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EDITOR'S INTRODUCTION

The Wagner Forum for Undergraduate Research is an interdisciplinary journal which provides an arena where students can publish their research. Papers are reviewed with respect to their intellectual merit and scope of contribution to a given field. To enhance readability the journal is typically subdivided into three sections entitled "The Natural Sciences," "The Social Sciences" and "Critical Essays." The first two of these sections are limited to papers and abstracts dealing with scientific investigations (experimental, theoretical and empirical). The third section is reserved for speculative papers based on the scholarly review and critical examination of previous works.

The interested reader will find much on the pages that follow. The first section contains the abstracts of papers and posters presented at the 66th Annual Eastern Colleges Science Conference held in Wayne, NJ on April 14, 2012. The next contains a study on the effects of ethanol on the activity level of Zebrafish. This is followed by an intriguing comparison between the rate at which teeth erupt and skeletal growth in children of prehistoric Peru. The results are indicative of the health of these children and shed insight into the consequences of sociopolitical change. Moving on is an examination of how Janine Antoni used art to convey messages about family, femininity, and the role of motherhood. Also, be sure not to miss an exploration of religious fasting during the Crusades and the critical essay written in Spanish on the surrealist painter Remedios Varo.

Read on and enjoy!

Gregory J. Falabella, Ph.D.
Editor-in-Chief

Section I: Eastern Colleges Science Conference[1]

Abstracts

2 Remote Setting Oyster Spat; Artificial Reef/Reef Ball
John Andrejack, Kim Tetrault, and Dr. Donald Stearns

2 The Effect of Green Tea Extract (EGCG) and other Plant Extracts on *Bacillus subtilis*
Dilijeta Bajrami

2 The Digits of Pi
Andrea Gonzales and Dr. Otto Raths

3 The Effect of Garlic Extract on Quorum Sensing Pseudomonas Aeruginosa
John Augello

3 Selenium Supplementation and its Impact on Plasma Glutathione (GSH) among Arsenicosis Patients in Bangladesh
Ervila Behri, Stephanie Asusta, Elena Stekolchik, Melanie Valencia, and Dr. Mohammad Alauddin

4 Bacteriophage Therapy against Pan-Resistant Strains of *P. aeruginosa*
Benjamin Bustamante

4 The Effects of Green Tea Extract EGCG and Other Plant Extracts on Salmonella and Citrobacter
Krista Carbonara

5 Analyzing the Effect of Phthalates on the Development of *Drosphilia Melanogaster*
Leonard Giordano and Dr. Heather Cook

5 Using Gas Electron Multipliers (GEM) to Reconstruct Position Tracks Emanating from a Source
Gia DeStefanis

5 Zebrafish as a Model Organism for *Listeria monocytogenes* Central Nervous System Infection
Alina Guseynova, William Rivera, and Dr. Christopher Corbo

[1] Papers and posters presented at the 66th Annual Eastern Colleges Science Conference held in Wayne, NJ on April 14, 2012.

6 Properties of a Classical Black Hole Solar System
Carrie Holt and Dr. Otto Raths

6 Photosensitivity of Instar 4 Mosquito Larvae *(Aedes aegypti)* to Different Light Intensities
Thomas Iannacone and Dr. Donald Stearns

7 Capsaicin Induced Optic Nerve Damage in Zebrafish: A Model of Trans-neuronal Degeneration
Maximillian Lucci, Michael Broe, Michael Gutkin, Dr.Zoltan Fulop, and Dr. Christopher Corbo

7 The Regeneration of Blood Vessels in the Zebrafish *(Danio rerio)* Optic Tectum
Richard Morgan

8 The Effect of Green Tea Extract (EGCG) and Ten Other Plant Extracts on the Growth of Staphylococcus
Julia Mullins

8 Digital Database and Interactive Microscopic Brain Atlas for Adult Zebrafish *(Danio rerio)*
John Passantino, Prof. Linda Raths, Dr. Christpher Corbo, and Dr. Zoltan Fulop

9 Effect of a Green Tea Extract (EGCG) and Other Plant Extracts on the Inhibition of Growth of *Enterobacter aerogenes* and *Echerichia coli*
Ashley Polizzotto

9 The Cellular Response of Adult Zebrafish Optic Tectum: A Model for a *Listeria monocytogenes* Infection
William Rivera, Alina Guseynova, Michael Gutkin and Dr. Christopher Corbo

10 Morphological Analysis of Mast Cell Distribution of Surviving Organotropic Culture of Adult Zebrafish Optic Tectum during the First Week
Deeksha Chawla, Elissa Troisi, Michael Gutkin, Prof. Linda Raths, Dr. Christopher Corbo, and Dr. Zoltan Fulop

10 Imaging Primary Cilia in Pancreatic Cancer Tumor Initiating Cells
Gina Auricchio, Dr. Jennifer Bailey, Dr. Florencia McAllister, Dr. Anirban Maitra, and Dr. Steven Leach

11 How the Children Grow: Tracking the Health Impacts of Sociopolitical Change in Prehistoric Peru
Rose Tobiassen

12 Spectral Photosensitivity of the Fourth Instar Larval Stage of the Mosquito *Aedes aegypti*
Rachel Tripp and Dr. Donald Stearns

12 Olfactory Sense and Species Recognition in the Zebrafish *(Danio rerio)*
Alyssa Spivak

13 Sodium Selenite Supplementation and Plasma Glutathione Peroxidase Activity in Arsenicosis Patients in Bangladesh
Elena Stekolchik, Lisa Schneider, Ervila Behri, Stephanie Asusta, Nicole Deluzio, Melanie Valencia, and Dr. Mohammad Alauddin

13 Enhancing Plasma Selenoproteins through Selenite Supplementation in Arsenicosis Patients in Rural Bangladesh
Melanie Valencia, Ervila Behri, Stephanie Asusta, Elena Stekolchik, and Dr. Mohammad Alauddin

14 The Brachistochrone Problem
Vincent Lombardo and Dr. Otto Raths

Section II: The Natural Sciences

Full Length Papers

16 The Effects of Ethanol on Zebrafish Activity Level
Ashley Nati

Section III: The Social Sciences

Full Length Papers

36 How the Children Grow: Tracking the Health Impacts of Sociopolitical Change in Prehistoric Peru
Rose Tobiassen

73 Stock Fading
Ryan Van Spronsen

Section IV: Critical Essays

Full Length Papers

88 Antoni's Touch: The Body and The Family in Janine Antoni's Work
Nicola Andersen

102 The Fantastic Travels and Travelers of Remedios Varo
Alexis Makwinski

114 Starvation for a Cause: Religious Fasting During the Crusades
Antoinette McCarty

122 Intimate Partner Violence and Aggression Among Male Veterans with PTSD
Mary Beth Somich

128 A Total Work of Art: In Search of the Gesamtkunstwerk
Erin Valerio

Section I: Eastern Colleges Science Conference

Remote Setting Oyster Spat; Artificial Reef/Reef Ball

John Andrejack (Biology), KimTetrault (Cornell Cooperative Extension of Sulfolk, NY), and Dr. Donald Stearns (Biological Sciences)

The Eastern Oyster (*Crassostrea virginica*) is the main species of oyster we study at Cornell Cooperative Extension on Eastern Long Island. This organism is capable of developing large reef structures in the environment to provide water filtration, species diversity, food source, and habitat. The process of remote setting oyster spat at our facility allowed us to oversee the development of the oyster larvae to the proper stage of growth. This process increased survival rate and allowed us to successfully transport the spat on shell to the desired location. We were able to implement this structure into the environment and observe its effectiveness by comparing test samples of water quality at the reef.

The Effect of Green Tea Extract (EGCG) and other Plant Extracts on Bacillus subtilis

Dilijeta Bajrami (Microbiology)[1]

Bacillus subtilis is a gram positive, rod shaped bacterium that is commonly found in soil as well as in outside environments such as in water and decaying plants. EGCG is commonly found in green tea leaves. It is part of the family, catechins, which are a type of antioxidants that are found in tea, wine and other products. Green tea has many antioxidants present and protects the body's cells. The objective of this experiment was originally to examine if EGCG can inhibit *Bacillus subtilis,* and then was further expanded to see if ten different plant extracts had any effect on the growth of the bacterium *Bacillus subtilis.*

The Digits of Pi[2]

Andrea Gonzales (Mathematics) and Dr. Otto Raths (Physics)

The most celebrated mathematical constant is probably Pi. This talk presents historical facts and data about Pi. A Chi squared, and other statistical tests, are performed on the digits of Pi.

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[1] Research conducted under the supervision of Dr. Kathleen Bobbitt (Microbiology)
[2] Recipient of Excellence Award

The Effect of Garlic Extract on Quorum Sensing Pseudomonas Aeruginosa

John Augello (Microbiology) [3]

It is seen that garlic extracts play a role in inhibiting quorum sensing in the formation of *P. aeruginosa* biofilms. There are certain plant compounds that derive from garlic extracts in which degrade specific auto-inducers that *P. aeruginosa* produce. Without these auto-inducers the *P. aeruginosa* may not be able to form a sufficient biofilm to cause serious infection. It may be possible that these plant compounds may be used therapeutically to prevent *P. aeruginosa* infections. A direct measurement of the effect of garlic extracts on *P. aeruginosa* quorum sensing and biofilm formation was conducted. A basic M.I.C. (Minimum Inhibitory Concentration) assay was executed involving two fold dilution series of *P. aeruginosa* and garlic extract. From these M.I.C. series, dry slides were created for visual evidence of the possible effects of the garlic extract on biofilm formation of *P. aeruginosa*.

Selenium Supplementation and Its Impact on Plasma Glutathione (GSH) among Arsenicosis Patients in Bangladesh

Ervila Behri (Chemistry), Stephanie Asusta (Chemistry), Elena Stekolchik (Chemistry), Melanie Valencia (Chemistry) and Dr. Mohammad Alauddin (Chemistry)

Almost 97% of 150 million people in Bangladesh depend on ground water which is reported to be contaminated with arsenic. About 100 million people in Bangladesh have been exposed to arsenic above the World Health Organization (WHO) guideline level of 10 µg/l. Arsenic is carcinogenic substance and exposure to high level of As through drinking water is causing adverse health effects in vast population. In a clinical trial, sodium selenite supplements have been orally administered among arsenicosis patients in Bangladesh to combat arsenic poisoning. Plasma Se level did increase after 24 and 48 weeks of supplementation. In one detoxification pathway As and Se is believed to form As-Se-GSH complex and removed by biliary excretion. The glutathione (GSH) seems to play an important role in arsenic removal. In this study we measured plasma (GSH) in patients after Se supplementation. We will report findings from our ongoing study.

