Strongly Agree*

1 ..... 2 ..... 3 ..... 4 5

4. I will have an argument with my roommate about this.

Strongly Disagree *Neutral* *Strongly Agree*

1 ..... 2 ..... 3 ..... 4 5

5. I suspect my roommate has stolen my money in the past.

Strongly Disagree *Neutral* *Strongly Agree*

1 ..... 2 ..... 3 ..... 4 5

6. I will demand that my roommate give back my money.

Strongly Disagree *Neutral* *Strongly Agree*

1 ..... 2 ..... 3 ..... 4 5

Please read the following scenario carefully.

After witnessing your roommate take your money, he/she emotionally breaks down in front of you. They start to explain that his/her parents got laid off around the same time and the family is struggling for money. Your roommate was too embarrassed to tell you that he/she could not afford groceries and other necessities. Your roommate explains that he/she never meant to hurt you or to have to steal money from you.

Please read the following statements and circle only one number for each statement.

Please read the following statements and circle only one number for each statement.

7. I am still angry at my roommate for stealing my money.

Strongly Disagree *Neutral* *Strongly Agree*

1.....2.....3.....4.....5

8. I will let my roommate keep the money.

Strongly Disagree *Neutral* *Strongly Agree*

1.....2.....3.....4.....5

9. My roommate needs my money more than I do.

Strongly Disagree *Neutral* *Strongly Agree*

1.....2.....3.....4.....5

10. I want to discuss this issue with my roommate, rather than argue about it.

Strongly Disagree *Neutral* *Strongly Agree*

1.....2.....3.....4.....5

11. Stealing my money was wrong.

Strongly Disagree *Neutral* *Strongly Agree*

1.....2.....3.....4.....5

12. I will let my roommate keep some of the money.

Strongly Disagree *Neutral* *Strongly Agree*

1.....2.....3.....4.....5

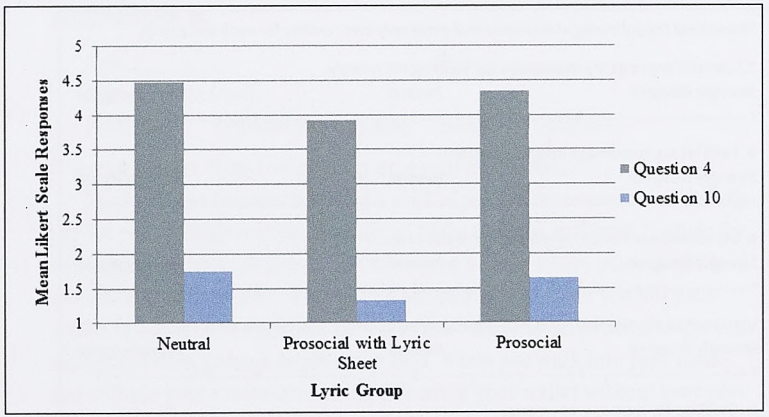
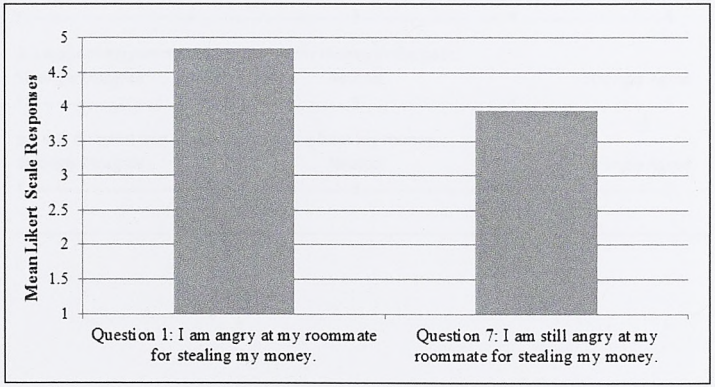


Figure 1. Differences in likelihood of arguing. Mean answers on a Likert Scale question from 1 (Strongly Disagree) to 5 (Strongly Agree) for question four, "I will have an argument with my roommate about this" and question ten, "I want to discuss this issue with my roommate, rather than argue about it." The asterisk indicates the significant difference from the Tukey post hoc, $p < .014$. The participants in the group who heard the prosocial song while reading the lyrics were less likely to argue with their roommate than those in the neutral song group with no lyrics.

Figure 2. Differences in anger. Mean answers on a Likert Scale question from 1 (Strongly Disagree) to 5 (Strongly Agree). Significant difference occurred between the two questions, with lyric type having no effect $F(1, 67) = 65.61$, $p < .001$. Participants were less angry once they were informed of why their roommate stole the money, regardless of what song they heard.



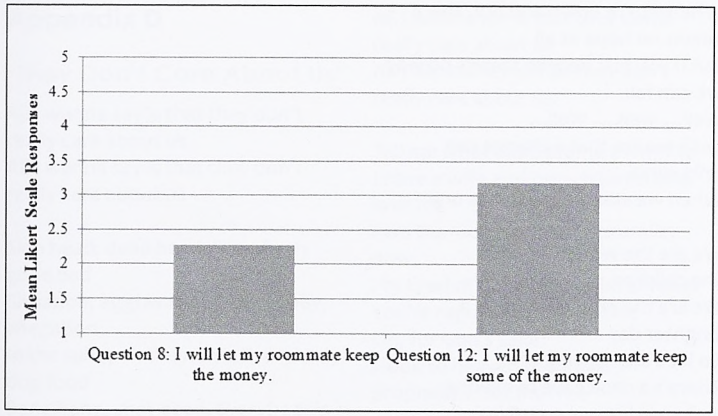


Figure 3. Differences in likelihood of giving. Mean answers on a Likert Scale question from 1 (Strongly Disagree) to 5 (Strongly Agree). Significant difference occurred between the two questions, with lyric type having no effect $F(1, 67) = 51.27$, $p < .001$. Participants were more likely to let their roommate keep some of the money, regardless of what song they heard.

Appendix C

"We Are the World"

There comes a time, when we heed a certain call
When the world must come together as one
There are people dying, and it's time to lend a hand to life
The greatest gift of all

We can't go on, pretending day by day
That someone somewhere will soon make a change
We all are a part of God's great big family
And the truth, you know,
Love is all we need
We are the world, we are the children

We are the ones who make a brighter day
So let's start giving
There's a choice we're making,
we're saving our own lives
It's true we'll make a better day
Just you and me

Send them your heart, so they'll know that someone cares
And their lives will be stronger and free
As God has shown us by turning stone to bread
So we all must lend a helping hand

We are the world, we are the children
We are the ones who make a brighter day
So let's start giving
There's a choice we're making, we're saving our own lives
It's true we'll make a better day
Just you and me

When you're down and out, there seems no hope at all
But if you just believe there's no way we can fall
Well... well.... Well...
Let's realize that a change can only come
When we stand together as one

We are the world, we are the children
We are the ones who make a brighter day
So let's start giving
There's a choice we're making,
we're saving our own lives
It's true we'll make a better day
Just you and me

Appendix D

"They Don't Care About Us"

All I wanna say is that they don't really care about us
All I wanna say is that they don't really care about us

Skin head, dead head, Everybody gone bad
Situation, aggravation, Everybody allegation
In the suite, on the news, Everybody dog food
Bang bang, shot dead, Everybody's gone mad

All I wanna say is that they don't really care about us
All I wanna say is that they don't really care about us

Beat me, hate me, You can never break me
Will me, thrill me, You can never kill me
Do me, sue me, Everybody do me
Kick me, strike me, Don't you black or white me

All I wanna say is that they don't really care about us
All I wanna say is that they don't really care about us

Tell me what has become of my life
I have a wife and two children who love me
I am the victim of police brutality, now
I'm tired of bein' the victim of hate
You're rapin' me off my pride
Oh, for God's sake
I look to heaven to fulfill its prophecy... Set me free

Skin head, dead head, Everybody gone bad
Trepidation, speculation, Everybody allegation
In the suite, on the news, Everybody dog food
Black male, black mail, Throw your brother in jail

All I wanna say is that they don't really care about us
All I wanna say is that they don't really care about us

Tell me what has become of my rights
Am I invisible because you ignore me?
Your proclamation promised me free liberty, now
I'm tired of bein' the victim of shame
They're throwing me in a class with a bad name
I can't believe this is the land from which I came
You know I really do hate to say it
The government don't wanna see
But if Roosevelt was livin', He wouldn't let this be, no, no

Skin head, dead head,
Everybody gone bad
Situation, speculation,
Everybody litigation
Beat me, bash me, You can never trash me
Hit me, kick me, You can never get me

All I wanna say is that they don't really care about us
All I wanna say is that they don't really care about us

Some things in life they just don't wanna see
But if Martin Luther was livin', He wouldn't let this be, no, no

Skin head, dead head, Everybody gone bad
Situation, segregation, Everybody allegation
In the suite, on the news, Everybody dog food
Kick me, strike me, Don't you wrong or right me

All I wanna say is that they don't really care about us
All I wanna say is that they don't really care about us
(Repeat 3 times)

Designer:

Perry Bason

logo for the
Office of Sponsored Programs,
2012

Designer:

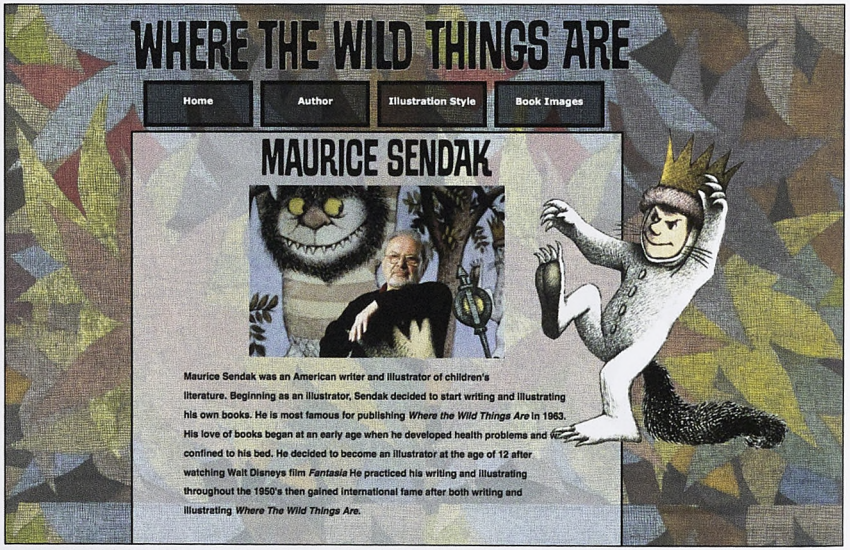
Danielle Dmuchowski

poster for a production of "Amazons and Their Men," 2012

Designer:

Mariah Asbell

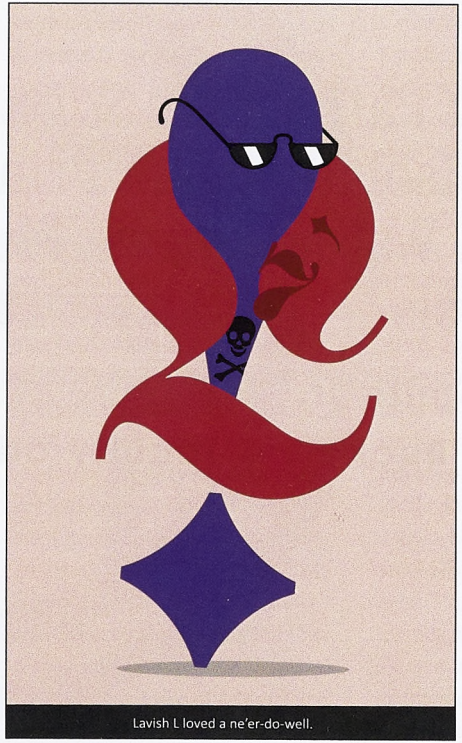
page from a website about Maurice Sendak's "Where the Wild Things Are."
2012



Designer:

Matthew Sakach

illustration using only letterforms for an abecedarian, 2012



Identifying Pathogenic *Salmonella* Serotypes Isolated from Prince Edward County, VA Waterways via Multiplex PCR Analysis

Timothy M. Smith Jr.

Dr. David W. Buckalew, faculty advisor

Introduction

The bacteria classified within the genus *Salmonella* are gram-negative, facultative, rod-shaped bacteria (Yingqin et al., 2012) within the well-documented Family Enterobacteriaceae. However, the taxonomy of *Salmonella* is somewhat complex. The current taxonomic scheme consists of the genus *Salmonella* containing two species — *S. enterica* and *S. bongori* (Bhaduri et al., 2009). Within the species *S. enterica*, there are seven groups or subspecies *(ssp.)*, which are further composed of serovars. Currently, there are 2,579 recognized *Salmonella* serovars (Dera-Tomaszewska, 2012). The most common pathogens for humans are found in Group 1, which contains all of the serovars of *Salmonella enterica ssp. enterica* (Miljković-Selimović et al., 2010). When citing a particular serovar, one may choose to state the entire genus, species, subspecies, and serovar such as in *Salmonella enterica ssp. enterica* serovar Typhimurium, or one can abbreviate with genus, subspecies, and serovar such as in *S. enterica* serovar Typhimurium.

The genus is well known as a human pathogen causing "salmonellosis" and is most commonly associated with cases of gastroenteritis, but can also include self-limiting enterocolitis, typhoid fever, or bacteremia (Lee et al., 2012). It is currently a topic of debate as to whether all serovars of *Salmonella enterica* are pathogenic to humans as stated by Bhowmick et al. (2010) and Hassanein et al. (2011) or whether only certain serovars can cause illness as stated by Cabral (2010). The two serovars that are most clinically relevant are *S. enterica ssp enterica* serovars Typhimurium and Enteritidis (Madigan et al., 2006). According to the World Health Organization (2005), 61% of reported cases of salmonellosis are atttributed to the *S. enterica* serovar Enteritidis, while *S. enterica* serovar Typhimurium contributes to 18% of reported cases.

The reservoirs for *Salmonella* occurrence are numerous. Broiler houses containing chickens are a major source of *Salmonella* as are most avian species, and many reptiles and insects, such as the Litter Beetle, can also serve as potential reservoirs (Bleasdale et al., 2009). Poultry farmers must take substantial measures in order to avoid contamination with their food products. Yet, despite precautionary measures by farmers, containment mechanisms are sometimes breached (Mukherjee et al., 2004). While many farmers have on-site sanitation strategies adopted from recommendations by the United States Department of Agriculture Food Safety Inspection Service, these strategies may be unfit to control every *Salmonella* serovar (Hong et al., 2008). In the case that a control strategy fails, it would be beneficial for the farmer to identify the specific serovar to gain a better understanding of its source and thus be aware of critical points of intervention.

Currently, most methods of serotyping are expensive and require a high degree of training to interpret and understand (Martinez et al., 2010). The most common non-molecular means of serotyping involves antibody agglutinations using a wide array of latex bead solutions coated in a variety of surface antibodies (polyclonal) specific for a given serovar — requiring both a time-consuming and expensive process. This makes molecular typing a much more viable option for many. Hong et al. (2008) developed an antigenic key based on a multiplex polymerase chain reaction (MPCR)

that utilizes primers specific to the O, H1, and H2 gene sequences for antigens of *Salmonella* isolated from chicken broiler houses in order to serotype clinically relevant serovars which commonly occur there.

This study utilizes Hong et al.'s (2008) serotyping method to examine the type specificity of *Salmonella* serovars isolated from local waterways near Farmville, Virginia. Most available environmental literature focuses on the entire Genus of *Salmonella* without specifying serovar. This study will attempt to identify the presence of *S. enterica ssp. enterica* serovars Typhimurium, Enteritidis, Hadar, and Heidelberg. To accomplish this task, molecular (nuclear-acid based) characteristics are to be assessed by MPCR technology to determine or type the individual isolates of *Salmonella* bacteria.

Materials and Methods

Creating the *Salmonella* Isolate Library

Water samples were collected from three locations in Prince Edward (PE) and Cumberland Counties in Virginia: Appomattox River (APP2), Saylor's Creek (SAY5), and Green Creek (GRE16). Each sampling location was specifically chosen as it reveals a variable, yet chronic, record of high indicator bacterial presence. The samples were collected by lowering a sterile container mid-column into the stream while avoiding the uptake of autochthonous debris. Samples were then placed on ice and transported back to the laboratory for processing.

In the laboratory, the samples were assayed via membrane filtration using one milliliter (mL) of sample diluted with sterile, buffered water and filtered through a 0.45 um pore size filter membrane (Millipore, Bedford, MA). The filter membrane was transferred to a 50 mm petri plate containing 1.5 mL of tetrathionate enrichment broth (Oxoid, United Kingdom) enhanced with novobiocin (Merck, Whitehouse Station, NJ) (40 mg/L) to reduce background enteric bacterial growth and incubated at 35°C for 6-8 hours. The filter membrane was then transferred to a 50 mm petri plate containing 1.5 mL of sterile Brilliant Green Bile (BGB) broth (Remel, Lanexa, KS) and incubated an additional 24 hrs at 35°C.

At 24 hours, the plates were examined for all colony-forming units (CFU) presumed *Salmonella spp.*based upon colonial phenotype (i.e., color and morphology) — all presumed colonies were enumerated for the *Salmonella spp.*count at this time. Representative CFU's of differing colonial phenotype were photographed and then aseptically transferred to Triple Sugar Iron (TSI) agar slants for further diagnostic testing and for later serological confirmation. TSI agar slants were incubated at 35°C for 48 hrs.