[3] Research conducted under the supervision of Dr. Kathleen Bobbitt (Microbiology)

Bacteriophage Therapy against Pan-Resistant Strains of P. aeruginosa

Benjamin Bustamante (Microbiology)[4]

Hospital infections always propose a great risk to both patients and physicians alike. An issue that is presented when dealing with these secondary infections is the overexposure to antibiotics. Although antibiotics are one of most effective ways of treating a patient with a bacterial infection, an underlying problem emerges and that is the development of antibiotic resistant bacterium. *P. aeruginosa* is is an opportunistic organism that can cause many different forms of infections and produce toxins that can cause cell necrosis. This organism has mechanisms that allow it to become resistant to many different forms of antibiotics making the eradication of this infection more complicated. In this study I use Pseudomonas cultures isolated from local water sources then expose them to 11 different forms of antibiotics. From the same water source I isolate and purify bacteriophages and perform double plaque assays against the antibiotic resistant cultures.

The Effects of Green Tea Extract EGCG and Other Plant Extracts on Salmonella and Citrobacter[5]

Krista Carbonara (Microbiology)[6]

Epigallocatechin Gallate, better known as EGCG is a well known antioxidant. Its main function is to protect cells from being damaged by detrimental molecules produced during the digestion process. EGCG is most commonly found in green tea. Most manufacturers produce many variations because of its supposed ability to inhibit bacterial growth. The goal was to determine if it truly lived up to its reputation. Two microbes chosen, *Citrobacter* and *Salmonella* were exposed to green tea to test if either would be inhibited. After exposing these two microbes to the EGCG, it was found that both bacteria had still grown despite its supposed "inhibitory" abilities. Other plant extracts were then tested to determine their inhibitory effects on *Citrobacter* and *Salmonella.* These extracts included, trans cinnamic acid, glycyrrhizic acid ammonium salt (licorice), berberine chloride, tannic acid A.C.S, capsaicin, betulinic acid, papain, vitamin K, phloretin, and giant sage. The same dilution series was carried out to test these new

[4] Research conducted under the supervision of Dr. Kathleen Bobbitt (Microbiology)
[5] Recipient of Excellence Award
[6]Research conducted under the supervision of Dr. Kathleen Bobbitt (Microbiology)

extracts and it was concluded that trans cinnamic acid has inhibitory properties against both *Citrobacter* and *Salmonella* while glycyrrhizic acid showed slight inhibitory properties against *Salmonell*a. These plant extracts did not inhibit growth.

Analyzing the Effect of Phthalates on the Development of Drosphilia Melanogaster

Leonard Giordano (Biopsychology) and Dr. Heather Cook (Biological Sciences)

EDCs consist of a diverse group of molecules that are both naturally occurring and produced synthetically. The goal of this project was to determine whether phthalates used to make plastics affect the viability and/or development of Drosophila melanogaster. Our data indicate that tested concentrations do not affect fly development or viability.

Using Gas Electron Multipliers (GEM) to Reconstruct Position Tracks Emanating from a Source

Gia DeStefanis (Physics and Mathematics)[7]

A preliminary study of the development of a new detector using Gas Electron Multipliers (GEM) to reconstruct position tracks emanating from a source will be presented. The long term goal is to image tracks in three dimensions and generate a Position Emission Tomography (PET) image.

Zebrafish as a Model Organism for Listeria monocytogenes Central Nervous System Infection

Alina Guseynova (Microbiology), William Rivera (Microbiology), and Dr. Christopher Corbo (Biological Sciences)

Listeria monocytogenes is a serious food-borne pathogen that has caused gastroenteritis, meningitis, and septicemia. *L. monocytogenes* is also known to cause infections of the central nervous system (CNS). Zebrafish are an excellent model organism because they are easy to maintain and handle, but they also possess the central nervous system of a

[7] This work was performed under the direction of Drs. Craig Woody and Bob Azmoon at Brookhaven National Lab during a summer of 2011 Science Undergraduate Laboratory Internship Program.

vertebrate organism. In this study, zebrafish were inoculated with *L. monocytogenes* in the gills, mouth, and eyes to see which site would be a likely entry point to eventually lead to a central nervous infection. To see if the *L. monocytogenes* was able to enter the CNS, these locations of the fish were inoculated with *L. monocytogenes* and the zebrafish's brain was plated out according to a time course. Oxford media, a selective media for *Listeria,* was used to determine if *L. monocytogenes* was present in the brain tissue. The eyes and the gills proved to be the sites that most often lead to central nervous system infections. Approximately 70% of the fish came down with a CNS infection after inoculation into the eye. This could be because the eye has direct contact with the optic nerve that could have passed the infection to the brain. The gills closely followed with 64% while the mouth only had 25% of the fish positive for LM in the brain.

Properties of a Classical Black Hole Solar System

Carrie Holt (Physics) and Dr. Otto Raths (Physics)

A theoretical model that calculates the properties of a classical black hole solar system will be presented. Important parameters such as the event horizon, star and planet densities, have been calculated.

Photosensitivity of Instar 4 Mosquito Larvae (Aedes aegypti) to Different Light Intensities

Thomas Iannacone (Biology) and Dr. Donald Stearns (Biological Sciences)

Fourth- instar *Aedes aegypti* mosquito larvae were tested for their negative phototactic behavior in response to light cues, compared with their behavior under the same conditions but without exposure to light. Using a wavelength of 610 nm (orange light), the trials were conducted using four different light intensities and compared with a dark control as well as with each other. One-way ANOVA and Tukey testing were performed to determine which light cues elicited negative phototactic responses that were significantly different. In addition, χ^2 testing was completed to compare the distributional responses of the larvae under these different light conditions. High variability in percent negative phototaxis per treatment resulted in most tested light cues showing no significant difference ($\alpha = 0.05$) when compared with the dark control. However, χ^2 testing showed significant ($p < 0.05$) differences in the distributions of the test organisms

compared with the dark control for the tested light cues. The larvae appear to be extremely sensitive to very low light levels.

Capsaicin Induced Optic Nerve Damage in Zebrafish: A Model of Trans-neuronal Degeneration

Maximillian Lucci (Biopsychology), Michael Broe (Biology), Michael Gutkin (Microbiology), Dr.Zoltan Fulop (Biological Sciences), and Dr. Christopher Corbo (Biological Sciences)

The purpose of this experiment was to investigate the nature of capsaicin as a neurotoxin in adult zebrafish. Capsaicin is the primary capsaicinoid of cayenne peppers, and it is known to be a potent toxin to sensory neurons. Zebrafish were selected as the model organism due to its easy maintenance, low cost and its vertebral central nervous system. Capsaicin was injected into the zebrafish eye to develop a model of trans-neuronal degeneration. In this model, the sensory neurons of the retina were killed by the neurotoxin, and consequently, the connecting neurons in the optic tectum will be damaged due to a lack of stimulation. We studied the effect of capsaicin on both the retina and the optic tectum using light microscopy. At 24 and 48 hours post capsaicin exposure, the presence of blood cells both in the ventricle and in the periventricular grey zone was detected. Additionally, dead or dying cells were found to be present in both the retina and the optic tectum. The presence of these dead cells suggests that this may be a successful model to study trans-neuronal degeneration.

The Regeneration of Blood Vessels in the Zebrafish (Danio rerio) Optic Tectum

Richard Morgan (Biopsychology)[8]

Oil immersion light microscopy was used to analyze the blood vessels of a zebrafish optic tectum from an organotypic culture at distinct time periods. The extraction of the optic tectum and the production of slides occurred in previous experiments. The regeneration of the blood vessels was distinguished via evaluation of the red blood cells and the endothelium. Diminished nuclei of the endothelium and the red blood cells indicate a debilitated blood vessel. A healthy blood vessel was established from intact nuclei in the red blood cells and the endothelium. Healthy and debilitated blood vessels

[8] Research conducted under the supervision of Dr.Zoltan Fulop (Biological Sciences).

were distinguished at distinct time periods. The transition from a blood vessel that consists of diminished nuclei to a blood vessel comprised of prosperous nuclei indicates regeneration. The aggregation of red blood cells produced in the extracellular tissues of the blood vessels replicate mechanisms evident in embryonic development. The analysis supports the hypothesis that regeneration of the blood vessels in the optic tectum will occur following extraction from the zebrafish.

The Effect of Green Tea Extract (EGCG) and Ten Other Plant Extracts on the Growth of Staphylococcus

Julia Mullins (Microbiology)[9]

EGCG, or Epigallocatechin Gallate, as well as 10 other natural plant extracts are thought to prevent the growth of 2 species of *Staphylococcus*: *S. epidermidis* and S. *aureus*. These 10 additional extracts are Vitamin K, Weed pollens from Artemisia tridentate, Capsaicin, Phloretin, Tannic Acid, Glycyrrhizic Acid, Betulinic Acid, Papain, Cinnamic Acid, and Berberine Chloride. After performing 3 ten-fold dilutions for each of the 11 plant extracts, for each of the two species of *Staphylococcus*; it was found that for *Staphylococcus aureus*, Cinnamic acid works best in inhibiting the growth of the bacteria, followed by Tannic Acid and Berberine Chloride. It was also found that for *Staphylococcus epidermidis*, Berberine Chloride works best in inhibiting the growth of the bacteria, followed by Tannic Acid, and Glycyrrhizic Acid.

Digital Database and Interactive Microscopic Brain Atlas for Adult Zebrafish (Danio rerio)

John Passantino (Biology), Prof. Linda Raths (Biological Sciences),
Dr. Christpher Corbo (Biological Sciences), and Dr. Zoltan Fulop (Biological Sciences)

The premise of this research was to create a database program for microscopic images of the adult zebrafish (*Danio rerio*) brain. During the last few semesters we have been able to compile and catalog an extensive neuromorphological material for the adult zebrafish brain. Using advanced microscopic techniques, multiple images of the zebrafish brain have been produced in the horizontal, coronal and sagittal views. The data have come from relatively high resolution imaging of zebrafish brains on which neuroanatomical

[9] Research conducted under the supervision of Dr. Kathleen Bobbitt (Microbiology)

structures are well recognizable. Photoshop CS5 was used to mask, layer and color the digital photographs in the atlas. Specifically, desired regions of the brain in each picture were identified, colored-labeled and assigned a description in attempt to increase the interactive ease of users. Microsoft Access 2007 was the basic application used to create this digital database. It allows for the reduction of photographic storage space and the production of visually appealing forms to present the data. The database program that we have created allows for efficient storage of the photographic data, while making it easily accessible and interactive for users.

Effect of a Green Tea Extract (EGCG) and Other Plant Extracts on the Inhibition of Growth of Enterobacter aerogenes and Echerichia coli

Ashley Polizzotto (Microbiology)[10]

Echerichia coli also known as *E.coli* and *Enterobacter aerogenes* are gram negative bacilli. Epigallocatechian Gallate EGCG has been said to be one of nature's most powerful antioxidants. The objective of this research was to determine which concentration, if any, of EGCG and ten plant extracts could inhibit the growth of *E.coli* and *Enterobacter aerogenes*. The concentration of EGCG tested in this experiment ranged from 1260mg/ml to 0.00000126mg/ml. Results of this experiment showed that EGCG has no antimicrobial activity against *E.coli* and *Enterobacter aerogenes.* As for the ten other extracts, the highest concentrations had no effect except for Tannic Acid (500mg), Cinnamic Acid (250mg) and Berberine Chloride (250mg).