After the incubation period on TSI agar, sugar use, CO_2, H_2S production, and growth morphology were recorded. Aseptically obtained samples from the TSI tubes were then subjected to serologic confirmation using Oxoid Rapid *Salmonella* Antibody Beads™ agglutination.

Serologic confirmation by antibody agglutination was performed by mixing a loop of presumptive bacteria into the polyclonal antibody bead mixture for ten seconds on an assay card, which was tilted back and forth for an additional minute as per manufacturer's instructions. Agglutination of the beads signified a positive test for *Salmonella spp.*

All bacterial isolates from TSI agar slants revealing positive agglutination were transferred to

nutrient broth media to be added to the isolate library. Isolates in the library were held at room temperature and aseptically transferred to new nutrient broth media once every seven days.

Extraction of Genomic DNA (gDNA) from Isolates and Obtaining Control gDNA

An isolate was inoculated in nutrient broth media and incubated at 37°C for at least 18 hrs. Genomic DNA of the isolate was then extracted using the DNeasy Blood and Tissue Kit (Qiagen, Hilden, Germany) according to the manufacturer's instructions. The cell lysate was then centrifuged at full speed (13,000 rpm for 5 min) to pellet the cellular debris. Two uL of the supernatant was used as a template for the MPCR modified from Jamshidi et al. (2009). Thirty-two isolates in total were processed.

Genomic DNA from 6 *Salmonella spp.* serovars was obtained from the Center for Food Safety, Dept. of Avian Medicine at the University of Georgia. The gDNA from serovars Mbandaka, Kentucky, Enteritidis, Typhimurium, Heidelburg, and Anatum were obtained to provide a positive control for the various antigenic formulae during the multiplex PCR process. All 6 control serovars produced the expected antigenic formulae upon PCR amplification.

MPCR Primer Design

For further confirmation that the samples were *Salmonella spp.*, a DNA primer specific for the *stn* gene, which codes for the *Salmonella* enterotoxin, was used (see Table 1) (Makino et al. ,1999). To specifically distinguish between different bacteria or groups of bacteria, researchers often look for unique differences between the genomes of the bacteria. To differentiate between serogroups of *Salmonella*, the DNA sequence of specific genes within each serogroup that codes for certain antigens (a foreign molecule that may invoke an immune response) is often chosen as the differentiation factor (DF). To view gene-specific differences, a variety of synthesized primers were utilized in the MPCR. This study adopted the serogroup-specific primer sequences that were used by Hong et al. (2008).

Hong et al. (2008) chose the O-antigen, part of the lipopolysaccaride (LPS) on the surface of gram-negative bacteria, H1 antigen, and H2 antigen (H antigen proteins are associated with the flagellar surfaces of bacteria) as DF's for pathogenic *Salmonella* serogroupings. The genetic differences between the alleles that code for the O, H1, and H2 antigens amongst the serogroups may be exploited to differentiate them because the O, H1, and H2 antigens have several possible alleles (Joys, 1985; Samuel and Reeves, 2003). For the antigenic formulae for *S. enterica* serovars that were relevant to this study, see Table 2. The antigenic formulae for a particular serovar consists of 3 alleles: one from each of the O-antigen, H1 antigen, and H2 antigen alleles. The O-antigen allele is expressed as a number (e.g., serovar California has an O-antigen allele of 4). The H1 and H2 antigens also have their own respective nomenclature for the various alleles such as *fliC*.

To develop the specific primers needed to isolate the sequence of nucleotides that code for these DF's, the serogroup-specific *wba* operon (related to the O-antigen), *fliC* allele (related to H1 antigen), and *fliB* allele (related to H2 antigen) were compared amongst serogroups to identify portions of sequences that consistently differed

Table 1: Forward (F) and reverse (R) primer sequences for each gene and expected amplicon size magnified by MPCR of the *Salmonella* isolates – Adapted from Hong et al. (2008)

Target gene	Primer sequence	Expected amplicon size	References
O-antigen multiplex			
abe1 (4)	F: GGCTTCCGGCTTTATTGG R: TCTCTTATCTGTTCGCCTGTTG	561	Hong et al. (2008)
wbaD-manC (6,7)	F: ATTTGCCCAGTTCGGTTTG R: CCATAACCGACTTCCATTTCC	341	
abe2 (8)	F: CGTCCTATAACCGAGCCAAC R: CTGCTTTATCCCTCTCACCG	397	
prt (2 or 9)	F: ATGGGAGCGTTTGGGTTC R: CGCCTCTCCACTACCAACTTC	624	
wzx – wzy (3,10)	F: GATAGCAACGTTCGGAAATTC R: CCCAATAGCAATAAACCAAGC	281	
H1-1 Multiplex			
fliC (i)	F: AACGAAATCAACAACAACCTGC R: TAGCCATCTTTACCAGTTCCC	508	
fliC (g,m)	F: GCAGCAGCACCGGATAAAG R: CATTAACATCCGTCGCGCTAG	309	
H1-2 Multiplex			
fliC (r)	F: CCTGCTATTACTGGTGATC R: GTTGAAGGGAAGCCAGCAG	169	
fliC (z_{10})	F: GCACTGGCGTTACTCAATCTC R: GCATCAGCAATACCACTCGC	363	
H2 Multiplex			
fljB (1: 1,2; 1,5; 1,6; 1,7)	F: AGAAAGCGTATGATGTGAAA R: ATTGTGGTTTTAGTTGCGCC	294	
fljB (1l: e,n,x; e,n,z_{15})	F: TAACTGGCGATACATTGACTG R: TAGCACCGAATGATACAGCC	152	
Control Primers: Stn Enterotoxin *Stn gene*	F: CTTTGGTCGTAAAATAAGGCG R: TGCCCAAAGCAGAGAGATTC	260	Makino et al. (1999)
Control Primers: Universal 16S *16S Eubacteria*	F: AGAGTTTGATCCTGGCTCAG R: ACGGCTACCTTGTTACGACTT	1500	Weisburg et al. (1991)
Control Primers: *E. coli* Control *Ecol*	F: GACCTCGGTTTAGTTCACAGA R: CACACGCTGACGCTGACCA	585	Wang et al. (1996)

O	H1	H2	*S. enterica* serovar
4	g,m	-	Essen
4	g,m	z_{67}	California
4	g,m	z_{39}	II
4	i	l,2	Typhimurium
4	i	1,6	Agama
4	r	1,2	Heidelburg
4	i	1,5	Lagos
8,20	z_{10}	1,2	Bazenheid
6,8	z_{10}	1,2	Zerifin
8,20	z_{10}	1,5	Paris
6,8	z_{10}	1,5	Mapo
6,8	z_{10}	1,7	Cleveland
8,20	r	l,w	Brikama
6,8	r	l,w	Goldcoast
8	g,m,s	-	Emek
8	g,m,t	-	Reubeuss
8,20	i	l,w	Magherafelt
6,8	i	l,w	Cyprus
8	i	z_6	Kentucky
8	z_{10}	e,n,x	Hadar
9	g,m	-	Enteritidis
3,10	i	1,2	Cuckmere
3,10	i	1,5	Amounderness
3,10	e,h	l,6	Anatum
3,10	i	1,6	Tibati
3,10	i	1,7	Truro
3,10	r	1,5	Ughelli
3,10	r	1,7	Elisabethville

Table 2: Antigenic allele formula key for *S. enterica* serovars identifying O alleles, H1 alleles, and H2 alleles that were relevant to this study – Adapted from Hong et al. (2008)

between groups. The specific primer sequence along with its recognized antigenic allele can be seen in Table 1. Primers for this study were synthesized by Integrated DNA Technologies®, Inc. (US) and all primers present in Table 1 were utilized in this study.

Three control primers were also utilized in this study. They included: 1) The *Stn* enterotoxin gene targeting primer which served as a positive control for *Salmonella spp.* forming a band at 260 bp for *Salmonella* spp .— other bacterial species should not produce an amplicon when paired with the *Stn* primers as this gene is specific for the Genus; 2) The Universal prokaryotic 16S primer was also a positive control primer that amplifies a highly conserved region coding for the 16S ribosomal subunit. Any eubacteria should amplify a region of approximately 1500 bp when paired with the Universal 16S primers while non-eubacteria should not produce such amplicons; and, 3) The *E. coli* control primer was used as a negative control for PCR processing as it produces an amplicon of 585 bp for *E. coli,* producing no amplicon with other bacterial species. The *E.coli* primer was chosen as a negative control to ensure against laboratory contamination throughout any part of the serotyping process.
E. coli was chosen specifically because of its shared presence in the raw water samples and because of the evolutionary relatedness of the two bacterial species.

Mulitplex Polymerase Chain Reaction and Standard Gel Electrophoresis

While it may be possible to allelotype many of the serotypes listed in Table 2, this study focused on allelotyping the four serovars discussed in the introduction: Typhimurium, Enteritidis, Hadar, and Heidelberg. Due to logistical conflicts regarding the addition of different primers to the PCR mixture, a single reaction mixture with all of the O-antigen primers was not possible. Instead, a single isolate first underwent an array of amplifications for each allelotyping with one primer in the reaction tube. This meant, for example, that isolate 1 required a minimum of 5 reaction vessels for the O-antigen allelotyping (one reaction vessel for each O-antigen allele primer — see Table 1). The same protocol was used for the H1 antigen allelotyping and the H2 antigen allelotyping. In addition to the primers selected for the antigenic alleles, each isolate was subjected to the positive control primers (Universal 16S primer and *stn* primer) as well as the *E. coli* negative control primer to ensure PCR integrity.

Once the O-antigen allele was established, if it matched one of the four serovars for the putative O-antigen allele (see Table 1), then a second allelotyping PCR was performed using the appropriate H1 primer set. Again, if the second allelotyping matched one of the four serovars above then a third and final PCR using the H2 primer set was completed. The visualization of amplicon products after gene amplification was made via standard gel electrophoresis.

For the PCR reactions, 2 uL of extracted gDNA was utilized in the QIAGEN Multiplex PCR Kit (Qiagen, Hilden, Germany) along with the appropriate primer set, all of which were contained in a sterile 0.5 mL PCR tube (modified from Hassanein et al. 2011). The PCR kit typically contains Taq polymerase (an enzyme that anneals nucleotides to DNA strands; capable of surviving the high temperatures

needed for DNA denaturation), free deoxynucleoside triphosphates (used as the building blocks of amplicons), and buffers. The enzyme, nucleotides, and buffers are collectively known as the master mix. The 0.5 mL PCR tube containing the extracted gDNA, master mix, and the appropriate primer set was placed into a thermocycler programmed to raise and lower its internal temperature over prescribed times in a series of cycles.

The changes in temperature are to promote three major steps in PCR: denaturation (strands of the gDNA disassociate from one another at high temperatures), annealing (the primers associate with the complementary strand of gDNA at lower temperatures), and extension (Taq polymerase builds the remainder of the strand containing the primer using the free nucleotides at medium temperatures). The specific PCR conditions for this experiment were 30 cycles of 94°C for 5 min, 94°C for 1 min (denaturation), 55o°C for 1 min (annealing), and 72°C for 1 min (extension), 72°C for 5 min, then preserved at 4°C according to Hong et al. (2008).

Once the PCR completed, 5 uL of the (possible) product containing the amplicons had 1 uL of loading dye added in order to visualize the amplicons on the agarose gel. Six uL of amplicon product, 6 uL of 100bp marker, and 6 uL of a non-template control were loaded onto a 1.5% agarose gel submerged in 1X Tris-acetate-EDTA buffer stained with ethidium bromide and subjected to electrophoresis for 30 min at 100 volts per centimeter. The gels were then further stained with ethidium bromide (if needed) and photographed on a UV transilluminator (modified from Nashwa et al. 2009).

Results

After water samples were filtered and enhanced with tetrathionate/novobiocin for *Salmonella* growth, the filters were transferred to plates containing BGB and incubated for 35°C for 24 hours. After 24 hours, isolates were collected based on color response and colonial phenotype. Any colony expressing a pink to orange hue was considered positive for *Salmonella* spp., while most yellow colonies commonly tested negative for *Salmonella*. All colonies considered positive for *Salmonella* were enumerated and recorded as the count for *Salmonella* for the

Figure 1. Photograph of membrane surface showing 3 colonies confirmed as positive for *Salmonella*

sample date as part of another study (data not yet published). A representative colony chosen as one of the 32 isolates can be seen in Figure 1.

Representative presumptive colonies were aseptically transferred to TSI media to test for sugar use, CO_2, and H_2S production. A sample of the TSI inoculum was further tested by the antibody agglutination test to serologically confirm *Salmonella spp.* (Table 3). All isolates were examined for Gram staining reaction and cell morphology, of which all isolates tested as being Gram negative and rod-shaped.

It is interesting to note that while most *Salmonella spp.* normally produce hydrogen sulfide from thiosulfate (Midorikawa et al., 2009), 29 of the 32 environmental isolates collected did not demonstrate H_2S production on TSI media. These results could be the product of an environmental selection factor unique to this area, or they could be contributed to the presence of atypical environmental variants (Table 3).

All 32 of the isolates presented a K/A response on the TSI media, which is typical for *Salmonella spp.* This can be interpreted as meaning that only glucose was metabolized while peptone was used as a secondary carbon source (Hajna, 1945). Additionally, all of the 32 isolates tested positive for the antibody agglutination test, serologically confirming the isolate as *Salmonella spp.* The antibody agglutination test contains beads layered with polyclonal antibodies for over 30 *Salmonella spp.* surface antigens suspended in a latex solution.

Mulitplex Polymerase Chain Reaction and Gel Electrophoresis Results

The gDNA of all *Salmonella* was extracted and subjected to PCR magnification containing the control primers found in Table 1 for confirmation of: 1) bacterial gDNA presence, 2) *Salmonella spp.* presence, and 3) negative *E. coli* control presence. All of the bacterial samples successfully produced the expected 1500 bp amplicon when paired with the Universal 16S control primer. None of the bacterial samples except *E. coli* produced an amplicon when paired with the *E. coli* control primer.

a. An initial note on viewing electrophoretic results of PCR amplifications

A representative electrophoretic gel is presented in Figure 2. This gel, like many others in this study, compared a PCR product against a "ladder" of standardized DNA size fragments. For each antigenic allele group, a variety of primers were used to seek and magnify specific DNA sequences that could be compared to the known fragment sizes of the ladder. This study considered an isolate to possess a particular allele as long as it produced one amplicon of the expected size; although, as seen in lanes 2, 5, and 7 of Figure 2, many isolates produced multiple amplicons for a given reaction. This phenomenon could be explained due to primers reacting with other primers within the PCR process or with primers reacting with less-specific regions of DNA. Despite adjustments to optimize the PCR protocol, these extraneous bands remained to be present.

b. A sequence of electrophoretic gels — the logic behind Multiplex PCR allelotyping

Figures 3–5 represent the electrophoretic gel outcomes from a serotyping sequence for Isolate 3 starting with the O-antigen allelotyping results in Figure 3.

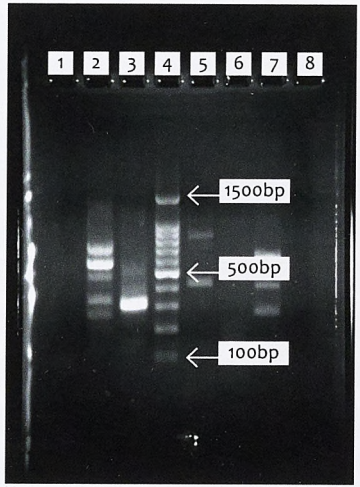


Figure 2. Photograph of a representative gel containing PCR amplicon products of the H1-1 allelotyping for the g,m allele with an expected band size of 309 bp. Left to right: lane 1 (*E. coli* negative control); lane 2 (Isolate 1 and g,m primer); lane 3 (Serovar Enteritidis – positive control); lane 4 (1500 bp DNA ladder); lane 5 (Isolate 2 and g,m primer); lane 6 (Isolate 11 and g,m primer); lane 7 (Isolate 13 and g,m primer); and lane 8 (Isolate 14 and g,m primer).

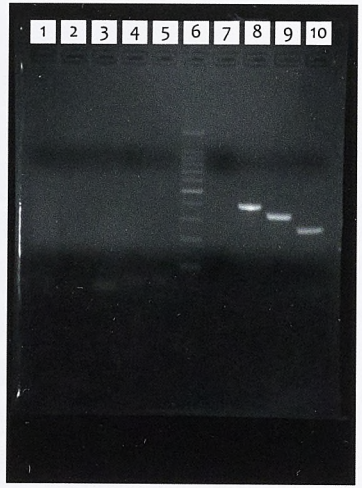


Figure 3. Photograph of representative O-antigen allelotyping gel containing PCR products of the O allelotyping for the "8" allele that has an expected band size of 397bp. Left to right: lane 1 (Isolate 1 and *abe2* (8) primer); lane 2 (Isolate 7 and *abe2* (8) primer); lane 3 (Isolate 10 and *abe2* (8) primer); lane 4 (1500bp DNA ladder); lane 5 (Isolate 14 and *abe2* (8) primer); lane 6 (1500bp DNA ladder); lane 7 (Isolate 18 and *abe2* (8) primer); lane 8 (Isolate 3 and *abe2* (8) primer); lane 9 (Isolate 3 and the *fliC* (z_{10}) primer); and lane 10 (Isolate 3 and the *stn* gene primer).

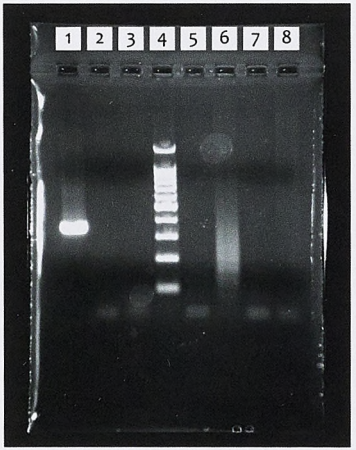
Table 3. TSI and confirmatory testing results from all isolates

Isolate #	Acid Reaction	Gas Production	H_2S Production	Rapid Salmonella Test
1	K/A	-	-	+
2	K/A	+	-	+
3	K/A	+	-	+
4	K/A	+	-	+
5	K/A	-	+	+
6	K/A	+	-	+
7	K/A	-	-	+
8	K/A	+	-	+
9	K/A	+	-	+
10	K/A	-	-	+
11	K/A	-	-	+
12	K/A	+	-	+
13	K/A	+	-	+
14	K/A	-	-	+
15	K/A	+	-	+
16	K/A	-	-	+
17	K/A	+	-	+
18	K/A	+	-	+
19	K/A	+	-	+
20	K/A	+	+	+
21	K/A	-	+	+
22	K/A	-	-	+
23	K/A	+	-	+
24	K/A	+	-	+
25	K/A	-	-	+
26	K/A	+	-	+
27	K/A	-	-	+
28	K/A	-	-	+
29	K/A	-	-	+
30	K/A	+	-	+
31	K/A	-	-	+
32	K/A	-	-	+

Isolate	*Stn* gene	O-antigen allele	H1 antigen allele	H2 antigen allele	Possible serovar(s)
1	+	4*	g,m*	-	Essen or California
2	+	8	g,m	-	Emek or Reubeuss
3	+	8	z_{10}	l,2; l,5; l,6; l,7	Bazenheid, Zerifin, Paris, Mapo, or Cleveland
4	+	8*	z_{10}	e,n,x; e,n,z_{15}	Hadar, Chomedey, Glostrup, or Istanbul
5	-	N/A	N/A	N/A	N/A
6	-	N/A	N/A	N/A	N/A
7	+	-	N/A	N/A	N/A
8	+	8	r*	-	Brikama or Goldcoast
9	-	N/A	N/A	N/A	N/A
10	+	-	N/A	N/A	N/A
11	+	8*	-	N/A	N/A
12	-	N/A	N/A	N/A	N/A
13	+	8	g,m*	-	Emek or Reubeuss
14	+	4	i	l,2; l,5; l,6; l,7	Typhimurium, Lagos, or Agama
15	+	8	i	-	Magherafelt, Cyprus, or Kentucky
16	+	8*	-	N/A	N/A
17	+	8*	i*	-	Magherafelt, Cyprus, or Kentucky
18	+	-	N/A	N/A	N/A
19	-	N/A	N/A	N/A	N/A
20	-	N/A	N/A	N/A	N/A
21	+	-	N/A	N/A	N/A
22	-	N/A	N/A	N/A	N/A
23	-	N/A	N/A	N/A	N/A
24	+	-	N/A	N/A	N/A
25	+	3,10*	i*	l,2; l,5; l,6; l,7	Cuckmere, Amounderness, Tibati, or Truro
26	+	-	N/A	N/A	N/A
27	+	-	N/A	N/A	N/A
28	+	3,10	r*	l,2; l,5; l,6; l,7	Ughelli or Elisabethville
29	+	-	N/A	N/A	N/A
30	+	4	g,m*	-	Essen, II, or California
31	+	-	N/A	N/A	N/A
32	+	4	i	l,2; l,5; l,6; l,7	Typhimurium, Lagos, or Agama

Table 4. Results from MPCR and serovar analyses. A "+" denotes that the expected amplicon was visualized via standard gel electrophoresis. A "-" denotes that no band was visualized and "*" denotes that an amplicon(s) was present other than the expected.

Figure 4. Photograph of the H1 antigen allelotyping gel containing PCR products of the H1 allelotyping for the "i" allele that has an expected band size of 508bp. Left to right: lane 1 (Isolate 3 and the *fliC* (z_{10})); lane 2 (Isolate 5 and the *fliC* (z_{10})); lane 3 (Isolate 6 and the *fliC* (z_{10})); lane 4 (1500bp DNA ladder); lane 5 (Isolate 7 and the *fliC* (z_{10})); lane 6 (Isolate 8 and the *fliC* (z_{10})).



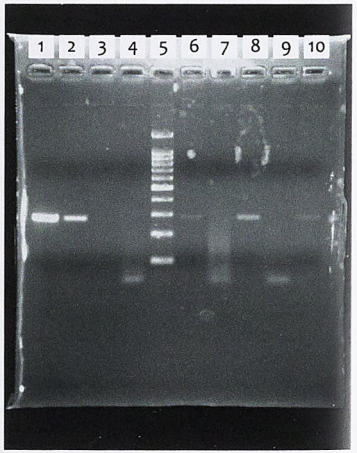


Figure 5. Photograph of the H2 antigen allelotyping gel containing PCR products of the H2 allelotyping for the "*fljB* (I: 1,2; 1,5; 1,6; 1,7)" alleles that has an expected band size of 294bp. Left to right: lane 1 (Heidelberg Control and the *fljB* (I: 1,2; 1,5; 1,6; 1,7) primer); lane 2 (Isolate 3 and the *fljB* (I: 1,2; 1,5; 1,6; 1,7) primer); lane 3 (Isolate 4 and the *fljB* (I: 1,2; 1,5; 1,6; 1,7) primer); lane 4 (Isolate 8 and the *fljB* (I: 1,2; 1,5; 1,6; 1,7) primer); lane 5 (1500bp DNA ladder); lane 6 (Isolate 14 and the *fljB* (I: 1,2; 1,5; 1,6; 1,7) primer); lane 7 (Isolate 15 and the *fljB* (I: 1,2; 1,5; 1,6; 1,7) primer); lane 8 (Isolate 25 and the *fljB* (I: 1,2; 1,5; 1,6; 1,7) primer); lane 9 (Isolate 15 and the *fljB* (I: 1,2; 1,5; 1,6; 1,7) primer); lane 10 (Isolate 28 and the *fljB* (I: 1,2; 1,5; 1,6; 1,7) primer).

If the PCR product of the isolates amplified the expected 260bp amplicon for the *stn* gene (present in all *Salmonella* spp.), then it was further subjected to O-antigen allelotyping. The band present in lane 8 of Figure 3 at approximately 397 bp represents an O-antigen allele labeled as *abe2* or "8." If, during the O-antigen allelotyping, an isolate produced an amplicon matching an expected amplicon for one of the alleles for the O-antigens, then it was further subjected to an H1 antigen allelotyping.

The results of an H1 allelotyping PCR reaction are presented in Figure 4. The band present at 363 bp in lane 1 of Figure 4 represents the appropriate size of the *Salmonella* H1 antigen allele labeled as fliC or "z_{10}" listed in Table 1. The band present at approximately 294 bp in lane 2 of Figure 5 represents the appropriate size of the *Salmonella* H2 antigen allele labeled as *fljB* or "I: 1,2; 1,5; 1,6; 1,7" listed in Table 1. Antigenic formulae were compared to those listed in the World Health Organization's 2007 "Antigenic Formulae of the *Salmonella* Serovars" publication for serotyping analyses (see Table 4 on page 77).

c. Analysis of the serotyping

Of the 24 isolates that tested positive for the *stn* gene, 15 isolates were typed to *S. enterica* subsp. *enterica* (or Group 1 *Salmonella*) and 13 isolates were able to be identified to one of the four targeted serovars: Typhimurium, Enteritidis, Hadar, or Heidelberg. As previously mentioned, Group 1 *Salmonella* are most closely associated with human illness.

Isolates 18, 21, 24, 26, 27, 29, and 31 amplified the *stn* region (e.g., were positive for being Group 1 *Salmonella* spp.) but did not exhibit any of the five O-antigen alleles that were tested in this study. Additionally, isolates 1, 2, 8, 13, 15, 17, and 30 did not amplify any of the H2 allele regions that were used in this study. These results may be due to the absence of the particular antigenic allele sought and/or it may be due to the isolate expressing an allele that was not tested in this study.

Many PCR products of the *Salmonella* isolates contained amplicons in addition to the expected singular band sizes targeted; meaning that in a single lane, multiple bands in addition to the target band would be present (isolates 1, 4, 8, 11, 13, 16, 17, 25, 28, and 30). This phenomenon could be explained due to primers reacting with other primers within the PCR process or with primers reacting with less-specific regions of DNA. Due to the sizes of the bands, it is more likely they were a result of improper primer binding during the annealing stage of the PCR process, possibly from non-optimal PCR mixtures or cycling parameters (Love et al., 1990).

Discussion

The main objective of this study was to determine whether the four most clinically relevant *Salmonella spp.* serovars from poultry houses could be isolated from the environmental waterways in PE and Cumberland Counties in Virginia. Table 4 shows that isolates 4, 14, 15, 17, and 32 have the potential to be either serovars Typhimurium, Kentucky, or Hadar. Due to the nature of the MPCR primer set designed by Hong et al. (2008), it is uncertain that any of the isolates are one of the clinically relevant serovars. However, it is possible that isolates 4, 14, 15, 17, and 32 are one of the four clinically relevant serovars, which means that approximately 15% of the isolates are clinically relevant serovars.

A corollary study by our lab

examined the correlation between *Salmonella spp.* and the common water quality indicator species *Escherichia* coli. That study assessed the average amount of *Salmonella spp.* per 100mL sample and found, on average, approximately 3,800 *Salmonella spp.* cells in water samples from Sayler's Creek (data not yet published). If the 15% mark is accurate, this would mean that in every 100 mL of water from Saylor's Creek (SAY5) there could potentially be 570 *Salmonella* cells of clinically relevant serovars. It is important to account for the fact that isolates for this study were only gathered during cold-weather months, as isolates were not taken from warm-weather samples. Bacterial concentrations are typically lower during cold months of the year. A year-long study examining *Salmonella* serotypes from the local waterways would need to be completed to rule out temporal or climatic effects upon serotype presence.

This study adapted Hong et al.'s (2008) serotyping method, which was designed for typing *Salmonella* from commercial broiler chicken houses, to environmental water samples to gain a perspective of possible serovars that may be found in local waterways. Specific O, H1, and H2 alleles were chosen for investigation of our isolate library, with the primary focus on serotyping four major pathogenic *S. enterica* serovars: Typhimurium, Enteritidis, Hadar, and Heidelberg. Although this study was not able to accurately serotype any of the aforementioned serovars, we were able to place many isolates in their respective "serogroups." As previously stated, the most common pathogens for humans are found in Group 1, which is *Salmonella enterica ssp. enterica* (Miljković-Selimović et al., 2010).

Within Group 1 *Salmonella*, there are 6 major serogroups of particular clinical relevance based upon the O-antigen allele. In combination with the H1 and H2 antigen alleles, many isolates could be narrowed down to just two or three possible serovars. According to Hong et al. (2008), it is possible, with relative certainty, to consider one's geographic location, superimposing known areas of serovar occurrence, to provide a reasonably accurate estimation of a given serovar. However, the reason that isolates in Table 4 cannot be identified to a single serovar is because for monophasic serovars, serovars only containing an H1 antigen allele (and no H2 allele), this serotyping method is less precise because it does not include all possible H2 antigen allele possibilities (Dauga et al., 1998). Therefore, it remains unclear whether an isolate is a monophasic or a biphasic serovar with an H2 antigen allele heretofore untested. The authors feel this was possibly the case with isolates: 1, 2, 8, 13, 15, 17, and 30. This problem is shown in Table 4 where an isolate is not identified to one particular serovar, but can be narrowed down to a selection of 2-5 different serovars, thus revealing the limitations of using these primers on environmental isolates of *Salmonella spp.*

A disparity existed between this study and Hong et al.'s (2008) study with regards to the MPCR. Initially, many attempts to "multiplex" all O-antigen primers into one reaction vessel for PCR failed to produce amplicons for any of the 32 isolates or positive controls. It is possible that miscalculation with respect to primer concentration contributed to the lack of amplification of the multiplexed primers in this study. It is unknown whether Hong et al. (2008) multiplexed the primers in

this sense with success. Regardless of Hong et al.'s (2008) reasoning for classifying the PCR as multiplex, this study decided to adopt the terminology used in Hong et al.'s (2008) study.

Traditional serotyping of *Salmonella spp.* involves the use of over 200 non-standardized antisera that is both costly and time-consuming. Also, since there is yet a standard set of antisera, Yoshida et al. (2007) noted that researchers wishing to duplicate experimental results are limited in their data comparisons. Hong et al.'s (2008) serotyping method addresses this problem by presenting a format that could possibly be standardized and is considerably more cost effective and time-saving for definitive identification of serovar groups. By nature, PCR reactions are specific in the sense that primers recognize a given sequence of DNA, which can precisely determine serovar identity.

In Hong et al.'s (2008) experiment, this specificity is a strength considering the parameters of their setting. In broiler houses, if an outbreak of *Salmonella* should occur, it would most likely be contributed to a certain group of serovars associated with poultry. However, in a study such as this, using samples containing a wide assortment of unknown serovars compounded by a potentially large number of variant specimens originating from environmental samples, the specificity now becomes a handicap to the serotyping process unless many more primers for alleles may be produced (Hong et al. 2008; Zamperini et al. 2007).

The discrepancies found regarding the observed and expected hydrogen sulfide production of this study's environmental strains should be further examined. It has been found that the *phs* gene within *Salmonella spp.* is responsible for hydrogen sulfide production (Bang et al., 2000). A study that determines the presence or absence of the *phs* gene in environmental isolates would be beneficial to the scientific community. Bang et al. (2000) developed a primer for the *phs* gene region of *Salmonella spp.* that could be used in a standard PCR protocol to determine whether the gene in present in a given isolate. The high percentage of our environmental isolates not producing H_2S within the TSI diagnostic medium is intriguing and merits further study.

Future studies should also examine alternative methods of serotyping environmental isolates with better cost-effectiveness than the traditional antisera approach and with the greater precision of Hong et al.'s (2008) MPCR scheme. It may be worth modifying their MPCR design approach not to constellations of antigenic complexes, but to discrete antigenic alleles. For instance, the H-2 antigen primer *fljB* that contains markers for the 1,2; 1,5; 1,6; 1,7 alleles will produce an amplicon for any isolate that has one of those four alleles. If a primer were to be designed that would allow for distinction between the alleles 1,2 and 1,5, for example, this would eliminate the previously discussed issue of determining whether an isolate is monophasic or biphasic. By examining the genetic code of the *fljB*, one could create 4 separate primers to amplify each of the four *fljB* alleles. If specific primers were made for each allele, it would be possible to determine exactly which allele a given serovar possesses. This approach would require more time involved in serotyping analysis, but should provide a more complete antigenic formula for a given isolate and thus better precision overall.

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Artist:

Annaliese Troxell

"Little Scarface"
2012
9 ½" X 2 ½" X 3"
suminagashi, handmade abaca paper, methylcellulose, linen thread

"Little Scarface" is based on researching body adornment, the history of the moccasin, and the literary Native American legend, The Hidden One. The story is of a young girl, called "Little Scarface," who after losing her mother is treated horribly by her two half sisters and soon becomes scarred and ugly. In the end her inner beauty wins the hand of the Hidden One, and all her scars are healed in the water of the river. In an effort to represent this story, I have made a single moccasin out of a hand–pulled sheet of abaca fiber paper. I chose to make only one in an effort to meld the common Anglo story of Cinderella with the Native American Indian story of "Little Scarface." Using a Japanese marbling technique called suminagashi, I treated the surface of the moccasin with blue and green dyes to represent the earth and water that brought "Little Scarface" her freedom, and tendrils of black ink to represent the smoke and ash that had disfigured her in the first place.

Artist:

T. Dane Summerell

"Repurposing Woodblocks"
2012

When printing, I fall in love with the smell of the ink, the sound of the smacking rollers, and the texture of the wood as it transforms from smooth to rough with every surface cut. Within the process of printmaking there is a lot of waste. By turning the woodblock into furniture it gives insight into the process of how the prints were created. The viewer is now able to see every little cut that went into creating the prints. Rather than just collecting dust, the woodblocks are repurposed into functional furniture. By placing all the prints around the furniture it allows the entire process to come together into a room filled with black and white.

Development of Salicylidene Anilines for Application in the High School Laboratory

Sarah N. Ganrude

Dr. Christopher Gulgas, faculty advisor

Abstract

The syntheses of salicylidene anilines are readily accomplished through one-pot procedures with minimal purification necessary to afford a functional crystalline product. These compounds are of interest due to their colorimetric response to 405 nm light in the solid state. A series of salicylidene anilines have been generated to study the effect of enol/trans-keto isomerization on the UV-Vis absorption behavior. The compounds are characterized using ^{1}H-NMR and UV-Vis spectroscopies. A screening process based on colorimetric response, synthetic ease, and safety concerns has been applied to identify the most suitable candidates for illustrating important concepts in the high school chemistry curriculum. The synthesis and characterized response profile of the molecules and specific learning objectives for integration into a functional teaching unit shall be discussed.