The Cellular Response of Adult Zebrafish Optic Tectum: A Model for a Listeria monocytogenes Infection

William Rivera (Microbiology), Alina Guseynova (Microbiology), Michael Gutkin (Microbiology) and Dr. Christopher Corbo (Biological Sciences)

Listeria monocytogenes is a facultative, intracellular, gram-positive bacterium that may infect humans following the ingestion of contaminated food. In this study, *L. monocytogenes* was injected into the vitreous humor of the adult zebrafish eye to determine if the organism could cause an infection of the optic tectum. Approximately 20

[10] Research conducted under the supervision of Dr. Kathleen Bobbitt (Microbiology)

adult zebrafish were injected in the eye with *L. monocytogenes*, and through plating techniques as well as light and electron microscopy, the time course of the infection was studied. The signs of infection were seen in the brain as early as four hours post injection. We could detect the presence of *L. monocytogenes* in the periventricular grey zone of the optic tectum by 7 days post injection.

Morphological Analysis of Mast Cell Distribution of Surviving Organotropic Culture of Adult Zebrafish Optic Tectum during the First Week

Deeksha Chawla (Biopsychology), Elissa Troisi (Biopsychology), Michael Gutkin (Microbiology), Prof. Linda Raths (Biological Sciences), Dr. Christopher Corbo (Biological Sciences), and Dr. Zoltan Fulop (Biological Sciences)

In order to examine the distribution of mast cells over 7 days, we took montages or compressed images of slides made from a previous study. These slides were created from a simple Zebrafish brain surgery which sliced the optic tectum in 4 pieces. These pieces were then deposited in a nutrient rich solution where they were kept for certain time points. In total, 3 fish optic tectums were dissected and the time points were kept at 2, 4, 6, 12, 24, 48, 72, 96 hours and 7 days. The fragments of the optic tectums were then stained and ready for observation after they had completed their respective time in the nutrient solution. The slides were examined for mast cell development through a Olympus 300 microscope under a 200x magnification. Mastocytes are rich in histamine in addition to other neurotransmitters. These cells specialize in fibrosis or connective tissue development. This in turn creates wounds and scarring at sites of damage. The results showed that there was a steady distribution of mast cells and granules for the first few hours but increased exponentially towards the end of the first week.

Imaging Primary Cilia in Pancreatic Cancer Tumor Initiating Cells

Gina Auricchio (Microbiology), Dr. Jennifer Bailey (Johns Hopkins University School of Medicine), Dr. Florencia McAllister (Johns Hopkins University School of Medicine), Dr. Anirban Maitra (Johns Hopkins University School of Medicine), and Dr. Steven Leach (Johns Hopkins University School of Medicine)

Primary cilia (PC) are microtubule projections eminating from the apical surface of epithelial cells and are responsible for the transduction of growth factor and morphogenetic signaling pathways. Observations in the field of pancreatic cancer suggest the absence of PC in human pancreatic intraepithelial neoplasia (PanIN) and pancreatic ductal adenocarcinoma. However, PC have been noted in differentiated acinar cells undergoing acinar to ductal metaplasia. This metaplasia is characterized in pancreatic injury and accelerates tumor formation in the presence of acinar specific *Kras*^{G12D} mutations sponsoring the hypothesis that PC are maintained in pancreatic tumor-initiating cells. To address this hypothesis, confocal microscopy (CFM) was used to quantify the percentage of cells within human PanIN: on a tissue array of n=23, it was determined in 15% of PanIN lesions that 13-30% of the cells expressed a primary cilium. CFM was also used to image mPanIN lesions from a mouse model that expressed *Kras*^{G12D}: PC in cuboidal epithelium was present in these transitional lesions. This data is informative with regard to the earliest initiating events in pancreatic cancer.

How the Children Grow: Tracking the Health Impacts of Sociopolitical Change in Prehistoric Peru[11]

Rose Tobiassen (Anthropology)[12]

The health of children is used as a proxy measure for quality of life. The rate at which a person's teeth erupt is determined by genetics, while skeletal growth is affected by environmental factors; stress early in an individual's life can result in stunted bone growth relative to dental development. Using this idea, this study compares the skeletal and dental age of 107 individuals from two sites in northern Peru in order to determine the amount of stress experienced by children across time periods. The sites include Cerro Oreja, occupied during the Salinar (400-1 BC) and Gallinazo (AD 1-200) periods and Huaca de la Luna, occupied during the Moche (AD 300-400) and Chimu (AD800-1530) periods. Cerro Oreja was an important urban center before the state-level society developed. With the founding of the Southern Moche State, Cerro Oreja was abandoned and Huaca de la Luna became the Moche state capital, which was later reused by the Chimu Empire. Given the dating of these sites, understanding child growth can help us track the health consequences of sociopolitical change. The sample sizes available were small, and therefore made determining significant difference between time periods

[11] Recipient of Excellence Award
[12] Research conducted under the supervision of Dr. Celeste Gagnon (Anthropology)

difficult. However it appears that the Salinar period children of Cerro Oreja suffered least from environmental stress, and the Noche children of Huaca de la Luna suffered most. A number of factors may have contributed to this stress, including changes in the economic system, the rise of social inequality, and environmental changes.

Spectral Photosensitivity of the Fourth Instar Larval Stage of the Mosquito Aedes aegypti

Rachel Tripp (Biology) and Dr. Donald Stearns (Biological Sciences)

The spectral photosensitivity of the fourth instar larval stage of the mosquito *Aedes aegypti* was investigated. The setup allowed larvae to swim either towards a given directional light cue (positive phototaxis) or away from it (negative phototaxis) as a response. Each tested light cue was a combination of the light intensity 9.55 x 10^{-13}µEm^{-2}s^{-1} and a particular wavelength. Thirteen wavelengths (450 – 710 nm) were tested at that light intensity. For each trial, 10 dark-adapted larvae were placed in the center of a horizontal test chamber, the stimulus light from a projector was turned on, and the distribution of the 10 larvae was determined after the 30s stimulus period. For each of the wavelengths used, 10 individual trials were completed with 10 organisms being tested per replicate. There was also a dark control group treated the same way but not exposed to light. Positive phototaxis was never observed. Degree of negative phototaxis varied, depending on the light cue. Chi-square testing comparing the distributions, as well as ANOVA and Tukey testing to compare percent negative phototaxis for the 14 different groups, showed different photosensitivities to different wavelengths. This larval stage was sensitive to a broad range of wavelengths, but not to 570 nm. These results were compared with similar research involving other larval stages.

Olfactory Sense and Species Recognition in the Zebrafish (Danio rerio)

Alyssa Spivak[13]

Chemical sensory signaling is known to be an extremely advantageous ability and plays a crucial role in eliciting behaviors in many species. Specifically, the ability of fish to recognize conspecifics through chemical signaling and form social aggregations has proven to reduce predation under natural conditions. In this study, the ability of zebrafish

[13] Research conducted under the supervision of Dr. Brian Palestis

(*Danio rerio*) to recognize conspecifics is examined through various behavioral analyses. Zebrafish were placed in a tri-sectional aquarium and were presented with various stimulus fish, conspecifics and heterospecifics (purple passion danios (*Danio roseus*)). The location of the test zebrafish was then monitored for ten minutes and all time intervals were recorded. A visual test, blind test, and scent test were all utilized to relinquish the possibility of any visual cues during the experiment (olfactory cues were available for each of the tests). Results show that test zebrafish did spend significantly more time near conspecific stimulus fish when both olfactory and visual cues were available. Possible reasons for such results are discussed as well.

Sodium Selenite Supplementation and Plasma Glutathione Peroxidase Activity in Arsenicosis Patients in Bangladesh

Elena Stekolchik (Chemistry), Lisa Schneider (Chemistry), Ervila Behri (Chemistry), Stephanie Asusta (Chemistry), Nicole Deluzio (Psychology), Melanie Valencia (Chemistry), and Dr. Mohammad Alauddin (Chemistry)

About 100 million people of which 35 million are children in Bangladesh have been exposed to arsenic above the World Health Organization (WHO) permissible level of 10 µg/l from drinking arsenic contaminated groundwater. Arsenic is a known carcinogen. Many of the arsenic poisoning victims are showing skin lesions, melanosis, keratosis and other adverse health effects. In a clinical trial, selenium supplements in the form of sodium selenite have been given to arsenicosis patients in Bangladesh to combat arsenic poisoning. Selenium is believed to play a role in detoxification of As by forming a As-Se-GSH complex. However, Se is also incorporated in a number of selenoproteins. Glutathione peroxidase (GPx), an important selenoprotein which acts as body's defense against reactive oxygen species (ROS). In our study we have measured GPx activity in plasma after 0, 24 and 48 weeks of Se supplementation and we observe an increase in plasma GPx activity with Se supplementation. In this presentation we will report our findings.

Enhancing Plasma Selenoproteins through Selenite Supplementation in Arsenicosis Patients in Rural Bangladesh

Melanie Valencia (Chemistry), Ervila Behri (Chemistry), Stephanie Asusta (Chemistry), Elena Stekolchik (Chemistry), and Dr. Mohammad Alauddin (Chemistry)

Vast population in rural Bangladesh have been exposed to arsenic above the World Health Organization (WHO) guideline level of 10 µg/l through consumption of arsenic laced groundwater for the last few decades. Arsenic is a slow poison and causes serious health effects and various types of cancer. Selenium has been reported to counter As toxicity. Orally administered Se may enhance a number of selenoproteins such as GPx, thioredoxin reductase (TrxR) in blood. Both GPx, TrxR are body's defense against oxidative injury. In a clinical trial in rural Bangladesh Se supplements were given to patients and controls received matching placebo. In a few patients thioredoxin reductase (TrxR) an important selenoprotein has been measured. The TrxR, selenoprotein P are observed to be mildly elevated in supplement group. Selenium seems to be an effective antidote to As poisoning. We are extending the measurement of these selenoproteins to more patients. Our recent findings will be reported in this presentation.

The Brachistochrone Problem

Vincent Lombardo (Physics) and Dr. Otto Raths (Physics)

The Brachistochrone problem, solved by Jean Bernoulli, has been called the most celebrated problem of the 17th century. This study presents a linear approximation, using conventional calculus to the Brachistochrone problem. Possible methods of including friction will be discussed.

Section II:
The Natural Sciences

The Effects of Ethanol on Zebrafish Activity Level

Ashley Nati (Biology)[1]

In this study, the activity level of zebrafish across various ethanol concentrations was analyzed. Along with quantifying locomotion, swim patterns such as freezing bouts, erratic zig-zagging movements, and thigmotaxis were also observed. These swim patterns were used to test the idea that ethanol has an anxiolytic or sedative effect on zebrafish. This study did not exhibit any significant correlation between ethanol and activity level in zebrafish. Throughout all treatments there was evidence of consistent freezing bouts, erratic zig-zagging movements, and positive thigmotaxis suggesting that ethanol did not have an anxiolytic effect. Although the study did not show significant patterns of activity level of zebrafish in different concentrations of ethanol, it provided insightful information on overall zebrafish swim patterns as well as suggestions and modifications for future studies.