Introduction

Salicylideneanilines belong to a class of organic compounds best known for exhibiting photochromism in the solid state. These crystals have been studied since 1962 for this unique property.[1] Photochromism occurs when a substance absorbs light and changes color. Upon irradiation with near ultraviolet light (405nm), the observed color of the salicylideneanilines in this study deepens to red; when left in the dark or irradiated with visible light, they revert to their original color.[2] This property is due to the isomerization between the enol and *trans*-keto forms of the molecule. In this transformation, the proton bonded to the oxygen atom is translocated to the imine nitrogen atom.[2]

In order to view these properties, salicylaldehyde was reacted with several anilines. Four of these molecules will be discussed, shown in Figure 1. Two are pale yellow crystals that are not fluorescent at room temperature and exhibit photochromism (molecule 1 and 4), while the other two (molecule 2 and 3) are not photochromic, but exhibit fluorescence in the solid state. This photochromic property can further be explained by the nonplanar nature of the molecules in the crystals that exhibit photochromism, therefore allowing a substantial twist in the N-aryl bond.[2] Figure 2 illustrates the structural change that occurs during this isomerization.

These molecules are of interest in a high school lab setting due to their colorimetric response to 405nm light. Using an inexpensive blue laser pointer, students would be able to manipulate the crystals as well as observe how structural differences in a series of anilines affect the photochromism in the crystalline product. Also, since these

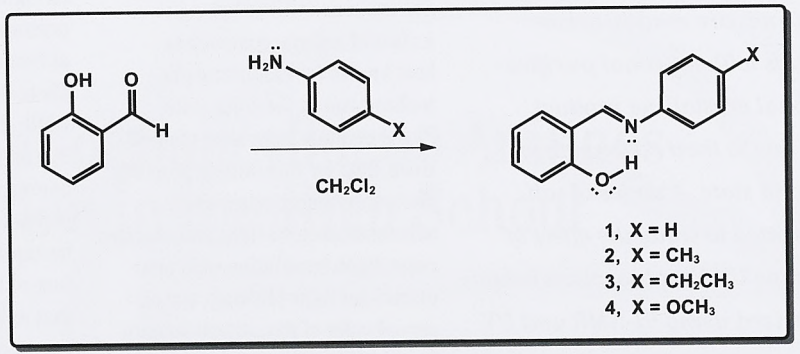


Figure 1: Salicylaldehyde reacted with four different anilines to form a crystalline product.

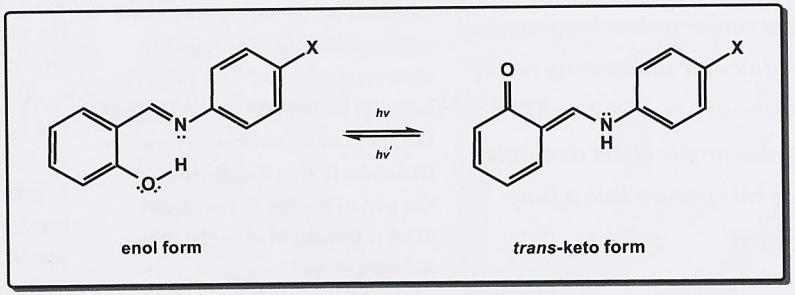


Figure 2: Enol/*trans*-keto isomerization of salicylidene aniline.

crystals are easily synthesized with minimal purification necessary to afford a functional crystalline product, they are suitable candidates for an introduction into complicated organic structures and light absorption in a high school curriculum.

Methods

It is important to note that anilines are known to have some level of toxicity. Manipulation of these solids should occur in a fume hood with adequate personal protective gear (gloves, goggles).

Molecule 1

Salicylaldehyde (3.096g) and dichloromethane (DCM)(25ml) were added to a 250ml Erlenmeyer flask on a stir plate. Aniline (2.37g) was placed in a flask and dissolved with DCM (10ml). The diluted aniline was then pipetted drip by drip into the Erlenmeyer flask still on the stir plate; the solution immediately

changed color. The solution was allowed to mix for 24 hours then left to crystallize. After a week, yellow crystals were created that were then crushed into a powder that became an orange color. This molecule showed photochromism.[1] H-NMR (CDCl3, 60 MHz) 7.06-7.40 (9H) 8.57 (1H) 13.4 (1H).

Molecule 2

Salicylaldehyde (.322g) and DCM (2.5ml) were added to a 25ml flask on a stir plate. P-Toluidine (.282g) was placed in a flask and dissolved with DCM (1ml). The diluted aniline was then pipetted drip by drip into the Erlenmeyer flask still on the stir plate. The solution was allowed to mix for 24 hours then left to crystallize. After a week the stir bar was removed and then the solution began to crystallize. The molecule was then recrystallized by adding boiling methyl alcohol to product on hot plate until completely dissolved. Once dissolved, solution was removed from heat and a watch plate was placed on top of the flask to allow slow recrystallization. When solvent was almost completely evaporated, solution was vacuum filtered to obtain pure crystals. Molecule showed florescence but not photochromism.[1] H-NMR($CDCl_3$, 60 MHz) 2.37 (3H) 7.03-7.37 (8H) 8.60 (1H) 13.34 (1H).

Molecule 3

Salicylaldehyde (.306g) and DCM (2.5ml) were added to a 25ml flask on a stir plate. 4-Ethylaniline (.303g) was placed in a flask and dissolved with DCM (1ml). The diluted aniline was then pipetted drip by drip into the Erlenmeyer flask still on the stir plate. The solution was allowed to mix for 24 hours then left to crystallize. After a week, the solution crystallized. The molecule was then recrystallized by adding boiling methyl alcohol to product

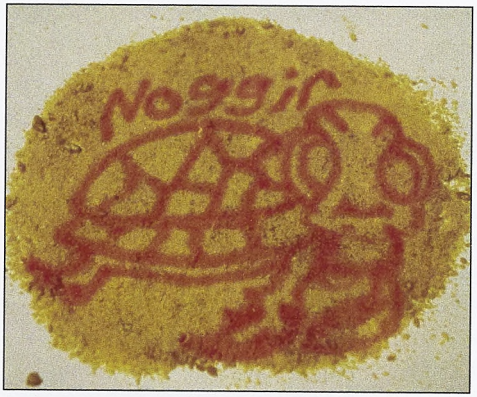


Figure 3. Molecule 1 selectively irradiated using a blue laser pointer (405 nm) to produce a complicated image.

Figure 4. Molecule 4 selectively irradiated using a blue laser pointer (405 nm) to produce a spiral, illustrating the short lifetime of the red *trans*-keto form.

on hot plate until completely dissolved. Once dissolved, solution was removed from heat and a watch plate was placed on top of the flask to allow slow recrystallization. When solvent was almost completely evaporated, solution was vacuum filtered to obtain pure crystals. Molecule showed florescence, but not photochromism.[1] H-NMR($CDCl_3$, 60 MHz) 1.23 (s,3H) 2.72 (s, 2H) 7.01-7.35 (8H) 8.56 (1H) 13.33 (1H).

Molecule 4

Salicylaldehyde(3.28g) and DCM (25ml) were added to a 250ml flask on a stir plate. *P*-anisidine (3.31g) was placed in a flask and dissolved with DCM (10ml). The diluted aniline was then pipetted drip by drip into the Erlenmeyer flask still on the stir plate. The solution was allowed to mix for 24 hours, then left to crystallize. After a week, the solution did not crystallize, therefore it was evaporated with N_2 and vacuum filtered. Adding boiling methyl alcohol to product on hot plate until completely dissolved then recrystallized molecule. Once dissolved, solution was removed from heat and a watch plate was placed on top of the flask to allow slow recrystallization. When solvent was almost completely evaporated, solution was vacuum filtered to obtain pure crystals. Molecule showed photochromism, however the effect did not last as long as with molecule 1.[1] H-NMR($CDCl_3$, 60 MHz) 1.34 (1H) 3.8 (2H) 7.02-7.26 (8H) 8.61 (1H) 13.3 (1H).

Results and Discussion

Molecule 1 was found to be photochromic after the simple synthesis. The product crystallized out and showed the desired property without recrystallization. Upon absorbing blue-violet light (405 nm) from a commercially available laser pointer, a color change from yellow-orange to deep red was observed on a solid sample of this molecule. The color change lasted several minutes and it was possible to draw a complex picture with the laser pointer. Figure 3 depicts the photochromic behavior using a drawing of a cartoon turtle. Molecule 4 was also photochromic, but the property was better observed after the product had been recrystallized. When using the laser pointer to draw on these crushed crystals, not even a complete spiral could be drawn before the outside of the spiral began to fade (Figure 4). The lifetime of the *trans*-keto form was apparently not as long as with molecule 1.

Molecules 2 and 3 were bright yellow crystals that fluoresced a bright green upon irradiation with the 405nm light. Although no photochromism was observed, the solid-state fluorescence of these molecules was studied further. Both were examined using a fluorimeter to measure maximum emission and excitation wavelengths, shown in Figures 5 and 6 below. Molecule 2 emitted most efficiently at 559 nm and molecule 3 showed a maximum emission at 545 nm. Images of the fluorescence of molecules 2 and 3 were captured and this magnificent fluorescence is shown in Figures 7 and 8.

The properties of these molecules would be interesting for discussion in a high school setting due to their easy manipulation and as an introduction to organic chemistry. While students may not be able to understand the complex nature of the proton shift that causes the enol to *trans*-keto transformation, there are several state and national standards that this series of experiments would cover. The execution of the experiment would depend on the maturity and curiosity of the students. For some classes they would

be able to conduct the procedure of making the crystals themselves, others would only be capable of manipulating the crystals to observe the properties that they exhibit. If the laboratory only had one fume hood, this experiment would prove more difficult to do with a large class. However, students could work in groups to examine one crystalline product while other groups research the materials and the properties that the products have. Then they could discuss their finding and how their group's product reacted to the light.

One such Virginia SOL that could be covered (CH:1) states: "The student will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data." Selected key concepts include (b) safe use of chemicals and equipment and (d) manipulation of multiple variables, using repeated trials. Safety is a key

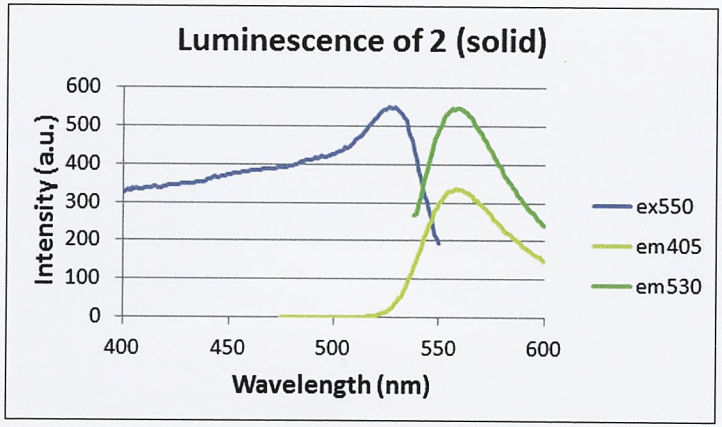


Figure 5. Luminescence of solid molecule 2, where "ex550" represents the excitation spectrum for a 550 nm emission and "em405" represents the emission spectrum for a 405 nm excitation.

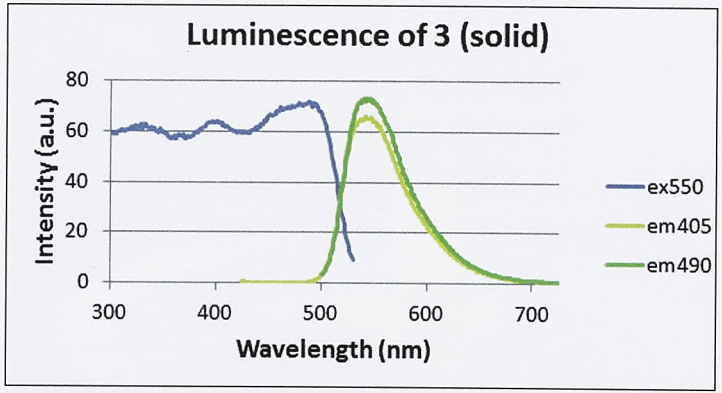


Figure 6. Luminescence of solid molecule 3, where "ex550" represents the excitation spectrum for a 550 nm emission and "em405" represents the emission spectrum for a 405 nm excitation.

Figure 7. Luminescence of molecule 2. The blue light is reflection, not fluorescence

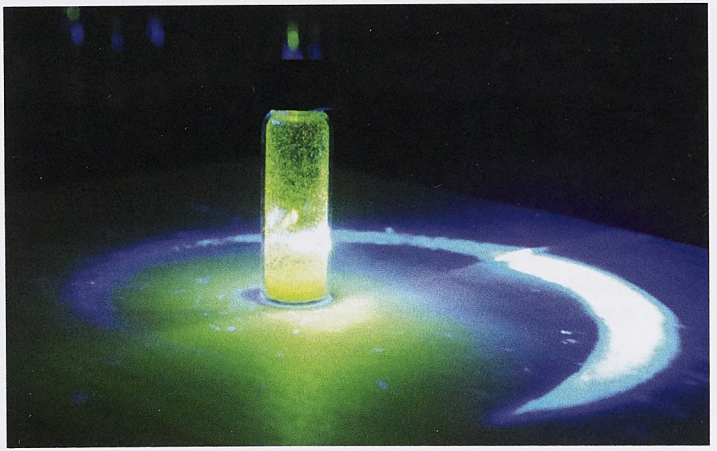


Figure 8. Luminescence of molecule 3. The blue light is reflection, not fluorescence.

issue in this experiment due to the toxicity of anilines, and students would have to work in a fume hood, wear goggles, and wear gloves when handling these products. Students will have to manipulate multiple products in order to understand the complexity of the crystals and that different variables will produce different results. Alternatively, in a group scenario students would be expected to produce observations of their product to be shared with the network of other groups.

Inclusion of the salicylidene anilines in a high school curriculum also satisfies objectives of the national standards.[3] Some national standards that this experiment would cover include:

- Elements may be bonded together into molecules or crystalline solids.
- The physical properties of compounds reflect the nature of the interactions among its molecules. These interactions are determined

by the structure of the molecule, including constituent atoms and the distances and angles between them.

- Light can initiate many chemical reactions.
- In other reactions, chemical bonds are broken by heat or light
- Carbon atoms can bond to one another in chains, rings, and branching networks to form a variety of structures.

All of the products formed crystalline solids, and the properties and the structure of the anilines involved in the reaction highly influences the properties of the product. It is important for students to understand that chemical reactions can take place without the addition of other chemicals or elements to the system, which is directly observable in this isomerization. This experiment introduces them to the network of carbon atoms to form structures in large molecules. Also it shows students that light can be used to break bonds and cause chemical changes or reactions within molecules.

Conclusion

While several anilines were combined with salicyladehyde during the course of this study, only two molecules were found to be photochromic. One of them has hydrogen, while the other has an ether group branching off the carbon ring, and therefore it is difficult to know before the reaction takes place if specific anilines will cause the photochromic property. More tests are needed to find other salicylidene anilines that exhibit photochromism. Additionally, it will be interesting to study the length of time that the *trans*-keto form will stay before reverting back to the molecule's original enol form (and color). This further research would help in the development of the lab for the classroom so that students would have multiple molecules to analyze. Due to the complex and interesting nature of the photochromism, students would benefit in participation in this proposed lab because it would be enjoyable to analyze the molecules, and would introduce them to organic chemistry, which is often lacking in a high school setting.

References

(1) Cohen, M.D.; Schmidt G.M.J. "Photochromy and thermochromy of anils." *J. Phys. Chem* 1962, 66, 2442-45.

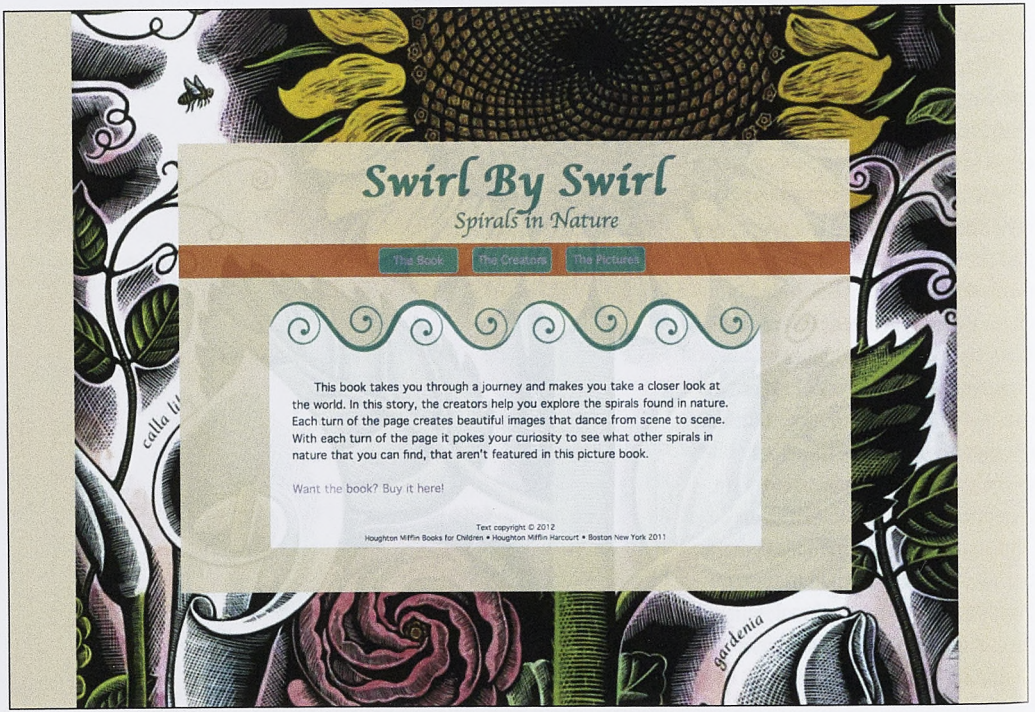
(2) Harada, J.; Fujiwara, T.; Ogawa, K. "Crucial role of fluorescence in solid-state thermochromism of salicylidene anilines." *J. Am. Chem. Soc.* 2007, 129, 16216-16221.