I. Introduction

Ethanol

Ethanol is a two carbon organic compound composed of an ethyl group with a hydroxyl group. It is naturally produced through fruit or grain fermentation. Ethanol is soluble in both aqueous and lipid environments and therefore has an effect on practically all organs of the body (Lockwood *et al.*, 2004). Especially, ethanol has a profound effect on the central nervous system, affecting motor coordination, sensory perception, and cognition (Duglos and Rabin, 2003).

Behaviorally, ethanol at low concentrations induces euphoria, relief from anxiety and stress, relaxation, disinhibition, hyperactivity, and a neurostimulatory effect (Phillips and Shen, 1996; Peng *et al.*, 2009; Echevarria *et al.*, 2011; Mathur and Guo, 2011). Ethanol in higher doses creates the opposite effect, including depressant, hypoactive, and potentially sedative effects (Peng *et al.*, 2009; Echevarria *et al.*, 2011). Overall, ethanol has a facilitatory effect at lower doses and an inhibitory effect at higher doses (Gerlai *et al.*, 2000), a dose-response curve known as hormesis (Calabrese and Baldwin, 2003).

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Zebrafish General Information

Zebrafish (*Danio rerio)* is a small vertebrate (3-4 cm long) that is an emerging animal model for behavioral pharmacology, developmental biology, genetics, drug discovery, chemical and environmental toxicity, neurobiology, neuropsychopharmacology, and neurotoxicology (Gerlai *et al.,* 2000; Parng *et al.,* 2007; Blaser *et al.*, 2010; Maximino *et al.,* 2010). The organism is a freshwater, cyprinid, teleost species whose behavior can be easily studied in a controlled environment (Gerlai *et al.,* 2000; Gebauer *et al.,* 2011). It is a preferred model organism, in some cases, over rodents, because of its low cost, low maintenance, and (because it naturally prefers shoaling) ability to house large numbers of organisms in confined spaces (Gerlai *et al.*, 2006; Blaser *et al.*, 2010; Gebauer *et al.*, 2011).

Zebrafish produce hundreds of offspring per spawning, which can occur every other day (Gerlai *et al.*, 2003; Gerlai *et al.*, 2006). Their offspring are transparent and develop externally, which is useful in many *in vivo* studies (McGrath and Li, 2008). Larvae and embryos are also highly susceptible to various toxins and can easily be used as models of neurotoxicity throughout their development (Parng *et al.*, 2007). Drugs can be administered through diffusion or orally after seventy two hours postfertilization, which is when zebrafish larvae are able to swallow (McGrath and Li, 2008). As early as six days postfertilization, larvae are mature swimmers that have functioning motor and sensory systems (Irons *et al.*, 2010). These motor functions develop in a predictable sequence which allows for the study of drug effects on locomotion starting from the embryonic stage (Parng *et al.*, 2007).

Zebrafish are increasingly studied as a model organism for behavioral pharmacology, particularly when studying the effects of ethanol (Blaser *et al.*, 2010). Genetic studies with zebrafish have shown DNA sequence homologies between zebrafish and mammals, especially in genes related to ethanol metabolism, indicating that zebrafish are candidates for human models (Gerlai *et al.*, 2006). Zebrafish have seventy to eighty percent of their genes similar to those of humans (Gebauer *et al.*, 2011). As early as 120 hours postfertilization, zebrafish develop organs and tissues, including brain, heart, liver, pancreas, kidney, intestines, bone, muscles, nerve systems, and sensory organs, that are similar to mammals anatomically, physiologically, and molecularly (McGrath and Li, 2008). Not only have there been similarities found between the neuroanatomy of the zebrafish and mammals but also of other vertebrates (Turay, 2010). Also, since the genome, transcriptome, and proteome of the zebrafish have been established (Maximino *et al.*, 2010), zebrafish can be examined side by side with its vertebrate and mammalian counterparts in numerous behavioral and developmental studies. These advantageous qualities of zebrafish larvae are beneficial to the studies of large-scale genome

mutagenesis and gene mapping, transgenesis, protein overexpression or knockdown, cell transplantation and chimeric embryo analysis, and chemical screens (Guo, 2010). With all of these qualities conducive to in-depth study of zebrafish, studies on behavior and locomotion in ethanol can easily be extrapolated to determine more widespread comprehensive effects.

Effects of Ethanol on Zebrafish Central Nervous System

Zebrafish easily absorb ethanol into their blood stream. They intake the mixture of ethanol and distilled water through the blood vessels in the gills and through the body surface (Gerlai *et al.*, 2006). In approximately one hour, the level of ethanol in the blood of zebrafish is in equilibrium with that of the tank water (Duglos and Rabin, 2003; Lockwood *et al.*, 2004). These effects are evident when translated into the behavior seen in zebrafish. Examples of the behavioral ramifications of ethanol are changes in locomotor activity, social behavior, scototaxis (preference for darkness), thigmotaxis (preference for the edge of a container rather than the center), and movement patterns. As seen in humans, increased amounts of alcohol in the blood produces anxiolytic effects and sedation, while small amounts of alcohol produces effects of disinhibition and euphoria (Lockwood *et al.*, 2004). This is similarly seen in zebrafish, where they express suppressed locomotive activity when in high concentrations of ethanol, while in lower concentrations exhibit hyperactivity.

Zebrafish share homologies in genes (with vertebrates and mammals) for ethanol metabolism, as well as anatomical similarities (Gerlai *et al.*, 2006). The basic layout of the zebrafish brain does not fundamentally vary from that of vertebrate brains. Zebrafish larvae and embryos are often used to perform studies on the effects of ethanol on the central nervous system of zebrafish. It has been seen in mammals that ethanol affects neuronal proliferation and motor neuron survival (Parng *et al.*, 2007). These effects have also been observed in larval zebrafish. Due to the transparent nature of zebrafish development, specific neurons and axon tracts can be studied *in vivo* (McGrath and Li, 2008). Zebrafish have an organized stereotypical vertical pattern of primary motor neurons (Parng *et al.*, 2007; McGrath and Li, 2008). Treatment with ethanol on developing zebrafish larvae has significant effect on motor neurons. A study conducted by McGrath and Li (2008) showed that treatment with ethanol produced primary motor neuron loss in the somite region of zebrafish. A study by Parng *et al.* (2007) also showed disruption of motor neurons with loss of primary motor neurons in the somite region. Ethanol affects gamma-aminobutyric acid-A ($GABA_A$) receptors and N-methyl-D-aspartic acid (NMDA) receptors in the zebrafish brain (Maximino *et al.*, 2011). $GABA_A$ receptors are predicted to be involved in the anxiolytic effects of ethanol, as well as the

depressant effect of ethanol at higher doses (Gebauer *et al.*, 2011). Ethanol acts as an allosteric agonist for GABA. It induces the $GABA_A$ receptor to have a conformation which increases the affinity for the GABA neurotransmitter for the $GABA_A$ receptor. GABA binding to $GABA_A$ activates $GABA_A$ and sparks the entering of chloride ions into the presynaptic membrane. This hyperpolarizes the neuron and causes an inhibitory postsynaptic potential (IPSP), decreasing the chance of an action potential to occur. For this reason, ethanol creates anxiolytic and sedative effects. Ethanol acts on NMDA receptors as an uncompetitve antagonist. When NMDA binds to the active site of the receptor, it usually creates an excitatory response. However, when ethanol also binds to an allosteric site, this response is inhibited.

Ethanol also alters the adenyl cyclase mediated phosphorylation of extracellular signal-regulated kinase (ERK) in the forebrain (Peng *et al.*, 2009; Maximino *et al.*, 2011). The amount of phosphorylation of ERKs is an indicator for zebrafish behavioral sensitivity to ethanol (Peng *et al.*, 2009). At a low dose of ethanol, there is an increased level of phosphorylated ERK and at a high dose of ethanol there are decreased phosphorylated ERK levels (Peng *et al.*, 2009). Dopamine and opioid systems are involved in the stimulatory effects of low-dose ethanol treatment, while inhibition of NMDA receptor and potentiation of GABA receptors plays a role in the depressive effects of high-dose ethanol treatment (Peng *et al.*, 2009; Maximino *et al.*, 2011). Ethanol affects the brain, vision, and motor function in humans and is consequentially used for study of neuronal defects in zebrafish (Parng *et al.*, 2007). The similarity of the developmental levels of spinal cord development among zebrafish and other vertebrates makes zebrafish an effective candidate for comparative study (Brustein *et al.*, 2003). Since the brain is more sensitive to ethanol than other organs, the observed behavioral effect seen from ethanol treatment on zebrafish is likely due to its effect on the brain (Mathur and Guo, 2011).

Ethanol Hormesis in Zebrafish

As noted above, hormesis is commonly exhibited in acute ethanol treatments with zebrafish. Low doses of ethanol produce stimulation while high doses produce inhibition (Kurta and Palestis, 2010; Irons *et al.*, 2010). Ethanol influences zebrafish behavior in a dose-dependent manner, enhancing certain behaviors with low to intermediate doses and suppressing others at higher doses (Echevarria *et al.*, 2011). This hormesis creates an inverted U-shaped dose-response curve.

Various studies have shown the same trend of increased locomotion in lower doses of ethanol and decreased locomotion in higher doses of ethanol. In a study by Irons *et al.* (2010), low doses incited hyperactivity and high doses produced hypoactivity. A

study by Maximino *et al.* (2011) also exhibited the inverted U-shaped dose-response curve for locomotion, with increased locomotion at 0.5% ethanol and a nonsignificant decrease at 1.0% ethanol. In a study by Gerlai (2003), 0.25% and 0.5% doses of ethanol induced hyperactivity while 1.0% induced hypoactivity. Another study by Gerlai (2000) produced the same results with 1.0% ethanol inducing depressive effects on activity even lower than that of controls. These sedative effects were associated with general slowness and impaired coordination of swimming (Gerlai *et al.*, 2000). Although using higher overall concentrations of ethanol, Peng *et al.* (2009), larval zebrafish exposed to 1.5% ethanol exhibited increased locomotor activity while those exposed to 3.0% ethanol displayed sedation. Not only do effects on locomotion demonstrate an inverted U-shaped curves, but also on behaviors involving anxiety responses (Echevaria *et al.*, 2011).

Zebrafish Kinetic Responses and Ethanol

In addition to studying the level of locomotion in zebrafish exposed to ethanol, other behaviors can also be observed and analyzed. Frequent characteristic movements of zebrafish include freezing and erratic movements or "zig-zagging." These actions tend to indicate fear or anxiety in zebrafish (Gebauer *et al.*, 2011; Blaser and Penalosa, 2011). The idea of ethanol acting on zebrafish as an anxiolytic would therefore reduce this tendency to freeze and move erratically. However, although these behaviors typically represent fear and anxiety drugs that have locomotor stimulant effects could affect these behaviors independent of their state of anxiety (Blaser and Penalosa, 2011). This calls for further analysis of the role of fear and anxiety in behaviors responding to ethanol treatment.