(3) *National Science Education Standards.* (2001) National Academy Press: Washington, D.C. 179.

Designer:

Malina Rutherford

page for a website about a children's book illustrator who uses scratchboard and colored inks,
2012



Designers:

Hannah Hopper and Matthew Sakach

interior spread from a Longwood Herbarium brochure, 2012

MISSION

The mission of the Harvill-Stevens Herbarium at Longwood University is to promote the conservation of native plant species in Virginia. We intend to serve our students, faculty, staff, and interested individuals as an educational and research resource for the study of Virginia plants.

HISTORY

The Harvill-Stevens Herbarium of Longwood University was founded in 1963 by Dr. Alton M. Harvill, professor emeritus at then the Department of Natural Sciences at Longwood College. The oldest plant specimens, from early 1920s and 1930s, were collected by Dr. George William Jeffers and Dr. Edith Stevens, also dedicated professors in the Department of Natural Sciences, now Department of Biological and Environmental Sciences. The collection has grown since, and today we hold more than 75,000 plant specimens.

Dr. Harvill established what is considered one of the finest and most significant collections of vascular plant specimens in the mid-Atlantic region. Thousands of specimens in our herbarium are unique, irreplaceable, and important instruments to the historical documentation of the past distribution, nature, and ecology of plant species in Virginia and southeastern of the United States.

PUBLICATIONS

Our botanical collection served as a main reference for the publication of three volumes of the Atlas of the Virginia Flora (1977-1981, 1986, and 1992), a fundamental publication on the geographical distribution of plant species in the Commonwealth. Dr. Harvill contributed to most of the occurrence data in these maps by traveling and collecting around the state for many years while teaching at Longwood. The digital version of these atlases is now accessible online in the Digital Atlas of the Virginia Flora (for more information visit: http://vaplantatlas.org).

Dichanthelium latifolium (L.) Harvill

PROJECTS

The Harvill-Stevens Herbarium is actively working towards the creation of a plant database to facilitate the accessibility of our plant specimen information for students, teachers, researchers, and the general community. This information enables us to provide useful data to understand patterns of plant distribution, abundance, migrations, and species loss. Botanical historical plant records, like the ones held at Longwood University, are essential for the study of climate change effects on plants, land conservation strategies, and for environmental sciences education.

INTERNSHIP AND VOLUNTEER OPPORTUNITIES

Students and volunteers are vital for the accomplishment of herbarium projects. Working in the herbarium provides valuable skills not only for the study of plants, but also training in museum management, conservation, and science education. Interns and volunteers are not required to have previous experience, but must have a great passion for plants and conservation. Individual training is provided to work on activities such as: mounting plant specimens, data entry, identification, loan processing, and general organization of the collection.

Asclepia verticillata L.

Cercis canadensis L.

Cypripedium acaule Aiton

Wisteria frutescens (L.) Poir.

Liriodendron tulipifera L.

Dicentra canadensis (Guildir) Walp.

Because That's What Daddies Do: Effects of Fathering Patterns on son's Self and Gender Identities

John William Berry, Jr.

Abstract

The present study included an open-ended survey format that targeted males between the ages of 18 and 26. The 25 participants who responded were asked a series of questions related to their relationship with their fathers in order to understand how their personal gender identities were created and influenced by their fathers. The findings show three major trends: how fathers become helpless, fathers' influence of son's gender through words and actions, and how fathers influence their son's view of fathering and what it means to be a man.

Acknowledgments

I would like to thank my two cousins, Joseph and Jackson Palmore, and our grandmother, Phyllis Palmore, for being the inspiration for the topic of this study. Also, I thank the Communication Studies Faculty and Staff of Longwood University for their continued support and guidance throughout the duration of the project.

Introduction

Importance

From a boy's infancy, he continuously learns and absorbs ideas of what he "should" become throughout his life. These ideas develop into a constant, spinning wheel of thoughts, assumptions, and conclusions being turned over and over in his head. Initially, these conclusions are fueled by the ideas and visions of those closest to him, like family and childhood friends with whom he is particularly associated. As he matures into adolescence, media and other institutions in society begin to impose their own expectations of what the boy "should" be like at his age. Ultimately, all of these influences come to one question: What is it that makes a "man" out of a boy, and even further, how do his paternal influences help him to arrive at those conclusions?

The relationship between a father and a son can be a wonderful factor in the lives of those who experience such bonds. The health of this type of relationship depends on the maintenance behaviors of both parties. Many factors contribute to the amount of satisfaction fathers and sons experience, including love, affection, closeness, responsiveness, and attentiveness. In some instances, the bonds between the two individuals may be strong and the mentioned factors may be well employed. Sadly, not all fathers demonstrate all or any of these qualities to their sons. In the same way, their sons are not always willing to reciprocate. The communication phenomenon I have explored involves the effects of fathering patterns on son's gender identities and how it is created through father-son interactions and influences. The purpose of this study has been to examine the masculine gender traits exhibited by fathers toward their sons. Specifically, I have analyzed how sons understand their relationship with their fathers and how ideas of masculinity and being a "real man" are created through their interactions with one another. In these relationships, I believe that there is a great deal of uncertainty in how masculinity and ideas of "real men" are created and sustained. So, I have identified areas of research that shed light on understanding how these relationships are maintained including the culture of fatherhood, response patterns, negative relational factors, and how feelings are generated through use of language and expression of emotions.

Rationale

There is a widespread association in western culture that connects females and mothering to closeness and affection; however, men are perfectly able to produce the same effects. Belluck reports that men biologically change when they become fathers (2011). Hormone levels change and their perceptions of their selves change to accommodate the new title, "father." These changes present the idea that men naturally possess the ability to become good fathers, but will they use it effectively?

For example, Paul Johnson, a professor at the University of Southern Maine, is highly involved in his son's life. Through reflection on this relationship, he realized the strengths and needs for improvement in his fathering techniques as well as his abilities to work through situations where fathering and other demands on his time clashed. This example shows how a father can potentially take the biological initiative given to all fathers and use fathering to produce satisfaction, not only in parental respects,

but also in overall communication effectiveness (Johnson 2008).

Some fathers, however, may place greater value on other aspects of their lives than they place on parenting. These values may include career, leisure, or commitments to other groups or people. Thankfully, in a study that surveyed nearly 1,000 men in the United States, it was concluded that though values independent of fathering are important, most fathers believe that these things do not compete with being a parent (Tichenor 2011). This may be true, but there are deeper, more delicate feelings between fathers and sons that affect more than just the values of each person.

Miller reports that "care giving and the practices and associated responsibilities of caring change over time" (2011). It is vital to understand that these factors are changing and to study the patterns of care giving, determine effectiveness, and propose improvements for the future of such practices. Relationships between fathers and sons, as mentioned, are delicate and maintenance-driven, which require a great deal of care. In order for these relationships to survive, there must be some knowledge of how factors, such as masculinities and fathering patterns, affect the relationship and help to form each member's own identity.

Theoretical Standpoints

Symbolic Interactionism

Griffin defines symbolic interactionism as "communication through symbols; people talking to each other" (2009). The idea of this theory circles around three main principles. First, the meanings we create and associate with things are based on the interactions we have from infancy. In other words, no meaning exists within an object or even concepts, but rather we learn meaning and choose to accept and retain it, or change it to suit our own needs and desires. These meanings are continuously shaped and revised with each interaction throughout our lives. For instance, ideas of masculinity are conveyed through use of colors in an infant's bedroom and the clothing the infant wears. Also, phrases such as "you're going to grow up to be big and strong like your dad" place expectations of what the child should become.

Second, language is the creator of meaning. We assign names to people, objects, and ideas. These names have no necessary connection to the object. For instance, there is no necessary relationship between the word *baseball* and thoughts of men, strength, and bravery. It is through the language we use in symbolic interactions that we form ideas of meaning.

Third, that each person's interpretations of signs is dependent upon their individual ways of thinking. The dialogue we have in our minds is where we ultimately choose what meanings to apply and how those meanings will affect our decisions about life and the things we do. Our thought processes make the difference between seeing and acknowledging, and retaining and reacting. For example, Samuel may see his father drinking heavily and becoming violent. Though this could most definitely affect Samuel's perceptions of fathering and masculinity, it is Samuel's job to sort through that information in his own way to determine how he will react to it.

With the three principles that Griffin has provided, we can begin to understand how interactions influence people's identities and we see how the formation of individual self occurs. More specific to the topic of fathers and sons, we see that both characters in the relationship have a significant amount of pull on

how symbols are created, interpreted, and retained. The creation of meaning begins with the paternal influences at birth and never ends, but continues, when the son chooses his own beliefs and values, which are then challenged as he goes through life and adds hundreds of interactions to his experience.

Masculine Expectations

Wood discusses the qualifications of "growing up masculine" (2009). These are the objectives that society demands males must achieve in order to be fully accomplished in their "manhood." The first is "Don't be female." From their infancy, boys are taught that they should in no way behave or think like women and girls. Doing so would, by this account, expose them to ridicule and being made fun of.

Next, males must be successful. As they are expected to play sports and to play well, grown men are expected to be employed and to excel in their chosen professions.

Being aggressive refers to males who appear to be daredevils and are praised for being reckless. Being tough is seen as appropriate and necessary if boys aspire to grow into men who can beat the competition and ultimately rise above competitors.

Where would men be without sex? Men are characterized as wanting sex at all times and having multiple partners. Achieving this apparently increases masculinity for heterosexual males. Men who remain virgins or who abstain from other forms of sexual pleasure are seen by society as weak.

Lastly, being self-reliant requires that "real men" do not need other people to aid them in any way. Masculinity is grounded in self-reliance and man's' need to break away from constraints and "be a man."

In most cases, fathers model several if not all five of these "requirements" placed on males by society. These behaviors are characterized to fit into the masculine ways of behaving. So, when a father emphasizes how important it is for his son not to be female, be successful, be aggressive, be sexual, and be self-reliant, the son is likely to embrace those characteristics and use them in their own definitions of masculinity.

What Daddies Do: Review of Related Literature

Fatherhood as a Changing Culture

Morman and Floyd (2002) define fatherhood as "a familial role that is historically bound, in the sense that it is subject to social, economic, and political influences that can change expectations for how fathers should act" (p. 395). In regards to father-son relationships, a combination of evolving expectations of masculinity and what it means to be a "real man" are proof that the way fathering is "done" is changing. Morman and Floyd suggest a change in historical beliefs about fatherhood, and with it, a new era of father-son relationships (2002). For instance, stereotypical views of fathers and sons show the duo doing projects together and being outdoors and active. But more recently, the typical strong, outdoorsmen view is not as prevalent and has been traded in for the image of the affectionate, close, caring father. This is not to say that all fathers are now affectionate and caring; however, this type of fathering is becoming more socially acceptable whereas several decades ago, it would have been rarer.

Floyd and Morman suggest that change is being facilitated by way of what they call the combined modeling-compensation hypothesis

(2000). This idea holds that positive, nurturing fathering patterns learned from fathers should be modeled by men toward their sons. Negative, distant patterns, however, should be compensated for in the ways men choose to change their communication patterns toward their sons. The researchers found that men whose fathers were either very unaffectionate or very affectionate showed more affection to their sons either as a modeling of affectionate fathering or a compensation for unaffectionate fathering.

Fathers have increasingly become more practiced at noticing and attending to their children's needs and they are growing in the amount of closeness they create. Fathers seem to be realizing the changes in the culture of fathering. It is no longer enough to simply be there and serve as an authoritative figure. The image of the attentive, open-minded, affectionate father has replaced the distant, unattached father, and that is the hallmark of the current, changing fathering culture (Miller 2011).

Father's Response Patterns Affect Son's Relational Competence

Ashbourne, Daly, and Brown suggest that responsiveness on the part of fathers is influenced by their prioritization of what is important among values and perceptions (2011). As these things change, a son's ideas of masculinity are affected because his father's level of value on responsiveness has changed. Beatty and Dobos continue in a similar thought process by referencing unpredictable response patterns' effects on apprehension experienced by sons and fathers themselves (1992). Apprehension is defined as a fear that something unpleasant will happen. In regards to fathers and sons, apprehension is the fear that communication between the two will cause unpleasant results in the relationship. Unpredictable patterns of behavior, in whatever context, are able to produce higher levels of apprehension, thus hindering effective responsiveness between individuals.

Foster, Reese-Weber, and Kahn relate the idea of learned helplessness perspective in which the frequency of hassles, such as apprehension, communication tension, and work-related stress, leads to fathers feeling that they are not succeeding in parental efforts (2007). He may then choose to give up on seeking ways to manage stressful behavior. As he gives up, he may avoid direct communication more often in an attempt to avoid the apprehension that has been created. Ultimately, this creates a barrier to his son's ability to move toward and create good relationships.

All of these factors—including responsiveness, level of apprehension in communication, and frequency of hassles contribute to how the son's competence in social interactions is formed and utilized. It is clear that with higher levels of hassle and apprehension, the son's social interactions are likely to become less competent and effective. As emotional competence is weakened, so is one's idea of self-identity.

Frequency and Intensity of Negatives

As a result of the experiment involving fathers' parenting struggles and their effects on son's social competence, Foster, Reese-Webber, and Kahn determined that both the amount and regularity of hassles cause fathers to express themselves in more negative ways (2007). These results show that the more fathers are exposed to stress related to parenting, the less likely they are to be able and active in managing their stresses.

Both fathers and sons can create apprehension, which is a serious relational hassle. Once enabled, apprehension can remain a contributing factor in future relational satisfaction if left unmanaged (Beatty & Dobos, 1992). Consequently, apprehension and satisfaction are normally negatively correlated. For example, as apprehension increases within a relationship, satisfaction decreases, and vice versa.

Fathers, Father/Sons, and Their Sons: Generations of Feeling

Foster, Reese-Weber, and Kahn report that the ways in which fathers cope are indicators of how they express themselves in either negative or positive ways (2007). In addition, those levels of expressiveness contributed to their son's socio-emotional competence,or how they handle themselves among peers and ability to handle social situations effectively. Perhaps more importantly than social challenges, Morman and Floyd expressed that fathers felt more closeness and expressed more affection to their sons than those sons felt or expressed toward them (2002). Chiefly, this appears to be the result of fathers' lack of effective coping methods and the poor response techniques they employ in situations where the son is in need of more than just a paternal figure, but a father who uses every method at his disposal to keep their relationship strong.

Floyd and Morman explain that the amount of affection men receive from their own fathers is strongly related to how strong the relationships with their fathers were (2000). In the same way, the amount of satisfying behaviors exhibited toward their sons is greatly associated with the intimacy, involvement, and fulfillment of those relationships.

Research Questions

RQ1: How do fathers communicate to their sons what it means to be a man?

RQ2: Based on the father's behaviors and use of language, how does this communication affect the son's sense of gender identity?

Methodology

Participants

For the present study, the audience targeted was males between the ages of eighteen and twenty-six at a small southeastern liberal arts university. The only requirement in order to participate was that the males had a father whom they knew and that the relationship between them had a significant impact on the son's life in some way, whether positive, negative, or a combination of the two. Participants were recruited through the use of social media publicizing and by physical advertisements placed around the campus of the selected university. Also, student organizations made of predominantly males were made aware of the study and provided with the information to participate.

Through all recruitment efforts, twenty-five participants took part in the study. All participants were male. Of these, 95% were between the ages of eighteen and twenty-three and 5% were between twenty-four and twenty-six. Participants were mostly Caucasian, with the exception of three African American participants.

Procedures

Though the use of a survey format is typically used for purposes related to quantitative study, I employed it as a qualitative way of reaching a variety of unknown participants in order to gain their

views and experiences through open-ended survey questions. Keyton explains that regardless of which qualitative methodologies are used, they all share certain characteristics, such as the interest in the theoretical aspect and how people interpret communication processes (2011). Also, qualitative research, in any form, allows the researcher to use "interpretive lenses" to analyze and explore how communicators develop and create meanings from their experiences. These similarities are necessary in the grounding of my research method because they explain that qualitative research need not be strictly constrained to the typical methods associated with it, such as interviews or focus groups.

Originally, I planned to use interview methodology to gather information for the study. However, because of the nature of the questions related to father-son relationships, the Institutional Review Board (IRB) in charge of reviewing research proposals at my university ruled that the participants could be subject to psychological harm or emotional strain. The board decided that, for an undergraduate student, this type of research would not be appropriate.

While the decision of the IRB did present an obstacle, I proceeded to convert the interview questions I wrote into open-ended survey questions. For example, rather than using interview questions to inquire about the participants' opinions of their fathers, I used several rating scales where participants were able to rate their relationship with their father in terms of several different areas such as overall satisfaction, time spent together, and amount of affection shown. In doing this, I hoped to create a sort of interview setting online, figuratively speaking. The finished survey included several types of questions ranging from rating scales to open-ended questions that were answered with the participants' discretion as to the length and content. All of the questions were written and transferred from the interview format by myself with some consultation from research mentors in the field of communication studies. (See Appendix A.)

There were several issues that arose during the change between interviews and survey. First, the number of questions—about thirty with half being open-ended personal story questions—and the overall length of the survey proved to prevent participants from completing the entire thing. This caused some significant gaps in the findings because some participants skipped certain questions that were designed to interlock and were related to other questions. Therefore, without all questions being answered, it was difficult to link some participants' experiences with the questions related to how they were affected by the experiences.

The main issue in this situation is the loss of the nonverbal communication and the opportunity to ask follow-up questions in order to gain a better understanding of the experiences the participants shared. The survey did not answer the research questions directly, but instead gave support for previous research mentioned in the literature review as well as provided several prospects for future research to be done.

Data Analysis

Rather than switching to quantitative methodology to go along with the survey format of the research instrument, I chose to keep the qualitative aspect of my research goal and completed a thematic analysis of the responses given on the surveys. This analysis

helped me to answer my research questions because I specifically crafted the themes based on the answers I looked for to the research questions, while still allowing new themes to arise.

Themes were developed based on similarities in how the participants described how their fathers communicated to them what is to be a man and how they described their father's behaviors in certain situations. Also, trends arose based on the participants' perceptions of how they were affected by the interactions they had with their fathers.

Findings

The goal in this research has been to understand how gender identity is created through father-son interactions and how those interactions affect the son's sense of self. Through the qualitative survey conducted, I found three major trends related to the research questions and tying back to the research in my literature review. The first trend has to do with learned helplessness perspective (Foster, Resse-Webber, & Kahn, 2007). The second deals with the question of how gender identity is influenced by fathering patterns. The third trend supports the combined modeling-compensation hypothesis (Floyd & Mormon, 2000) and gives evidence related to what behaviors sons either want to continue with their children or discontinue. These three findings do not all directly answer my original research questions; however, they do provide further insight into the research of others and provide a solid grounding for further research on this topic.

Theme I: How Fathers Learn to be Helpless

The label, *father*, has multiple meanings and responsibilities that cultural traditional expectations have attached to it. One of these expectations involves fathers being expected to cope with stress in a way that is healthy and that does not discourage the rest of their family. This means that the father will be active in finding solutions, rationalizing the situation, and taking steps to understand his feelings and taking action toward betterment of himself and those around him (Foster, Reese-Webber, & Kahn, 2007). This can become a heavy burden, most especially when several stressors act at one time. Foster, Reese-Webber, & Kahn suggest that the more parenting hassles, the less rational the father will cope (2007). This supports their idea of the learned-helplessness perspective; that a hassled father may start to believe that his fathering efforts are unsuccessful and therefore he gives up trying to cope with stresses.

The results of this study yielded results in support of the learned helplessness perspective in that when the participants were asked to describe a time when their father was stressed or upset and his reaction, all of those who responded reported very similar reactions. The responses included, "He didn't show it," "he stayed away," "he went for a drive," "he stayed to himself," "withdrawing," "keeping to himself," "hid his emotions," and "became quiet." These responses all have one thing in common; they show that the father withdrew from the stressful situation in some way rather than coping with the situation then and there. Of course, we do not know how he coped over time, which is something that can be addressed in future research; however, the fact remains that he withdrew and that all of these participants saw it. The following question asked the participants to describe how their view of their father as a man was affected by his behavior during the stressful

situation. While half of the participant's views either stayed the same or somewhat increased, the other half's view decreased in some way. This trend helps us to understand part of the answer to RQ1; those son's perceptions of what it is to be a man are affected by how their fathers cope with stresses. Therein is a solid ground for future research on how such fathering behaviors affect son's own coping methods and ideas of how men should cope.

Theme II: "Don't Be Female" and "Don't Show Emotion"

The answer to RQ2 has been difficult to come by with the results that were given; however, there are hints within various questions' responses about how son's gender identities are influenced by their fathers fathering methods and actions. Symbolic interactionism theory opens the doorway into understanding an entire world of symbols, signs, language patterns, and how we use them all individually and together in order to create meanings, reinforce them, and modify them over time. Father-son interactions have the potential to create any number of meanings in both the father and the son, as with any other relationship. It becomes interesting, though, when sons change their behaviors and perceptions of their own actions because of some language choice or action of their fathers. These changed meanings have the potential to stay with the sons for their entire lives if they are not addressed or reevaluated.

For example, one participant stated that he used to go to stay the night with friends on a regular basis. This was something that he enjoyed doing and seemed natural to him. His father, on the other hand, did not think that it was acceptable for a boy to attend sleepovers. He told the participant, "That is girly, only girls do that" and ordered him to stop By issuing that command and ordering his son to stop an activity that he enjoyed simply because he deems it characteristic of the opposite sex, the father is affecting his son's sense of what boys in general *should* do. This could potentially cause the son to understand what his father said as a fact, rather than his father's own view. Foster, Reese-Webber, and Kahn explain that gendered behaviors that are acceptable by society are more likely to be modeled than those gendered behaviors that are traditionally associated with the opposite sex (2007). So, it may be natural for a father who subscribes to traditional gender roles to act in the way that the participant described. However, an issue arises because he is affecting his son's competence to choose for himself which roles he would like to be part of his own personal gender identity.

Another participant described a situation where his grandfather on his father's side of the family passed away. The participant stated, "He didn't cry or show any emotion to his children. This is where I learned that men don't cry, men do not show emotion." Here, because of the direct reaction to his father's behavior, this participant's idea of acceptable masculine behaviors was changed. In a similar way, a question was included in the survey where participants were asked to state how acceptable certain behaviors are for men. Of those who responded, 56.3% thought that a man crying in public is unacceptable. How the respondents came to the conclusion that crying is unacceptable is unknown. However, a study by Mormon and Floyd concluded that the father-son relationship is perhaps the most important predictor of son's future

communicative behaviors (2002). So, it is very possible that the percentage that found crying unacceptable were taught to believe that by their fathers. Further research may determine the origins of son's beliefs about gender roles and how they are enforced.

These results are related to the masculine expectations outlined by Wood (2009). The expectations that relate most directly to these results are the expectations that males "don't be female," and that they "be self-reliant" and not wear their hearts on their sleeves, for example. Mormon and Floyd explain that apprehension to communicate may be created and increased because of the expectations placed on males to identify with and act out the traditional masculine gender roles (2002). These roles include the inhibited ability to express emotion and affection, the need for success, and a need for power and control. My participants possibly struggled with these gender roles that were placed in front of them like an exam they were supposed to pass with excellence. Further study is needed to examine exactly how sons respond to traditional gender roles, but these results certain support the claim that fathers affect their son's perceptions of what are and what are not appropriate ways for males to behave.

Theme III: What Kind of Fathering Would You Model?

Everyone who has known their parents and interacted with them for any amount of time has known certain factors that they like and dislike about the way their parents chose to "do their parenting." Unconsciously, we constantly reevaluate our perceptions of the way we are "supposed" to act based on how our parents, in particular, respond to our actions. This relates to the reflected appraisal perspective outlined by Wood which involves our perceptions of another's view of us (2010). So, when we see our parents' reactions to our actions, we may choose to reflect their opinions in the ways we change our behaviors. These instances are termed *self-fulfilling prophecies* (Wood 2012). The turning point in life is when we begin to think freely of our parents and start to understand where we want to act and rear our own lives. At that point, which may be very different for different people, we choose whether to model the behaviors that our parents employed in raising us, or to compensate for them in some way.

The participants of this study were asked to identify things that they would like to continue with their children in the future if they choose to have them. Responses included encouraging them to have their own path and promoting a strong work ethic. The most common responses involved some form of teaching they would like to continue and showing support to their children in some way, but the responses were not as specific to the types of these actions they would like to continue. They were also asked to identify things they would not continue with their own children. Responses included: not making them feel neglected, degrading them, belittling them, and not using physical violence as punishment. The responses to these two questions support the idea originated by Floyd and Mormon that men whose fathers were affectionate and supportive will likely chose to model their father's behaviors while those whose fathers were distant and unsupportive will likely compensate for the behaviors that they did not approve of (2000). They will carry out this compensation in

the ways that they choose to raise their own sons. By doing this, a man is filling the "void" that his father left empty of whatever type of emotion or treatment he felt deprived of. Again, future research is needed to determine specific behaviors that participants want to continue or not, how those behaviors affected them through childhood and maturity, and also why they would like to continue them or not. Chiefly, these findings cause a claim to arise that sons have things that they both will and will not continue with their own children and that these are the result of their father's parenting behaviors.

Summary of Findings

Whether their coping methods become ineffective, certain masculine expectations are reinforced or teaching methods of fathering, each theme presents an insight into how fathers actively affect their son's perceptions of masculinity. We can understand how each could potentially create positive or negative reactions by sons, depending on how they interpret their fathers' behaviors. In the case of all of the themes, it can be concluded that fathers who are involved in their son's lives do inevitably have a significant impact on perceptions and performances of gender.

The three themes have provided excellent prospects and groundwork for future research, which has been a goal throughout the research process. Because of the change in methodology outlined in the method section, the results here are different than an interview method would have yielded and have proven to not answer the research questions directly. However, findings remain to be significant and the information here has given great insight into how fathers affect their son's self-identity. This seems to be the first of many future puzzle pieces that will be put together to create a series of related research, which will reveal significant results and insight into the world of father-son relationships.

Suggestions for Future Research

There are several ways in which this research can be expanded. First, if I am able to continue this research at the graduate level, I hope for the opportunity to conduct interviews as my method for collecting data. I believe that having the opportunity to record non-verbal communication, ask follow-up questions, and guide the participants' thoughts is essential in order to attain results from more nuanced, complex data. The prospect of being able to evaluate nonverbal communication stems from the thought that sons may or may not become noticeably emotional when describing certain memories or feelings regarding their fathers. By observing these, there is a whole new aspect of the fathers' effects on the son's gendered performances. How the sons express feelings about their fathers may expose how they are predisposed to handle emotion. They may refrain from crying or avoid direct reference to their feelings, which are actions typically associated with female expressions. Additionally, being able to ask follow-up questions and guide each conversation will allow for each interview to take its own form and focus on certain questions about experiences that will provide more precise information for the future data analyzation. In these ways, the present study can be expanded to generate much more qualitative evidence leading to new and exciting conclusions.

Conclusion

It is clear after the present study that the relationship between a father and a son bases itself around several changing, growing factors such as responsiveness, affection, closeness, and attentiveness. I can conclude now that interactions between the two people are symbolic in nature and carry a heavy weight from the time of infancy and throughout the lives of both individuals. Also, I believe that the expectations placed on males, mentioned by Wood, have a significant impact on how sons choose to create their own self and gender identities and that their father plays a part in channeling those societal expectations toward his son (2009). Through the qualitative survey, I have explored these types of interactions and expectations and provided proof of how perceptions are created within one of the most historically significant relationships in the familial realm. With further study on this topic and expanding into other aspects of masculine expressions within family units, evidence may be found that can contribute to men's understandings of how to nurture their gender identities, ultimately helping to create healthier and more free lives for anyone willing to question himself and learn the answer to the most valuable question, the question of "Why."

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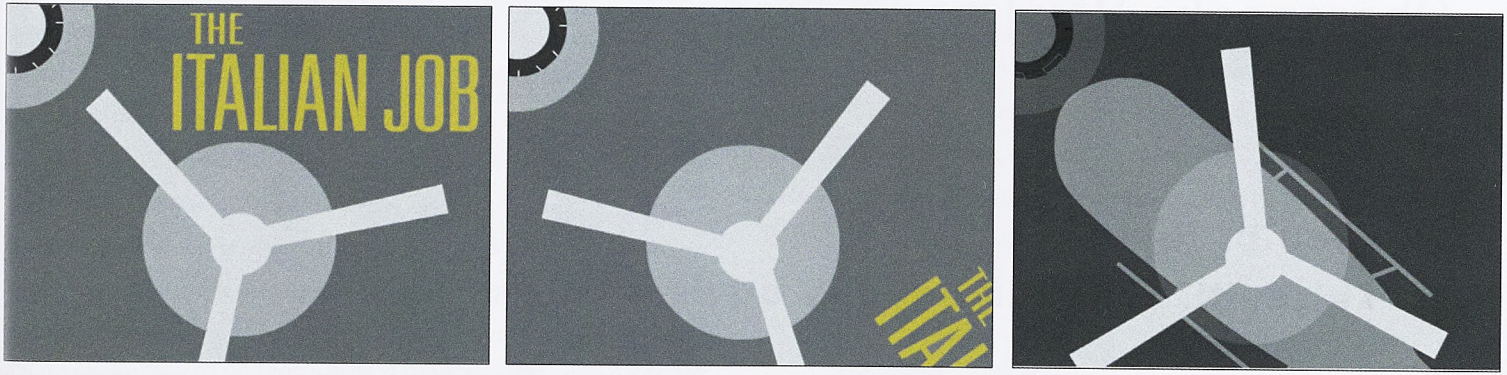
Designer:

James Early

poster for a talk on the role of the Cuban Revolution in the development of Reggae, 2012



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three frames from an animated title sequence
for the movie "The Italian Job,"
2012

The Influence of Tropical Cyclones on Chesapeake Bay Dead Zones

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Abstract

Concentrations of nitrogen (N), phosphorus (P), chlorophyll a (Chla), and dissolved oxygen (DO) were analyzed before and after the impact of six tropical cyclones (TCs) to determine their influence upon dead zones in the Chesapeake Bay. Using the Chesapeake Bay Data Hub, data was collected and analyzed using paired t test, both temporally and spatially. Temporally, TC Barry initiated the majority of the largest differences in concentrations with a decrease in DO (-1.51885 mg/L) and in Chla (-4.29649 μg/L). These drastic changes could be contributed to the time and track of Barry, and status of the Chesapeake Bay upon impact. All TC concentrations for each variable were averaged together to analyze spatial trends. DO concentrations increased throughout the Chesapeake Bay (0.903207 mg/L, 0.911879 mg/L, and 0.668812 mg/L) and were attributed to increased flow from tributaries. Examination of individual bay stations revealed the middle region of the bay is DO deprived and is a historically reoccurring dead zone. Both N and P concentrations decreased as latitude decreased and contributed to the influx of salinity from the Atlantic Ocean. N concentrations were not significant either temporally or spatially leading to believe that P is the more limiting nutrient. It was concluded that future studies should include TC characteristics, salinity, and tributary data into the analysis of dead zones. The middle area of the bay should also be focused upon since it exhibits the greatest change in concentration. Understanding the influence of TCs upon dead zones can help better understand the health of the United States' largest estuary.

Keywords: Tropical cyclone, dead zone, Chesapeake Bay

Introduction

Dead Zones in the Chesapeake

Each year, water bodies worldwide are threatened by events so disastrous that they have been given the name "dead zones." Dead zones have become an increasing concern globally as the number of dead zones has doubled each decade since the 1960s. Over 400 marine systems are affected by dead zones, covering an area of approximately 245,000 km^2 (Diaz and Rosenberg 2008). The United States is home to two well-documented dead zones. The first is in the Gulf of Mexico at the outflow of the Mississippi River, and is the largest anthropogenic dead zone in the western hemisphere (Joyce 2000) and second largest in the world (Rabalais et al. 2002). The area of the gulf that is threatened each year is home to a $3 billion fishing industry and 40,000 related jobs, making dead zones catastrophic to the local economy (Malakoff 1998). This work will focus on a second major U.S. dead zone, located in the largest estuary in the world, the Chesapeake Bay. The Chesapeake Bay extends 200 mi from the Susquehanna River to the Atlantic Ocean. As a major fishery and tourism source, the Chesapeake Bay is a source of economic revenue for much of Virginia and Maryland.

Scientists attribute the increase of anthropogenic dead zones in the Chesapeake Bay to a chain reaction that begins with land use in the watershed. Agricultural and urban development have increased polluted runoff in coastal watersheds since the 18th century (Boesch et al. 2001). Due to the mismanagement of crop and animal agricultural practices throughout its watershed, the Chesapeake Bay and its tributaries suffer regularly from nutrient pollution or eutrophication (Diaz and Rosenberg 2008). Eutrophication in the Chesapeake Bay is estimated to have occurred as early as 250–300 years ago, with the most rapid increase beginning around the 1940s (Cooper and Brush 1993). Most notably, the estuaries have experienced a substantial increase in nitrogen (N) and phosphorous (P). This is happening at a very large scale globally, and Vitousek et al. (1997) note that anthropogenic changes to the N cycle are double that of the carbon cycle.

Since N and P are essential nutrients for living organisms, when they exist in excess they support an exorbitant growth of aquatic biomass in the form of phytoplankton blooms. Such algal blooms occur naturally in the warm season, when there is ample light and an influx of new nutrients into a water body (Malone et al. 1988). Algal blooms are necessary for the Chesapeake Bay because phytoplankton are the dominant primary producers of the estuarine ecosystem (Joint and Pomeroy 1981), but they are known to have ramifications for habitats, ecosystems, and higher trophic levels (Paerl et al. 2007).

The algae flourish in the nutrient-rich waters. When they later die, they sink to the bottom, where they are consumed by benthic organisms (Mee 2006). Bacteria work to decompose the algae and use oxygen in order to perform respiration. When the dissolved oxygen (DO) concentration falls below 2ppm or 2ml O_2 / liter, hypoxia is established and the water struggles to support marine

life (Wenner et al. 2009, Diaz and Rosenberg 2008). Sometimes the water becomes completely devoid of DO (anoxic), especially in the bottom waters (Diaz 2001). Anoxia has been documented during the early and late summer in the Chesapeake Bay (Murphy and Kemp 2011). In the United States alone, hypoxia occurs naturally in half of the estuaries and anoxia occurs in about one third (Joyce 2000). Anthropogenic, and climatic factors, in addition to basin stratification, can often influence the occurrence of hypoxia, eutrophication, and algal blooms. With the increase of N-based fertilizers in the 1940s, there has been a notable decline of DO concentrations in many water bodies (Diaz et al. 2008).