Research by Gerlai *et al.* (2000) and Luca and Gerlai (2012) indicated that ethanol influences the characteristic behaviors related to fear and anxiety, concluding that ethanol could be acting on anxiety, perceptual, or motor mechanisms. Specifically, it has been seen in studies performed by Gerlai *et al.* (2000, 2006) where ethanol was referred to as an anxiolytic based upon findings that ethanol reduced fear inducing effects of a predator stimulus. There are measures of fear and anxiety proposed for zebrafish. Actions such as freezing behavior, bottom dwelling, and forming dense shoals are indicators of zebrafish fear responses (Gebauer *et al.*, 2011). According to Stewart *et al.* (2011), freezing is defined as a total absence of movement except for the gills and eyes for two seconds or longer. In a study performed by Maximino *et al.* (2010) zebrafish treated with ethanol displayed freezing responses. Erratic swimming or zig-zagging movements is locomotion interrupted by small directional or velocity changes with repeated rapid darting behaviors (Maximino *et al.*, 2010; Stewart *et al.*, 2011). According to Maximino *et al.* (2010), erratic swimming is a fear response by zebrafish.

According to Gebauer *et al.* (2011), fear is defined as "a response to imminent threat which in zebrafish has been studied as reactions to predators and alarm pheromone." In addition to fear, Gebauer *et al.* (2011) defines zebrafish anxiety as "a response to future of possible threats, usually manifested as avoidance behavior." In a study by Gerlai *et al. (*2000), control fish with 0.0% ethanol displayed these fear and anxiety reactions of freezing and erratic movement when placed in a novel environment. In this case, alcohol could be acting on anxiety, perceptual, or motor mechanisms and did so in an inverted U-shaped manner over the doses of 0.0% 0.25%, 0.5%, and 1.0% ethanol treatment. Lower concentrations of ethanol (0.25% and 0.5%) induced hyperactivity, however, along with freezing and erratic movement due to the novel environment. At the higher concentration (1.0% ethanol), hypoactivity was seen. This was due to the sedative effects of ethanol which induced impaired coordination as well as slowed swimming. In a study by Luca and Gerlai (2012), zebrafish also demonstrated freezing in a dose dependent manner with a higher percentage of time frozen in higher concentrations of ethanol (0.75%) and a lower percentage of time frozen in lower concentrations of ethanol (0.25%). This could have been due to ethanol having a generalized hyperactivity of low doses of ethanol.

In a study by Echevarria *et al.* (2011) treatment with the lowest concentration of ethanol (0.25%) zebrafish displayed the most erratic zig-zagging while at the highest concentration of (1.0%) this ceased and was even lower than the controls (0.0%). Other studies which introduce zebrafish to novel-environments show the elucidation of fear and anxiety responses through the analysis of erratic movements and freezing. Another study by Luca and Gerlai (2012) confirms that fear inducing stimuli increases erratic swimming in a dose dependent manner. Low ethanol concentrations induced more erratic movements as compared to control when a stimulus was presented. A study by Egan *et al.* (2009), confirmed that the increase in these types of movement usually indicates heightened anxiety.

Other Ethanol Related Studies with Zebrafish

Many studies have attempted to assess the levels of anxiety in ethanol-treated zebrafish. Some of these studies include thigmotaxis, shoaling, and scototaxis. Ethanol not only has an effect on the locomotor activity of zebrafish but also on other behaviors such as thigmotaxis, shoaling, and scototaxis. These responses have been thoroughly studied, often in junction with locomotive studies. They are additional indicators of hormesis in ethanol studies.

Thigmotaxis

Thigmotaxis is defined by Maximino *et al.* (2010) as a behavior where more time is spent in the periphery than in the center of the apparatus. Thigmotaxis can be also defined as "wall-seeking," and, in studies with rodents, is indicative of anxiety (Lockwood *et al.*, 2004). A study performed assessing light/dark preference of zebrafish treated with ethanol also demonstrated thigmotaxis in the zebrafish avoiding the light area (Blaser *et al.*, 2010). It can be extrapolated from data with rodents, that thigmotaxis is also representative of anxiety in zebrafish also. In a study with zebrafish larvae by Richendrfer *et al.* (2012), the larvae had a preference for the edge of the wells and suggested that this was an accurate measure of anxiety in the larvae.

Shoaling

Shoaling is the natural social preference of zebrafish to swim in aggregations with one another (Gerlai *et al.*, 2000; Gebauer *et al.*, 2011). This is a complex behavior that is governed by foraging strategies, antipredator behaviors, and reproductive behaviors (Gerlai *et al.*, 2006). Shoaling behavior may be related to anxiety, and the treatment with high doses of ethanol tends to reduce shoaling, and therefore anxiety (Duglos and Rabin, 2003; Gebauer *et al.*, 2011), while at low doses, zebrafish shoal more tightly (Gerlai *et al.,* 2000; Kurta and Palestis, 2010). According to Kurta and Palestis (2010), ethanol may have changed shoaling behavior with the alteration of anxiety levels, perception, and/or motor mechanisms. Ethanol's anxiolytic effect leads to the decrease in preference for group cohesion and preference for conspecifics and is correlated with their level of anxiety or fear (Gerlai *et al.*, 2000).

Scototaxis

Scototaxis is the preference for darkness. The natural habitat of zebrafish is in silt-bottomed, well-vegetated pools and rice paddies, where they have a natural preference to stay near the bottom in response to potentially harmful stimuli (Spence *et al.,* 2008; Mathur and Guo, 2011). This preference for dark environments can be useful in analyzing the anxiolytic effects of ethanol. In a study by Gebauer *et al.* (2011), zebrafish treated with ethanol strayed away from their natural preference for being in the dark zone and increased their time in the light zone. It also found that they increased their time spent in the light zone. This exemplifies the anxiolytic nature of ethanol on scototaxis. In a study by Maximino *et al.* (2011), the time spent in the light zone increased with the lower concentrations of ethanol (0.25% and 0.5%), but did not have effects at 1.0% ethanol. Gerlai *et al.* (2000) found that in treatments with ethanol concentrations of 0.5% and 1.0%, zebrafish avoided the dark zone. This would indicate that ethanol had an

anxiolytic effect at the doses of 0.5% and 1.0% since they were uninhibited in entering the white region of the tank. Since zebrafish naturally prefer the dark regions of their habitat, keeping them safe from predators, their exploration of the light regions could indicate the loss of fear and anxiety of predation. If ethanol at various concentrations allows them to enter into the light region, it could indicate that ethanol has an effect on the anxiety or fear level of zebrafish.

II. Materials and Methods

Pure ethanol was diluted with distilled water to concentrations of 1.0% EtOH, 0.5% EtOH, 0.25% EtOH, and 0.125% EtOH. These concentrations were chosen based on previous research (Kurta and Palestis, 2010 and references therein). The control was distilled water with 0.0% EtOH. The total volume of liquid in each trial was 300mL. Ten trials were performed for each of these ethanol concentrations. The materials and certain procedural steps were influenced by the study performed by Kurta and Palestis (2010). Our facilities and procedures have been approved by the Institutional Animal Care and Use Committee of the New York State Institute for Basic Research in Developmental Disabilities. The zebrafish, originally purchased from Animal Pantry in Staten Island, NY, were contained in a fish tank filled with distilled water at Wagner College in the Organismal Research Lab. Their tank was furnished with artificial plants, air stones, and regularly filtered with standard aquarium pumps. They were fed daily using tropical fish flakes purchased at local pet stores. All fish were contained under the same conditions in the lab prior to testing. Individual fish were taken directly from their tank, where they lived among other zebrafish, and placed into one of the five treatments. Each of the five treatments were performed using round 1000 milliliter, 20 centimeter diameter glass bowls with curved edges and flat bottoms which were placed over a 3 centimeter by 3 centimeter grid. The fish were kept in each treatment for 60 minutes undisturbed, and then recorded for 60 seconds. The time period of 60 minutes was chosen, based upon previous studies by Duglos and Rabin (2003), as the appropriate time for allowing ethanol levels in the brain to reach equilibrium.

A Logitech ClickSmart 820 camera and Windows Movie Maker software were used to record the zebrafish activity. We then counted the number of lines each fish crossed during the recorded 60 seconds to determine their activity level under the effects of different ethanol concentrations. The number of lines crossed was indicated by the fish's head crossing the line, and the crossing of intersections of lines counting as one line. The lines were counted using a Clay Adams Laboratory Counter. As similarly performed in studies by Gerlai *et al. (*2000) and Duglos and Rabin (2003), movement

within a segment, without the actual crossing of a line would not be recorded as a measurement for overall locomotor activity.

The activity levels of the four experimental groups were compared to the control group (0.0% EtOH) and to each other to note any differences and/or similarities. The general location of where the fish remained while in the bowl along with the relative speed of movement was noted in addition to number of lines crossed. The video was slowed by four times the actual speed to accurately count the number of lines crossed, and sped the video by four times to note the general location of the fish. The video was watched at normal speed to determine the relative speed and particular detailed actions. Fifty zebrafish were used in total for this experiment. After testing, the fish were placed in a different tank to assure that they would not be used again for another trial.

III. Results

At the conclusion of the one hour incubation period for each of the zebrafish trials, a one minute recording was taken. From this recording, the zebrafish movement was recorded and quantified. Table 1 portrays the results from all trials including the means and medians for each ethanol concentration.

[EtOH]	0.00%	0.125%	0.25%	0.50%	1.00%
	17	94	0	132	9
	0	0	11	4	37
	86	0	0	0	0
	69	12	26	76	0
	36	27	0	38	0
	98	74	0	24	77
	70	0	0	36	0
	0	0	0	51	68
	59	81	0	73	98
	1	46	24	0	0
Mean	43.6	33.4	6.1	43.4	28.9
Median	47.5	19.5	0	37	4.5

Table 1**:** Raw data for all trials performed. Indicated, is the number of lines crossed by each zebrafish in the one minute recording period following the one hour incubation in that particular ethanol concentration. The median was calculated in addition to the mean in attempt to account for the skewed nature of the data.

Figure 1 is an accurate graphical representation of the data, accounting for its skewed nature. Since the data points were widespread, the median, indicated by the thick black line, is an indicator for where the data actually lie, rather than an average of the data. There were many zeros in some of the data, along with few very large numbers. The large numbers brought up the average number of lines crossed greatly, therefore the median is used a point of indication on the graph, rather than the mean. The length of the box effectively indicates the general range of the data. It is evident that the majority of the trials had lower numbers of lines crossed because the whiskers are above the 75th quartile and hardly under the 25th. However, due to the large confidence intervals, there is no significant pattern.