The Impact of Tropical Cyclones

A dead zone forms in a body of water in part from an influx nutrients, namely N and P. Since 1945, the Chesapeake Bay has shown a significant increase of phytoplankton due to the input of nutrients from its tributaries (Jickells 1998). Thus, climatic events may flush excess nutrients to these waters, potentially spurring an algal bloom. Tropical cyclones (TCs) are believed to cause algal blooms and dead zones due to their ability to wash polluted runoff into the tributaries that feed the bay (Miller et al. 2006), and by mixing nutrients from the bottom waters (Wetz and Paerl 2008). As hurricane season is most active during the summer, algal growth is able to persist due to the plethora of light.

TC-induced dead zones have been documented in multiple water bodies. After Hurricane Floyd, Pamlico Sound of North Carolina suffered an algal bloom with an increase of chlorophyll a (Chla) from an average of 5-12 $\mu 1^{-1}$ to 23 $\mu 1^{-1}$ (Mallin and Corbett 2006). Between 1996 and 1999, Hurricanes Fran, Bonnie, and Floyd dramatically amplified the runoff of the Cape Fear River system and planktonic algae respirations were ten to fifty times greater (Mallin et al. 2002). In the Chesapeake Bay, Hurricane Isabel is documented as causing an abnormally large bloom by destratifying the bay and mixing the nutrients from the bottom waters. Flights conducted before and after Isabel showed a two-fold increase of Chla, covering an area of 3000 km. The bay returned to the long-term average by early October, one month after the hurricane's passing (Miller et al. 2006).

Wetz and Paerl (2008) note that the likelihood of a TC inducing a dead zone depends mostly on the current status of the bay. For example, as in Hurricane Isabel's case, if the bay is stratified then the TC may cause mixing of nutrients and increase the likelihood of a dead zone. Or, if the bay is lacking enough N (as N is usually the limiting factor in phytoplankton growth), the eutrophied runoff throughout the watershed may provide the N needed to spur algae growth. There have been scenarios in which a water body was deemed "dead" before a TC impact. An abnormally wet spring in 2011 caused an unusually large amount of polluted discharge to enter the Chesapeake Bay from its tributaries, and by early June a record 33% of the bay's volume was deemed hypoxic. This climbed to 40% by July. That September, Hurricane Irene crossed the bay, mixing the waters and giving it a breath of oxygen. While her impact may have been momentarily positive, it is likely that her nutrient pollution has impacted the bay's health negatively for the 2012 warm season (Maryland Department of Natural Resources).

Table 1: TCs that will be used in the study. Distance is their distance in miles from a central point in the Chesapeake Bay (mapped in Figure 2).

Name	Year	Month	Distance
Isabel	2003	9	98
Charley	2004	8	62
Gaston	2004	8	49
Ernesto	2006	9	23
Barry	2007	6	94
Hannah	2008	9	13

The Significance of this Research

While research suggests that certain TCs are responsible past Chesapeake Bay dead zones, many of the studies are not easily repeated and therefore results are difficult to compare. For example, Miller et al. (2006) required extensive preparation and data collection prior to, during, and after the hurricane using aircraft surveillance and remote sensing equipment. While they provide a helpful perspective on the Hurricane Isabel algal bloom, this technique may only be used in rare circumstances. Klemas (2012) mentioned two studies that were cost beneficial in measuring Chla since satellite imaging was used, but this still requires extensive training in remote-sensing techniques. It is the goal of this study to analyze Chesapeake Bay dead zones utilizing readily available water quality data and repeatable methodology.

In this study, concentrations of N, P, DO, and Chla are evaluated before and after recent TCs in the Chesapeake Bay. Individual TCs are analyzed to observe their influence on bay nutrient levels, and the spatial differences in impacts across the bay. This information could provide greater insight on how dead zones are influenced by climatic factors such as TCs.

The TCs used in this study vary in size, direction of approach, and intensity, but as Wetz and Pearl (2008) noted, the characteristics of the TC should not matter significantly. The TCs that were selected have occurred within the past 10 years and have tracked within 160 kilometers of a central point in the bay (Figure 1). This distance was chosen because this is the distance Hurricane Isabel passed by the bay, which is reported to have caused a large bloom. The selected TCs are: Isabel (2003), Charley (2004), Gaston (2004), Ernesto (2006), Barry (2007) and Hanna (2008) (Table 1). Including Isabel will help compare this study to past results. Gaston and Charley, both 2004, will provide insight on the impact of multiple TCs in a row in the Chesapeake Bay, similar to how Gustav and Ike (2008) combined to create devastating effects to Louisiana's marine ecosystems

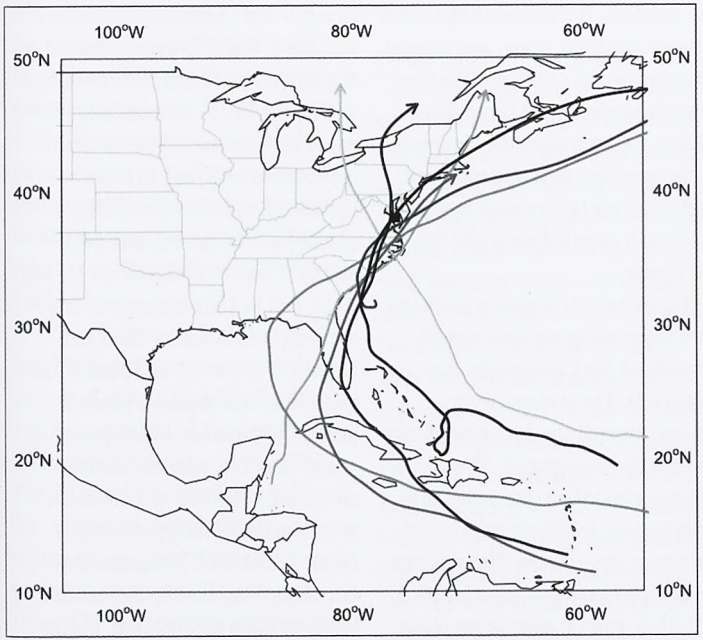


Figure 1: Tracks of the TCs being used in the study. The darkest tracks passed nearest the black point in the Chesapeake Bay, while all passed within 100 mi. Hurricane Isabel, known to have caused an algae bloom in the Chesapeake Bay, is the light gray track that continues inland toward the Great Lakes.

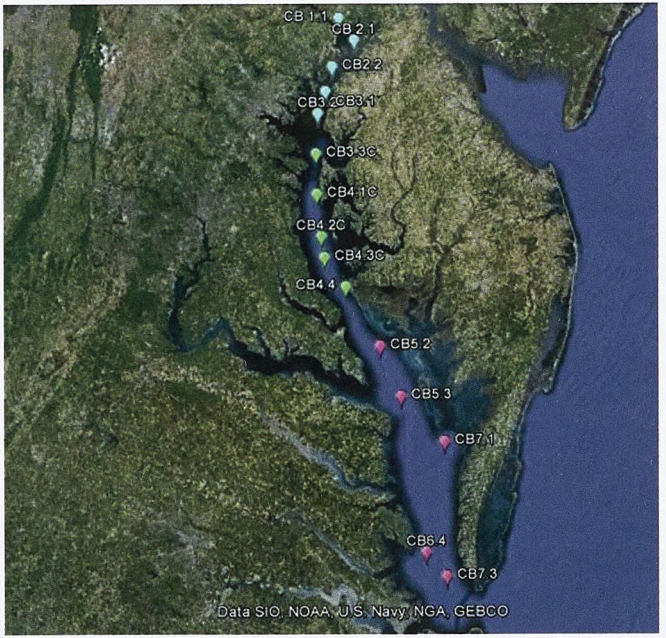


Figure 2: Location of stations within the Chesapeake Bay (Courtesy of Google Earth Maps). Light blue pegs indicate upper bay stations, green pegs indicate middle bay stations, and pink pegs indicate lower bay stations.

(Galvin et al., 2012). Data were analyzed one month before the TC passed through and one month after it passed. Wetz and Paerl (2008) show that the largest impacts of TCs on algal blooms are evident within a short time period after the TCs passing, and Miller et al. (2006) show that the bay recovered from the Isabel bloom within one month of the hurricane's passing.

Previous research suggests that TCs have an impact upon Chesapeake Bay nutrient fluxes and dead zones. Water quality data collected by the Chesapeake Bay Data Hub have not been used extensively to study the impact of TCs on bay nutrient levels. The following research questions (Q1, Q2, and Q3) and hypotheses (H1, H2, and H3) are tested using the data.

Q1. Do the water quality data suggest that Chesapeake Bay TCs cause an increase of N and P in the estuary?

H01: There will be no significant differences in N and P amounts in the Chesapeake Bay before and after the TCs.

Q2. Do the water quality data suggest that Chesapeake Bay TCs cause an algal bloom?

H02: There will be no significant differences in in Chla and DO amounts in the Chesapeake Bay before and after the TCs.

Q3. Are the upper, middle, and lower parts of the bay affected differently by Chesapeake Bay TCs?

H03: There will be no significant differences between the three areas of the Chesapeake Bay before and after the TCs.

Data Collection and Methods

The water quality data utilized are from the Chesapeake Data Program database, available at www.chesapeakebay.net/data, which extends from 1984 to the present. The database is a cooperation between the local, state, and federal government and contains data from 49 stations positioned throughout the bay and its watershed. For most of the variables, data are collected weekly during the warmer months and once a month during late fall and winter.

For this study, data are gathered from 15 pumping stations spread throughout the Chesapeake Bay (Figure 2). The stations were chosen primarily by data availability through the time period. Their location was also taken into account in order to have relatively even coverage across the estuary. The stations are grouped based on their location in the bay, each station being classified as "upper," "middle," or "lower" for the purpose of testing for spatial differences in TC impacts.

The variables collected for stations are N, P, Chla, and DO. The variables N and P were collected in mg/L and Chla in µg/L. Nutrient variables, N and P, were collected in the form of total nutrients present within the bay to include both inorganic and organic. These measurements were analyzed in order to include all nutrients accessible for phytoplankton growth and availability of data. The nutrients (N and P) as well as Chla concentrations are collected at the surface and bottom of the water and possibly at two additional depths if there is a present pycnocline. In the presence of a pycnocline, nutrient measurements are collected at 1.5m above and 1.5m below the pycnocline depth. Otherwise, measurements are taken from the top and bottom layers of the water column. Unlike freshwater stations, predetermined depths are not effective for the bay since stratification can occur rapidly throughout the year. DO is measured in mg/L and is collected at approximately 1–2 m intervals.

All collected data were averaged for each individual station based upon date. Data are gathered for one month pre and post TC. The exact dates of the observations vary between pumping stations, with each station having one or two observations each pre and post TC. The number of observations is shown in Table 2.

Paired sample t-tests are used to test the hypotheses using the data collected. For Q1 and Q2, the four variables are tested for significant differences pre and post each TC. For Q3, the four variables are tested for significant differences in each location group pre and post TC, based on the average of all TC interceptions. The next section outlines the results of the t-tests, followed by a discussion of any notable results.

Results

Individual TC impacts

Table 3 displays the differences in mean concentrations across time pre and post TC, with bold numbers meaning there was a significant difference according to the paired sample t-test. The concentration with the most significant changes was DO, with half of the TCs causing a significant increase in DO. Only two TCs had a statistically significant impact on the concentrations of Chla (Isabel and Barry). The only concentration to not exhibit any significant differences between pre and post averages was N. Changes in P were also small, but two TCs were statistically significant (Isabel and Ernesto).

As measured by the data hubs distributed throughout the Chesapeake Bay, all TCs, except for Charley, had a significant impact on at least one concentration. Hurricane Isabel significantly impacted DO, Chla, and P but in the opposite manner of which I hypothesized, with an increase in DO (1.7605 mg/L) and decreases in Chla (-2.0459 µg/L) and P (-0.01086 mg/L). Barry initiated the majority of the largest differences in concentrations, including a significant decrease in DO (-1.51885 mg/L), making Barry the only TC that did not cause a positive change in DO concentrations.

Two TCs impacted the bay in 2004, so both were used to analyze the impact of two storms in one season. Charley, the first bay TC from 2004, had less of an impact than Gaston, the second TC of the season. The only significant change brought by either of the TCs was the increase in DO (1.86056 mg/L) caused by Gaston. DO (1.30413 mg/L) was also the only significant change brought by Hanna in 2008.

Spatial variability of TC impacts

Similar to the individual TC results, DO was the concentration most impacted by each part of the bay, with all parts of the bay showing a significant increase post TC (Table 4). N was not found to be significant in any areas of the bay upon analysis. The middle area of the bay experienced the most significant changes in concentrations, and it exhibited a notable decrease in Chla (-2.77673 µg/L) post TC.

The data for each concentration are plotted from north to south in Figures 3–6 in order to show the spatial patterns in concentrations and fluxes. N concentrations decreased overall with latitude. The highest recorded N concentration was post TC for CB1.1 (1.5301 mg/L) and the lowest average nitrogen concentration was station CB7.3 pre TC (0.345419 mg/L). There were no significant differences pre and

	Upper Bay Observations	Middle Bay Observations	Lower Bay Observations
Isabel	20	19	12
Charley	15	15	17
Gaston	15	15	16
Ernesto	15	15	13
Barry	20	17	15
Hanna	15	15	13

Table 2: Number of bay observations observed for each designated area per individual TC. Observations were averaged for each individual station for each date collected.

	N			P			Chla			DO		
Hurricane	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change	Pre	Post	Chang
Isabel	0.922262	0.937216	0.01495	0.062826	0.051961	-0.01086	8.167145	6.121266	-2.0459	4.697332	6.457852	1.760
Charley	0.866947	0.809619	-0.05733	0.051836	0.050921	-0.00091	6.061629	6.419151	0.35752	4.684345	5.346266	0.661
Gaston	0.869117	0.937461	0.06834	0.055953	0.077246	0.02129	6.831968	4.513937	-2.31803	5.253362	7.113922	1.860
Ernesto	0.650388	0.75746	0.10707	0.063816	0.044967	-0.01885	6.147159	6.271339	0.12418	4.569955	5.440371	0.870
Barry	0.890848	0.757386	-0.13346	0.032212	0.078796	0.04658	11.30365	7.007163	-4.29649	6.656867	5.138022	-1.518
Hanna	0.630086	0.610686	-0.0194	0.062344	0.055798	-0.00655	8.14438	5.475898	-2.66848	3.954823	5.258954	1.304

Table 3: Averages of 15 selected bay stations per TC for each variable. Differences between pre and post TC concentrations based on the average of 15 selected bay stations. Bolded numerals indicate a significant ($p<0.05$) difference according to paired-sample t-tests.

post TC. P was also found to have a decreasing trend toward the more southern end of the bay. CB5.3 had an abnormal high P reading post TC at 0.22143 mg/L, perhaps an erroneous reading. Chla concentrations showed no remarkable spatial pattern, with the highest increase at station CB3.3C (12.191 µg/L) pre TC. Additionally, dissolved oxygen was significant in all areas of the bay between pre and post averages. DO concentrations decreased and increased in a parabolic fashion from north to south of the bay, with the middle of the bay having the lowest DO readings. The lowest recorded DO concentration was CB4.1C (2.716421 mg/L) pre TC and the highest was CB2.1 (8.004821 mg/L) post TC.

Discussion

Individual TC Impacts

It was expected that TCs would cause an increase in nutrients N and P due to eutrophication of tributaries and mixing of the bay's water. This could result in an algal bloom, which would be signified by a substantial increase in Chla and a decrease in DO. The results reveal a trend that is opposite of the one anticipated in most of the variables and TCs.

N concentrations were expected to increase due to eutrophication and destratification. Algal blooms can occur due to eutrophication of the bay since N is often a limiting factor in oceanic, coastal, and estuarine waters (Paerl 1997). It was expected for N to increase during the impact of Isabel since there was a large algal bloom and vertical mixing of the water columns. The results presented no significant changes in N for any of the TCs. Besides dilution of the nutrient in the bay, other factors outside the bay may also contribute to the decrease, including soil absorption, plant uptake, microbial uptake, and denitrification of standing nutrient-rich waters on flood plains (Mallin et al. 2006). Inability to fully examine tributary variables may have led to a misunderstanding of the cause of N concentration during the TCs.

Comparatively, P concentrations were also expected to increase after TC tracks due to expected eutrophication of the bay by potential runoff from tributaries. However, the only two TCs to demonstrate any significant differences were Isabel (-0.01086) and Ernesto (-0.01885), in which P decreased (Table 3). A comparison of two consecutive hurricane seasons in the Neuse River Estuary and Palmico sound revealed thet shallow estuaries are able to recover from frequent hurricane impacts in regards to high nutrient loads of N and P (Burkholder et al. 2004). Data analyzed after TC impacts were limited due to insufficient consecutive collection of data after TC impacts. Similar to N concentrations, dilution may have also played a factor in decreased P concentrations. Glasgow and Burkholder (2000) found that P decreased as high volumes of flow entered the Neuse River Estuary between two consecutive years. This could be a possible explanation of why P overall decreased but could not be measured due to lack of tributary data.