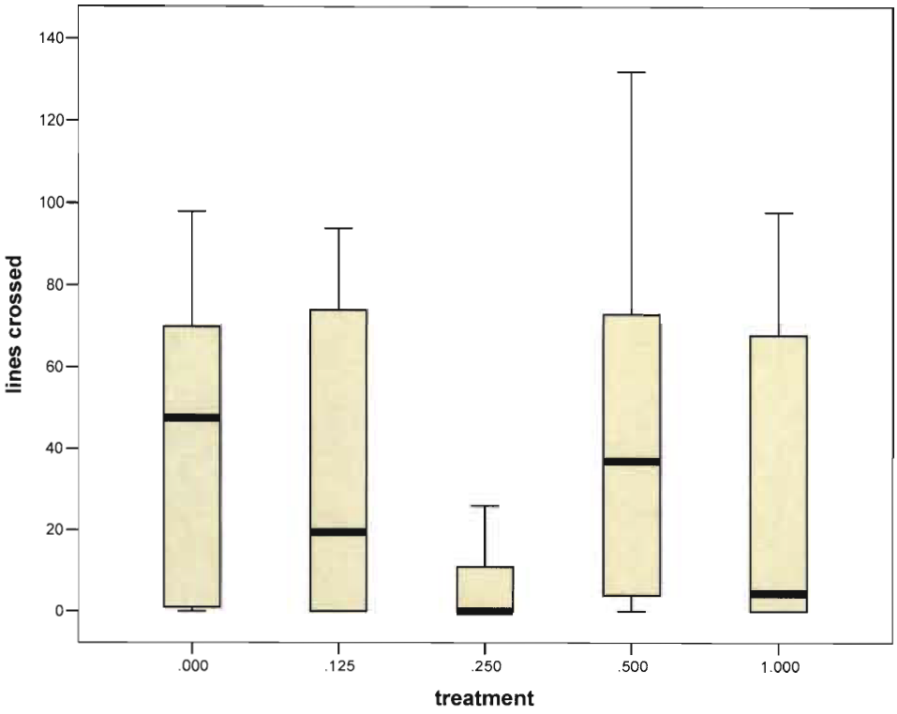

Figure 1**:** Box-plot indicating median, 25th and 75th quartiles, and maximum and minimum data points.

To assess the zebrafish activity level, a Kruskal-Wallis Test was used. This was because the numerical data did not form a normal distribution, and an ANOVA could not be used. As seen in Table 1, the data was skewed due to the absence of movement in

certain trials, contrasted by very high activity levels. Significance was defined as $p<0.05$. The data, as seen in Table 2, was found to not be significant when analyzed with 4 degrees of freedom, a chi-squared of 8.15, and a p-value of 0.086.

Ranks

	Treatment	N	Mean Rank
lines crossed	0.0	10	31.00
	0.125	10	26.60
	0.25	10	15.40
	0.5	10	30.60
	1.0	10	23.90
	Total	50	

Test Statistics[a,b]

	Lines Crossed
Chi-Square	8.147
df	4
Asymp. Sig.	0.086

a. Kruskal Wallis test

b. Grouping Variable: treatment

Table 2: Results of Kruskal-Wallis non-parametric test for amount of lines crossed per treatment.

In observing the zebrafish swim patterns, the fish preferred swimming at the edges of the bowl, as seen in Figure 2. They also exhibited freezing and erratic, zig-zag swim patterns. The freezing periods were analyzed for each of the treatment groups. For those fish that remained frozen throughout the entire one minute of observation, the location of the fish was noted. General observation of the fish's swimming location was also noted.

For all of the treatments, the zebrafish that displayed movement and swimming did so mostly at the edge of the bowl. This would be an indication of positive thigmotaxis. Six out of ten control zebrafish exhibited freezing at some point in their one minute recording period for at least 1.71 seconds. This includes those that showed no movement (two out of ten fish), which were all positioned at the edge of the bowl. The swimming motions were very fluid during all of the trials with movement. Seven out of ten zebrafish in 0.125% ethanol exhibited freezing for three seconds or more, including the four fish that exhibited no movement. One out of these four was in the middle with the rest at the edge. Zebrafish

Figure 2**:** An example of zebrafish exhibiting thigmotaxis within a trial.

in the 0.25% ethanol trials exhibited the most freezing (ten out of ten) along with the lack of movement in the majority of the trials (seven out of ten). Two out of seven were towards the middle of the bowl, while all others at the edge. The other three trials consisted of periods of freezing for 27 seconds or more. The trials with 0.5% ethanol had eight out of ten fish (including the two that showed no movement) displayed freezing for at least five seconds at a time. In this treatment, it was most prevalent for the zig-zag, erratic movements to be observed. Seven of ten fish would freeze then make zig-zag motions along the edges of the bowl before freezing again and repeating these motions. These fish did not cross an extremely large number of lines because of their frequent freezing and erratic twitching motions that did not cause them to cross over lines. When swimming, their movement was extremely rapid, and if it was continuous, would have resulted in an immense amount of line crossing. The periods of swimming required for the video to be slowed one-fourth to one-sixth of its original speed to accurately count the number of lines crossed. Eight of ten fish treated with 1.0% ethanol froze for eight seconds or more (including the five that did not move). All of the frozen fish remained at the edges of the bowl. One exhibited erratic twitching movements that were not large enough to move it out of one box (hence not crossing any lines). A summary for this data can be seen in Table 3. This data was analyzed using a Kruskal-Wallis test. Significance was defined as $p<0.05$; and with four degrees of freedom, a chi-squared of 6.21, and a p-value of 0.184, the test was not significant (Table 4).

[EtOH]	0.00%	0.125%	0.25%	0.50%	1.00%
	51.24	3.03	60	0	54.14
	60	60	48.68	56	25.52
	1.71	60	60	60	60
	22.85	23	51.53	18.73	60
	8.16	6.52	60	48.67	60
	60	0	60	52.01	0
	0	60	60	40.58	60
	60	60	60	12.44	8.56
	0	0	60	60	0
	59	0	27	50.11	60
Mean	32.296	27.255	54.721	39.854	38.822
Median	37.045	14.76	60	49.39	57.07
Std Dev	28.024	28.968	10.595	21.576	27.045

Table 3**:** Data for freezing bouts in each trial, in seconds. If multiple freezing bouts occurred in a trial, they were added to produce a total amount of time for that trial. Since the total recording period consisted of 60 seconds, zebrafish that exhibited no movement are charted above as 60. Those that did not freeze at all are charted above as 0. It is evident that freezing bouts were prevalent throughout the majority of the trials.

Ranks

		N	Mean Rank
lines crossed	0.0	10	21.90
		10	21.15
	0.25	10	34.60
	0.5	10	23.15
	1.0	10	26.70
	Total	50	

Test Statistics[a,b]

	Lines Crossed
Chi-Square	6.209
df	4
Asymp. Sig.	0.184

a. Kruskal Wallis test

b. Grouping Variable: treatment

Table 4**:** Results of Kruskal-Wallis non-parametric test for total amount of time frozen per treatment.

IV. Discussion

Analysis of the Effects of Ethanol on Zebrafish Activity Level

The lack of significance among the treatments was an unexpected outcome, especially since many other studies (as noted earlier) have shown that treatment with various concentrations of ethanol result in hormesis, especially when studying locomotion. A possible explanation for the lack of significant variation in locomotor activity among the trials could have been the temperature of the water. Although there were heaters for the aquariums where the fish were normally contained, the distilled water used for the ethanol dilutions were obtained from a different source, and could have been colder than the temperature of the aquarium. This could have induced shock for the fish, resulting in freezing for the one minute recording period.

In future studies, the temperature should be kept consistent in the aquarium water as well as in the treatment water to reduce possible variability. If the water temperature was the factor for the lack of significance in the activity level, then it could be correlated with the overall low activity levels across all treatments. According to EEG studies on goldfish (*Carassius auratus*) during seasonal changes by Laming (1981), lower EEG readings in the telencephalon during the winter correlated to the lower activity level of goldfish. This information could be used to infer that low water temperatures reduce zebrafish activity level as well.

In addition to the lack of significance in zebrafish activity levels across ethanol concentrations another unusual finding should be noted in trials performed using 0.25% ethanol. While the activity level was predicted to be at its peak in this concentration, it was, instead, the most depressed. The lack of overall movement along with high levels of freezing bouts caused this treatment to have the lowest activity levels. Also, fish in the control treatment were seen to have very fluid swimming movements. As ethanol was introduced, the freezing bouts and erratic zig-zagging movements increased. At 0.5% ethanol, especially, these movements were notably elevated. If the swimming was more consistent at 0.5%, the number of lines crossed (activity level) would have dramatically increased from the recorded values. If any of the treatments, 0.5% ethanol would be the one in which the fish showed most activity and anxiety responses. A study by Luca and Gerlai (2012) measured the amount of "jump frequency," which would be analogous to a zig-zagging swim pattern. They found that intermediate levels of ethanol increased jumping frequency, similar to our findings with 0.5% ethanol treated fish. They, however, attributed this to the novel tank environment, while this would be unexpected in our study since the fish were given a 60 minute period to habituate to their environment.

Another possibility for why this study did not provide significant results could be extrapolated from an explanation by Echevarria *et al.* (2011) in attempts to determine why their study did not correlate with another study by Lockwood *et al.* (2004). In the study by Echevarria *et al.* (2011), although results indicated hormesis, their results were partially different in comparison to the study performed by Lockwood *et al.* (2004). The study by Echevarria *et al.* (2011) used concentrations of 0.0%, 0.25%, 0.5%, and 1.0% and saw effects of hormesis, while Lockwood *et al.* (2004) used higher ethanol concentrations for their treatments and saw hormesis. Lockwood *et al.* (2004) began to see hyperactivity at 1.0% with hypoactivity at 4.0%. According to an interpretation by Echevarria *et al.* (2011), this could have been attributed to the use of more hardy larvae. Since there was no significant difference among treatments in our study, one possible explanation could be extrapolated from Echevarria *et al.*'s (2011) explanation that our fish were more hardy and unaffected by the low concentrations of ethanol.

Studies performed by Michael Garber in our laboratory similar to our control trials showed that there was no consistent change in behavior due to time alone. He tested fish in 0.00% ethanol, each for a 60 minute period. He would record the number of lines crossed by the fish for 60 seconds at ten minute intervals. His results indicated that there was a large variability within each fish, and no pattern among all the fish tested. Some did not even move at all in many of his recording intervals, compensating for the possibility that the fish were frozen either because of non-habituation in a novel environment or getting tired after the swimming in the 60 minute period. These findings add to the results of our study. If there was large variation within the movement patterns of each control fish (0.00% ethanol), our lack of pattern could be due to this general variability within the individual fish.

The sample size of our tested fish should have been larger, to make up for the within-fish variability. It can also be noted that it is unusual for fish to be alone in a bowl. Their natural behavior consists of shoaling with conspecifics. Being alone in the bowl could have induced anxiety in them, different for each individual fish.

Analysis of the Effects of Ethanol on Zebrafish Swimming Patterns

The results of this study indicated that there was no pattern between difference in ethanol concentration treatments and activity level in zebrafish. The ethanol therefore, did not produce a significant anxiolytic or sedative effect on the zebrafish at any dose. In the analysis of the swimming patterns of the zebrafish across all treatments the frequent freezing, erratic movements, and zig-zagging patterns were seen in all trials. This movement pattern is indicative of anxiety (Egan *et al.,* 2009; Echevarria *et al.,* 2011) and hence it can be inferred that ethanol did not have an anxiolytic effect on the zebrafish.