After eutrophication, it was expected to see an increase in Chla and decrease in DO, signifying a dead zone. Once again, the data showed the opposite of what was expected. A specific example is Hurricane Isabel; where previous studies presented a decrease in DO due to the large algal bloom that resulted from winds of Isabel destratifying the bay's water column by vertical mixing (Li et al. 2006). This should be evident through an increase in Chla concentrations.

Table 4: Differences between pre and post TC concentrations in three segments of the bay (upper, middle, and lower). Bolded numerals indicate significant changes ($p<0.05$) in means according to paired-sample t-tests.

Bay Area (stations)	Chla	DO	P	N
Upper (CB1.1 -CB3.2)	-1.93009	**0.903207**	**0.014463**	0.059687
Middle (CB3.3C-CB4.4)	**-2.77673**	**0.911879**	**-0.01641**	0.008966
Lower (CB5.2-CB7.3)	0.075108	**0.668812**	0.022043	-0.00648

Miller et al. (2005) found that 6 days after Isabel, Chla increased spatially two to three times the long-term average. With such a large algal bloom, it would then be expected that a dead zone would result and be evident in the DO concentrations. However, the water quality data show a decrease in Chla and increase in DO, not supporting these ideas. One possible reason could be that Miller et al. (2005) are only seeing a spatial spreading of the algal bloom, rather than an actual growth of additional algae. From an aircraft, the expanded algal bloom could resemble a growing bloom rather than one that has been mixed across the surface. This would cause a decrease in Chla concentrations at an individual station. The turbulent mixing of the waters could also favor an increase in DO in the readings, similar to the Irene example discussed in the introduction.

Gaston and Charley were selected to study the effects of two consecutive TCs upon the bay. Based upon the data, successive TCs were inversely related to each other except in DO concentration (Table 3). Gaston had only one significant difference in DO (1.86056), while Charley had no significant differences. Peierls et al. (2003) discovered that variable Chla and N and P can be inversely related to each other during the occurrence of consecutive TCs. Based upon the Peierls et al. (2003) study, it is plausible that an algal bloom occurred during Charley (increase in Chla) that led to the usage of N and P by the phytoplankton for growth (decrease in N and P). When Gaston then hit only a short time after, the increase of N and P could have been attributed to a flux of nutrients from rivers. The decrease of Chla may be due to increase of turbidity by Gaston, which would limit light for phytoplankton for growth.

Spatial Variability of TC Impacts

Spatial variability of TC impacts was studied to determine differences in concentrations among the bay areas, as well as differences in their response to TCs. Both N (Figure 3) and P (Figure 4) gradually decrease with a decrease in latitude. In areas of the Chesapeake Bay where salinity is typically lower, N and P concentrations were found to be higher (Boynton et al. 1995). Smith (1984) also presented that as salinity increased, P inversely decreased, while N typically remained the same. This trend is

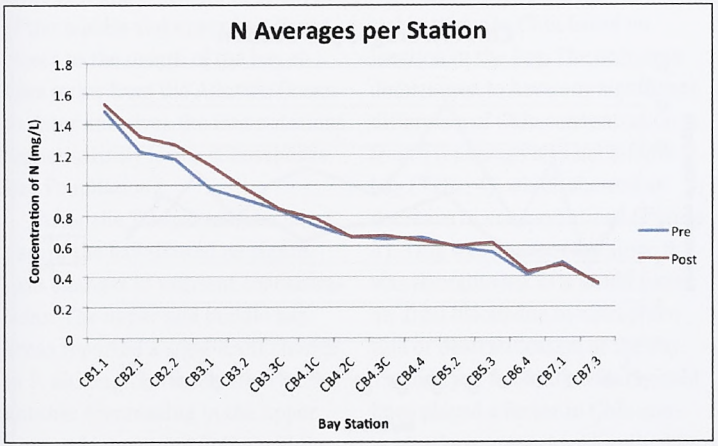
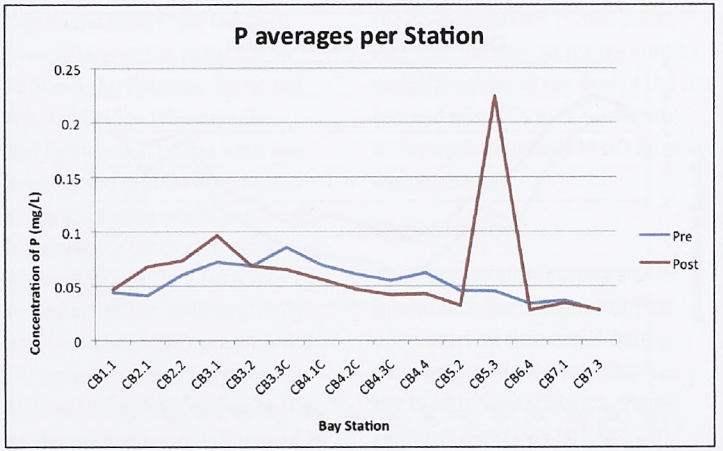


Figure 3: Average N concentration for each station North to South along the Chesapeake Bay. The blue line is the pre-TC average and the red line is post-TC average.

Figure 4: Average P concentration for each station North to South along the Chesapeake Bay. The blue line is the pre-TC average and the red line is post-TC average.



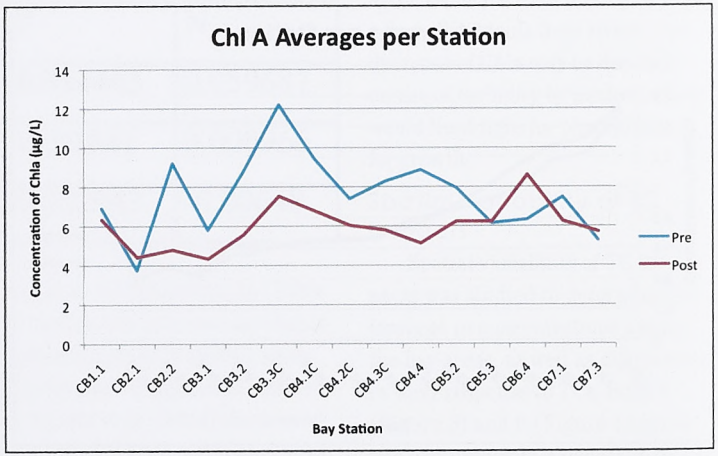


Figure 5: Average Chla concentration for each station North to South along the Chesapeake Bay. The blue line is the pre-TC average and the red line is post-TC average.

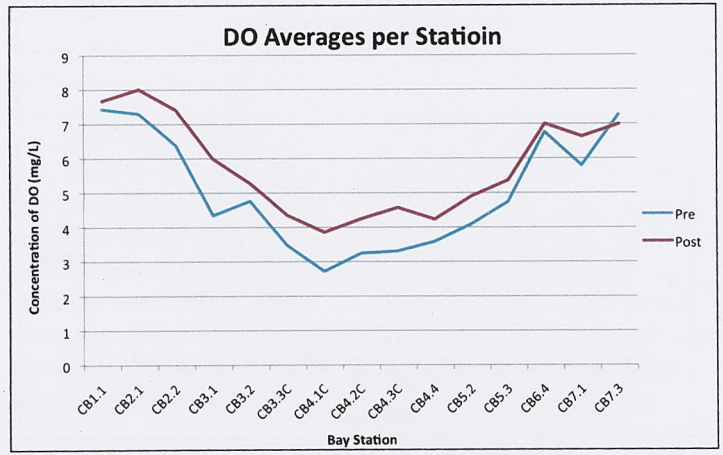


Figure 6: Average DO concentration for each station North to South along the Chesapeake Bay. The blue line is the pre-TC average and the red line is post-TC average.

noticeable, as the lower latitude stations have decreased concentrations of N and P compared to those of the middle and upper bay. Being closer to the mouth of the bay allows water from the Atlantic Ocean to enter and gives the lower stations higher salinity levels (Chesapeake Bay Foundation).

After the TCs passed, the lower part of the bay showed no significant changes in nutrient concentrations. The upper and middle bay areas reported a significant change in P, although inversely from one another (decreasing in the upper area and increasing in the middle area). None of the areas were significantly impacted by N. Paerl et al. (2006) discovered factors such as water residence time and stratification could play a role in nutrient concentrations. As water stands in areas such as flood plains, nutrients, such as N and P, are gradually leeched and used by biological processes. This process then decreases the amount of nutrients in the bay.

There were no obvious spatial patterns in Chla based on location in the bay. The only area determined to have any significant difference of Chla concentration from TC passage was the middle bay (Table 4), which showed a decrease in concentrations (Figure 5). This was unexpected since it was thought that TCs would cause an algal bloom due to eutrophication or destratification of the bay. Turbidity of tributary waters could have played a factor in Chla concentrations present within the bay. Irigoien and Castel (1997) found that the photosynthetic activity of Chla decreases with increases of water turbidity. It is possible that TCs generated enough flooding of tributaries that excess debris entered the bay, thus decreasing the concentration of Chla.

There is an obvious dip in DO in the middle of the bay, with the highest values being to the north and south (Figure 6). A comparable trend was found in a study where the north and south areas of the bay had similar DO concentrations and the middle bay had significantly lower DO measurements. Cowan and Boynton (1996) accredited this trend to reduced vertical mixing and increased loading of organic matter in sediments. Reduced vertical mixing may have contributed to the pycnoclines. The Chesapeake Bay Foundation reported that pycnoclines occur naturally in between the Potomac River and the Bay Bridge (Chesapeake Bay Foundation). This area was deemed the middle area in this project. Oxygen would not be able to penetrate through a pycnocline, where it would then turn into DO in bottom water columns. Kelly and Doering (1999) presented that DO concentrations vary horizontally within the Chesapeake Bay, as the pycnocline is influenced by wind-induced tilting and oscillating. An analysis of pynocline data before and after each TC could further explain these results.

DO increased significantly post TC for all three bay areas (Table 4). When the TCs made their way through Virginia, it is possible they were able to flush out more water into the bay and increased its flow. By increasing the flow of the bay, oxygen from the air is able to dissolve into the water, thus increasing DO concentrations (Chesapeake Bay Foundation). In future studies, quantifications of the flow of the bay pre and post TCs may contribute to the understanding of DO fluxes within the bay.

Conclusion

The purpose of this study was to investigate the influence of TCs upon nutrient fluxes and dead zones of the Chesapeake Bay using readily available data. Three research questions (Q1, Q2, Q3)

were derived to investigate the following prospects: influence of TCs upon N and P influx within the bay, reliability of water quality data to predict an algal bloom, and possible spatial differences among the bay. The null hypotheses (H1, H2, H3) presented that there would be no changes to the bay due to TCs or water quality data would not reveal algal blooms. Data collected by the Chesapeake Bay Foundation were analyzed one month prior and post TC impact. Data were collected from 15 stations located throughout the bay and analyzed independently for each TC and in spatial groupings using paired-sample t-tests. The results demonstrate spatial trends of nutrients and nutrient fluxes within the bay. These specific trends did not support hypothesis, and they open an interesting discussion of how TCs affect the Chesapeake Bay, as well as the reliability of water quality data.

The hypothesized results of this study were that a TC would increase nutrients and eutrophication and a resulting increase of Chla and decrease of DO. This would cause a dead zone within the bay. It is an interesting result that the algal bloom that reportedly occurred after Isabel was not evident in the water quality data. The way in which data were collected in past studies could have contributed to controversial Chla measurements such as that in Miller et al. (2005). Aerial data could record the growth of algae by satellite imaging, but possibly the concentration of Chla could be much lower due to spatial dispersion from the churned waters.

Furthermore, possible reasoning behind the DO trend witnessed in the data could be attributed to organic matter from previous years determining the overall DO concentration and not phytoplankton. Similarly, other TCs displayed erratic significant differences among their variables. It was decided that N and P are greatly influenced by biological tributary processes, which limit the flux of these variables into the bay. It was also determined that overflow from tributaries could have diluted N and P concentrations within the Chesapeake Bay after individual TCs.

Spatially, a trend was noticed in N and P as latitude decreases toward the southern end of the bay. The variable contributing to this trend was most notably salinity. As salinity increases, concentrations of N and P inversely decrease. The lower stations were closer to the mouth of the bay, where salinity conditions are higher due to the Atlantic Ocean. Upon further evaluation of the spatial data, the biggest area to exhibit differences among variables was the middle portion. Reasoning behind why the middle bay differs greatly may be attributed to the shape of the Chesapeake Bay's bottom. Due to the similarity to a bowl shape, most notable in the middle area of the bay, pycnoclines can very easily act like a lid and prevent the flow of oxygen to bottom layers (Chesapeake Bay Foundation). This could possibly explain why this area of the bay had such a tremendous decrease in DO compared to the other two areas. In addition, Chla was only found significant in this area of the bay as it decreased. Turbidity of waters could have played a factor in this concentration. For future studies, the middle area of the bay should be focused upon due to its tendency to exhibit the greatest influence from TCs.

Previous studies argued about the importance of TC characteristics versus current status of the bay as being the predictor of a TC's impact. Intensity or track may not be a perfect predictor of impact due to influx of nutrients often being attributed to either mixing or runoff into tributaries. However, it is important to look at storm variables

that may impact these two factors. I believe future studies should include TC characteristics (strength, track, speed, rain fall amounts, etc.), as they can greatly alter the bay's composition through factors such as dilution and mixing of columns. That being said, the current status of the bay is also important. As seen in the results of this project, if the bay waters are already high in Chla or low in DO, a TC may impact the bay in the opposite way from that which one would expect. As shown by Barry, if any levels are abnormally high, the TC may help them reach their natural equilibrium. In the case of Barry, newspaper articles suggest that a dead zone was beginning to form, hence the high Chla concentration. It would be interesting in future studies to analyze the impact of Barry upon that potential dead zone. Further investigations of Barry could also reveal whether time of year was the cause for such differences when compared to the other TCs.

Data collected for the experiment were solely from the Chesapeake Bay Data hub. These open-source data provide a more streamlined, inexpensive way to analyze bay health, compared to individual sampling methods, remote sensing, and other collection methods used in past studies. However, the data also come with a set of issues. First, the data lack temporal resolution and regularity. The data are only collected every couple of weeks, and still some stations were unable to provide numerical data pre and/or post TC. The stations used in this study were some of the few that had the data available for both time periods. This is still not ideal, as it is important to see the small-scale changes in nutrient levels to understand TC impacts, which would require at least daily observations. If the data hub was able to provide a more extensive record of data collection, variables collected would have been more reliable statistically. Second, this study initially involved the study of the tributaries to determine the cause of eutrophication. However, due to sporadic data availability, especially in the most important bay tributaries (e.g., Susquehanna River), this was an impossible feat with these data.

Without fully understanding eutrophication, it could not be determined if N and P fluxes in the bay were being caused primarily by tributary or bay variables. Since the results differed rather substantially from a number of past studies, this research encourages further studies to analyze the impact of TCs on Chesapeake Bay nutrient levels. While the data would improve with increased spatial and temporal sampling, they are still data from 15 points in the bay that are signifying a different relationship that previously believed.

Lack of salinity data also led to a misunderstanding of N and P concentrations within the bay. It could not be determined if salinity was a major factor in N and P trends or a lack of tributary data. Salinity data in future studies could be used to show similarities compared to that N and P concentrations, which should be inversely related. In addition, a lack of pycnocline data could not fully establish whether DO data were influenced by flow of the bay or an inability of oxygen to penetrate to lower water columns. By incorporating these three factors into future research the DO, N, and P concentrations could be understood more fully, as well as the impacts of TCs on the health of the world's largest estuary.

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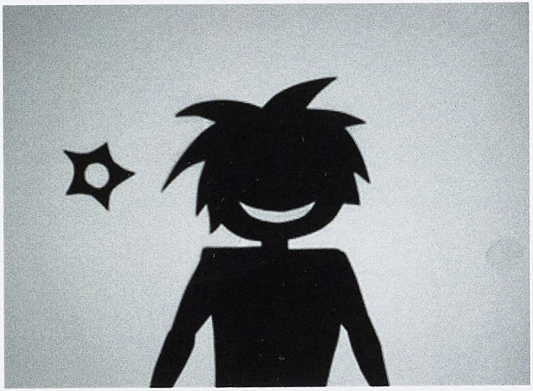

Designer:

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three frames from an animation entitled "FireFly," 2012

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logo for "Meals on Wheels" of Prince Edward County, 2012

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Matthew Sakach,
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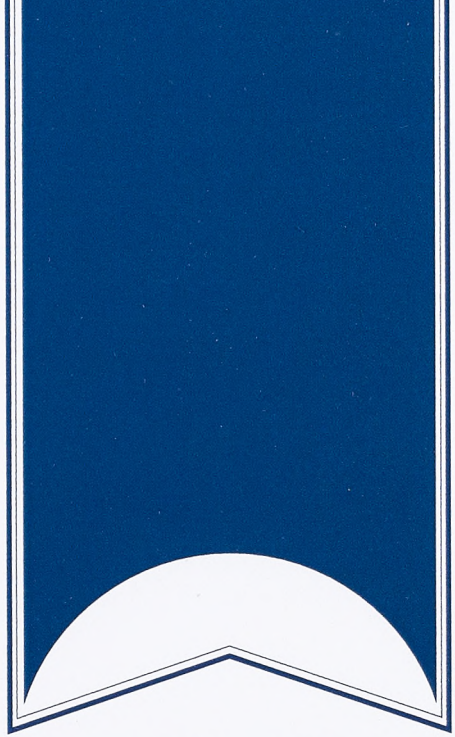
*spread from exhibition booklet
for a ceramics show,
2012*



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