Positive thigmotaxis was also observed among all treatments. With the exception of three of the 50 trials, all fish exhibited positive thigmotaxis, whether there was movement or no movement. As another indicator of anxiety (Richendrfer *et al.,* 2012), the observation of positive thigmotaxis in all treatments can also aid in deducing that ethanol did not have an anxiolytic effect on zebrafish in various ethanol concentrations.

Michael Garber also continued his studies (mentioned above), in our laboratory, using the same protocol, except with a square container, instead of round. When in the round bowls, we noted constant swimming around in circles against the edge of the bowl. However, when Michael Garber used the square container, he saw less of the constant edge-swimming around the bowl. Further studies on thigmotaxis could be performed using different shaped bowls to see if there is any correlation with the shape of the bowl and thigmotaxis.

General Conclusions

Overall, the purpose of this experiment was to identify whether or not an alteration of activity level can be seen when zebrafish were exposed to difference concentrations of ethanol. The predicted outcome was that the fish would be hyperactive in low concentrations of ethanol (0.125% and 0.25%) and be hypoactive in the higher concentrations of ethanol (0.5% and 1.0%). The swimming patterns of the zebrafish would also correlate in a dose-responsive manner. Positive thigmotaxis would be observed in lower concentrations, with decreased thigmotaxis at the higher concentrations. Freezing bouts as well as erratic zig-zagging movements were also expected to diminish as the ethanol concentrations increased. This would indicate that ethanol had an anxiolytic or sedative effect on the zebrafish. However, the results of this study did not correlate with the predicted outcome, as seen through the Kruskal-Wallis non-parametric test p value of 0.086 ($p<0.05$). Therefore, zebrafish did not show any pattern in relation to activity level and ethanol exposure. In future studies, the sample size could be increased (larger than our n=10 for each treatment), to see if a significant trend of hormesis can be seen.

Another suggestion for future studies would be to have a different system for monitoring the fish activity levels. In this study, the fish were left alone during the hour incubation period, a period of time based upon previous studies by Duglos and Rabin (2003), which were found appropriate in allowing the ethanol levels in the brain to reach equilibrium. The zebrafish were then monitored only for 60 seconds after the hour. To obtain a more precise indication of their activity level, they should be monitored more than once, to rule out the possibility that they were just still during the 60 second recording period and moving at other times.

V. References

Blaser, R.E., Koid, A., and Poliner, R.M**.** (2010). Context-dependent sensitization to ethanol in zebrafish (*Danio rerio*). *Pharmacoloty, Biochemistry and Behavior* **95:** 278-284.

Blaser, R.E. and Penalosa, Y.M. (2011). Stimuli affecting zebrafish (*Danio Rerio)* behavior in the light/dark preference test. *Physiology & Behavior* **104(5)**: 831-837.
Brustein, E. Saint-Amant, L., Buss, R.R., Chong, M., McDearmid, J.R., and Drapeau, P. (2003). Steps during the development of the zebrafish locomotor network. *Journal of Physiology* Paris 97: 77-86.

Calabrese, E.J. and Baldwin, L.A. (2003). Ethanol and Hormesis. *Crit Rev Toxicol* 33: 407-424.

Duglos, C.A. and Rabin, R.A. (2003). Ethanol effects on three strains of zebrafish: model system for genetic investigations. *Pharmacology, Biochemistry and Behavior* 74:471-480.

Duglos, C.A., Brown, S.J., and Rabin, R.A. (2011). Gender differences in ethanol-induced behavioral sensitivity in zebrafish. *Alcohol* 45: 11-18.

Echevarria, D., Toms, C.N., and Jouandot, D.J. (2011). Alcohol-induced behavior change in zebrafish models. *Rev. Neurosci.* 22(1): 85-93.

Egan, R.J., Bergner, C.L., Hart, P.C., Cachat, J.M., Canavello, P.R., Elegante, M.F., Elkhayat, S.I., Bartels, B.K., Tien, A.K., Tien, D.H., Mohnot, S., Beeson, E., Glasgow, E., Amri, H., Zukowska, Z., and Kalueff, A.V. (2009) Understanding behavioral and physiological phenotypes of stress and anxiety in zebrafish. *Behavioural Brain Research* 205: 38-44.

Gebauer, D.L., Pagnussat, N., Piato, A.L., Schaefer, I.C., Bonan, C.D., and Lara, D.R. (2011). Effects of anxiolytics in zebrafish: Similarities and differences between benzodiazepines, buspirone and ethanol. *Pharmacology, Biochemistry and Behavior* 99: 480-486.

Gerlai, R. (2003). Zebra Fish: An Uncharted Behavior Genetic Model. *Behavior Genetics* 33(5): 461-467.

Gerlai, R., Lahav,M., Guo, S., and Rosenthal, A. (2000). Drinks like a fish: zebra fish (*Danio rerio)* as a behavior genetic model to study alcohol effects. *Pharmacology, Biochemistry and Behavior* 67: 773-782.

Gerlai, R., Lee, V., and Blaser, R. (2006). Effects of acute and chornic ethanol exposure on the behavior of adult zebrafish (*Danio rerio*). *Pharmacology, Biochemistry and Behavior* 85: 752-761.

Irons, T.D., MacPhail, R.C., Hunter, D.L., and Padilla, S. (2010). Acute neuroactive drug exposures alter locomotor activity in larval zebrafish. *Neurotoxicology and Teratology* 32: 84-90.

Kurta, A. and Palestis, B. G. (2010). Effects of ethanol on the shoaling behavior of zebrafish (*Danio rerio*). *Dose-Response* 8: 527-533.

Laming, P.R. (1981). Brain mechanisms of behaviour in lower vertebrates. Cambridge: Cambridge University Press.

Lockwood, B., Bjerke, S., Kobayashi, K., and Guo, S. (2004). Acute effects of alcohol on larval zebrafish: a genetic system for large-scale screening. *Pharmacology, Biochemistry and Behavior* 77: 647-654.

Mathur, P. and Guo, S. (2011). Differences of acute versus chronic ethanol exposure on anxiety-like behavioral responses in zebrafish. *Behavioural Brain Research* 219: 234-239.

Mathur, P. and Guo, S. (2010). Use of zebrafish as a model to understand mechanisms of addiction and complex neurobehavioral phenotypes. *Neurobiology of Disease* 40: 66-72.

Maximino,C., Marques de Brito, T., Waneza da Silva Batista, A., Herculano, A.M., Morato, S., and Gouveia, A. J. (2010). Measuring anxiety in zebrafish: A critical review. *Behavioural Brain Research* 214: 157-171.

Maximino, C., Batista da Silva, A.W., Gouveia, A Jr., and Herculano, A.M. (2011). Pharmacological analysis of zebrafish (*Danio rerio*) scototaxis. *Progress in Neuro-Psychopharmacology & Biological Psychiatry* 35: 624-631.

McGrath, P. and Li, C. (2008). Zebrafish: a predicitive model for assessing drug-induced toxicity. *Drug Discovery Today* 13(9/10): 394-401.

Parng, C., Roy, N.M., Ton, C., Lin, Y., and McGrath, P. (2007). Neurotoxicity assessment using zebrafish. *Journal of Pharmacological and Toxicological Methods* 55: 103-112.

Peng, J., Wagle, M., Mueller, T., Mathur, P., Lockwood, B., Brentaud, S. and Guo, S. (2009). Ethanol-modulated camouflage response screen in zebrafish uncovers a novel role for cAMP and extracellular signal-regulated kinase signaling in behavioral sensitivity to ethanol. *Neurobiology of Disease.* 29(26): 8408-8481.

Phillips, T.J. and Shen, E.H. (1996). Neurochemical bases of locomotion and ethanol stimulant effects. *Int Rev Neurobiol* 39: 243-282.

Richendrfer, H., Pelkowski, S.D., Colwill, R.M., and Creton, R. (2012). On the edge: Pharmacological evidence for anxiety-related behavior in zebrafish larvae. *Behavioural Brain Research* 228: 99-106.

Spence, R., Gerlach, G., Lawrence, C., and Smith, C. (2008). The behaviour and ecology of the zebrafish, *Danio rerio. Biological Rev.* 83: 13-34.

Stewart, A., Wu, N., Cachat, J., Hart, P., Gaikwad, S., Wong, K., Utterback, E., Glider, T., Kyzar, E., Newman, A, Carlos, D., Chang, K., Hook, M., Rhymes, C., Caffery, M., Greenberg, M., Zadina, J., and Kalueff, A.V. (2011). Pharmacological modulation of anxiety-like phenotypes in adult zebrafish behavioral models. *Progress in Neuro-Psychopharmacology & Biological Psychiatry* 35: 1421-1431.

Section III:
The Social Sciences

How the Children Grow: Tracking the Health Impacts of Sociopolitical Change in Prehistoric Peru

Rose Tobiassen (Anthropology)[1,2]

The health of children is often used as a proxy measure for the quality of life in their societies. Because the rate at which an individual's teeth erupt is determined predominantly by genetics, and skeletal growth is more affected by environmental factors; stress or poor health early in an individual's life can result in stunted bone development relative to dental development. Building on this idea, this study compares the skeletal age (SA) and dental age(DA) of 106 individuals excavated from two archaeological sites in northern Peru in order to determine the amount of stress experienced by children during different phases. The sites sampled include Cerro Oreja, which was occupied during Salinar (400-1 BC) and Gallinazo (AD 1- 200) phases and Huaca de la Luna, which was occupied during the Middle Moche phase (AD 300-400) and again later during the Chimu phase (AD 800-1530). Cerro Oreja was an important urban center before the development of a state-level society. With the founding of the Southern Moche State, Cerro Oreja was abandoned and Huaca de la Luna became the capital. Huaca de la Luna was abandoned as the Southern Moche State went into decline, but was later reused as a cemetery by individuals of the Chimu Empire. Given the dating of these sites, understanding child growth can help us track the health consequences of sociopolitical change.

The sample sizes available from each site were limited, and therefore it was difficult to determine if there were any significant differences between the sites and occupation phases. However it appears that the Salinar phase children of Cerro Oreja, suffered from the least amount of stress. The Moche children of Huaca de la Luna, had the most significant differences in skeletal and dental age, suggesting that they suffered most from environmental stress. A number of factors could have contributed to this stress, including changes in the economic system, the rise of social inequality, and environmental changes resulting from devastating El Niño events.

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[2] Received an Excellence Award when presented at the 66th Annual Eastern Colleges Science Conference held in Wayne, NJ on April 14, 2012.

I. Introduction

Subadult skeletons provide useful insight into important aspects of past populations. In this study, the age of subadults as determined by long bone growth and epiphyseal fusion is compared to the age as determined by the development of dentition. Because teeth develop at a consistent rate, and long bone growth and fusion is affected by stress and other environmental factors (Baker et al. 2005; Reppien et al. 2006), the differences between these two ages can provide an understanding of the environmental stress of past populations.

This study includes skeletal remains of individuals excavated from the Cerro Oreja and Huaca de la Luna sites in the Moche valley of Peru (Figure 1). The sites have occupations ranging from 400 BC-1530 AD, and include four different cultural phases, some with a number of sub-phases as well. The earliest phase represented in the skeletal sample is the Salinar phase, which dates from 400-1 BC, and had a key center located at Cerro Oreja site (Gagnon and Wiesen 2011). Following the Salinar was the Gallinazo phase, which consisted of three sub-phases, the Pre-structural, Structural, and Post-structural, each of which also maintained an important center at Cerro Oreja (Gagnon 2008). The Southern Moche state evolved out of the Gallinazo phase, and for the Middle Moche phase, the state's capital was Huaca de la Luna (Billman 1999). After the fall of the Southern Moche state, the Chimu empire dominated the Moche valley, and although its political center was located at Chan Chan, people still used the site of Huaca de la Luna (Keatinge and Day 1973; Uceda et al. 1997). Subadult skeletal remains from the Salinar and Gallinazo, and the Middle Moche phase, and from the Chimu empire were analyzed for SA(skeletal age) and DA(dental age) in order to determine if, in certain places and during certain phases children faced more environmental stress.

Due to the poor preservation and limited availability of skeletal remains from the two sites, especially Huaca de la Luna, there is very little skeletal evidence available. The small sample sizes of the different populations make it difficult to determine how much a difference there really is between populations, however the data collected does provide insight into what patterns seem prevalent, and would likely show large amounts of difference using the same method if the sample sizes could be increased.

II. Age Determination of Subadults

Although the skeletons of subadults are generally poorly preserved, and therefore often overlooked in research, there is much information that they can tell us about past populations (Baker et al. 2004). When subadult skeletons are uncovered, the first and most important step is age determination. Knowing the age at death allows researchers to use subadult skeletons to understand a wealth of information about past

populations. Most often subadults are used to determined the fertility rate of the population (Buisktra et al. 1986); however, subadult remains are also incredibly useful in understanding how environmental factors affected growth and development, how civilizations treated children similarly or differently with regards to burial practices, the demographic structure of a population, or the overall health of a population (Baker et al. 2004).

Long Bone Development

Bones are made up of both organic and inorganic material, with organic material comprising a majority of bones in subadults, as opposed to only 24% in adults (Baker et al. 2005). The organic part of bone consists predominately of collagen, which is elastic and flexible. In infants and young children, some of the skeleton is still cartilaginous membrane, and has not yet developed into bone. The cartilage forms a model of the skeleton, and as subadults grow, bone slowly replaces the cartilage and connective tissue membrane. As the bone grows and replaces cartilage, it develops first as woven bone, before becoming lamellar bone, or mature bone.

In subadults, the bones have not yet completely fused together and so do not appear as adult bones do. The ossification site, also known as the primary center, appears during fetal development and birth (Baker et al. 2005). The secondary centers appear after the primary center has developed, and sometimes fuse with the primary center, or in many cases, develop into elements known as epiphyses. Epiphyses fuse to the main bone as subadults grow, with each epiphysis fusing at different stages of development.

In long bones, the primary center of ossification forms as the shaft, and the secondary ossification centers develop at the articular ends, allowing the bone to continue growing in length (Baker et al. 2005). When the shaft is finished growing, the epiphyses fuse on both ends at the epiphyseal surface, forming one primary center. Cartilage then begins to form around the ends, where the bone articulates with other bones. After the cartilage forms, the bone stops growing, and bone growth no longer aids in determining age at death.

Similar to the long bones, cranial bones do not form completely during the fetal development. The cranial bones have separate ossification centers that eventually fuse together along suture lines once growth is complete (Baker et al. 2005). However, unlike long bone growth, the suture lines of the cranial bones remain noticeable for much of an individual's lifetime, and only sometimes begin to disappear with age. Therefore, cranial suture closures can still be used to age some individuals long after sub-adulthood.

Dental Development

In addition to using the cranial and post-cranial bone growth and fusion to determine the age at death of subadults, the dental development of individuals is useful for determining the age of subadults. People have two sets of teeth, the first set includes the deciduous teeth, and the second set includes the permanent teeth (Baker et al. 2005). The deciduous teeth begin to develop during gestation, and are the first teeth to erupt (Figure 2). Some permanent teeth also begin to develop during gestation, but do not erupt until later in an individual's life. As an individual grows, the permanent teeth begin to erupt underneath the deciduous teeth, causing them to be shed. After a permanent tooth erupts, the root begins to grow, and usually finishes growing around two years after the crown is complete.

The gestation period for children generally lasts an average of 38 weeks, but can range from anywhere between 34 and 42 weeks (Hillson 1996). The formation of teeth begins at about 14 weeks, starting with the first deciduous incisor, and continues at a consistent rate with teeth beginning to form every two weeks the next tooth being second incisor and then to the canine. The molars develop on a different schedule, with the first molar beginning at 15 weeks, and the second and third molars following three weeks after. The permanent first molar also begins forming in the fetal stages, somewhere around 28-32 weeks after fertilization.

After birth, the teeth continue to develop fairly consistently, with the lower permanent incisors beginning development at three months, starting with the first incisors followed by the second incisors (Hillson 1996). The permanent canine begins developing around four months, and the upper permanent incisors start developing around the end of the first year. The premolars and permanent second molars begin developing towards the end of the second year. The crowns of permanent teeth begin to complete around three years, starting with the first molar crowns. The incisor crowns are completed around four years, the canine crowns and first premolar crowns around six years, and the second premolar and molar crowns around seven years. After the crowns if the teeth are complete, the root formation begins, and usually takes two to four years to finish. The root formation of the permanent first molars and incisors is usually complete around 12 years of age, and the rest of the teeth follow, with root formation being completely at consistent intervals. The only teeth that do not follow the pattern are the permanent third molars, which do not even start root formation until all of the other roots are complete.

The rate at which teeth grow and erupt is fairly consistent, therefore, the tooth eruption of an individual's deciduous and permanent teeth as well as the growth of tooth roots is very useful in determining the age at death of a subadult (Baker et al. 2005). In

fact, it is considered to be the most accurate method when it comes to age determination because tooth formation and eruption is much more closely related to genetics than bone growth and ossification, and therefore not affected by environmental factors.

Variability of Age Determination:

Skeletal growth of subadults is variable, and many cultural and environmental factors can affect the growth of an individual (Hoppa 1992). Often subadults in low stress environments, who have an abundance of resources grow to be taller and overall larger individuals, than those who are malnourished, and suffer from poor health. Studies have shown that the largest contributing factor to stunted child growth is malnutrition, followed by infection and disease. When a growing individual does not receive enough nutrition, the bone continues to grow, but at a slower rate. This means that malnourished children who are living in a high stress environment are overall smaller. The effect of malnourishment is most severe during the first five years of a child's life; malnourishment in older children, when bone growth naturally slows and epiphyses start fusing, has less of an effect on overall bone growth. Therefore, using long bone length to determine the age at death of an individual may not be accurate because bone length varies based on environmental factors; bone length is not necessarily a consistent factor among all subadults in the same cohort.

Contrary to the variability of bone growth, tooth eruption determines the dental age of an individual which is closer to chronological age. The development of dental tissue is much less affected by nutrition, disease, or other factors than bone tissue (Reppien et al. 2006). Tooth enamel is also incredibly resilient and often disintegrates at a much slower rate than other bones, and teeth are therefore often better preserved, providing a more accurate method for aging subadults, than long bone measurements and fusion. Overall, dental development is much less affected by outside environmental factors, than long bone growth, and is more accurate in determining the age of an individual (Walker 1969).

There have been a number of studies that have tested this hypothesis, using various skeletal populations. Walker (1969) looked at skeletal material excavated from Yokem Mound in Pike County, Illinois. The dental age of each individual was determined using a five-phase development model, and the long bones were aged based solely on epiphsyeal fusion. The variability in the growth and fusion of the long bones provided evidence for both periods of retarded growth as well as periods of rapid growth among subadults of the Yoke Mound population.

Johnston (1962) also analyzed long bone growth among subadult remains, aged to be five and a half years or less, from the Indian Knoll site. In this study, only long

bone measurements were used for determining the skeletal age of individuals. Johnston (1962) determined that the long bone growth of the Indian Knoll population was less than that of his comparative sample of American white children. This decrease in long bone growth was attributed primarily to differences in environment, and the effects of environmental factors of subadult growth.

Comparing the skeletal age of an individual to the dental age can provide great insight into the lives of past people and help in determining overall environmental stress and disease. Based on the studies done by Walker (1969) and Johnston (1962), long bone growth and development is clearly stunted by external, environmental factors. Therefore, a large difference between skeletal and dental age assumes that the individual's growth was stunted, and therefore is indicative of a high stress environment, malnourishment, or disease.

III. Background

Moche Valley Occupations

The Moche valley of northern coastal Peru (Figure 1), was occupied by various peoples spanning a number of cultural phases. One of the earliest phases of occupation was the Salinar, which lasted from 400-1 BC (Gagnon and Wiesen 2011). The Salinar phase differed from the preceding Guañape phase, which lasted from 1800-400 BC, as people moved from coastal sites to larger inland sites, such as Cerro Oreja. Archaeological evidence from the Salinar phase sites suggests that subsistence strategies slowly began to focus less on marine life and increase in domesticated llamas, used for both meat and labor (Pozorski 1979). There is also evidence of expanding canal systems during the Salinar, suggestions shift towards agriculture (Billman 2002; Gagnon and Wiesen 2011). This shift in subsistence strategies towards meat from inland animals as well the early establishment of agricultural technology allowed for an overall increase in productivity (Pozorski 1979). While people from the Salinar phase still relied on protein from the ocean, this movement towards inland meat, overtime, released the people from their heavy dependence on marine animals.

The political organization during the Salinar phase consisted of eight autonomous polities, separated by defensive barriers (Billman 1999). The main focus of the Salinar was defense, due to the overwhelming threats of highland and intra-valley aggression. Each individual polity had a two-tiered system of hierarchy in the early part of the phase, however these tiers collapsed into loosely formed confederacy among all of the polities by the later part (Billman 2002). Still, the Salinar polities were unable to defend themselves against the highland armies, and collapsed, leaving one central polity state located at Cerro Oreja, which controlled the northern coast (Billman 1999).

The Gallinazo phase grew out of the Salinar, and people continued to focus on defensive strategies in order to maintain power (Billman 1999). However, as opposed to Salinar groups, who existed as independent, and sometimes hostile communities, Gallinazo groups were more politically centralized(Billman2002). Warfare continued to dominate the Moche valley during the Gallinazo occupation, in response small polities came together, creating one large central polity centered at Cerro Oreja. The Gallinazo polity had a primary three-tiered hierarchy system centered at Cerro Oreja, with eight secondary polities located in the surrounding area. During the Gallinazo occupation of the Moche Valley, structures were built as fortresses and for purposes of defense, as opposed to monumental and ritual purposes, as is seen later during the Moche occupation (Billman 1999). Overall, the ideological base of the Gallinazo polities was very weak. The Gallinazo do not show archaeological evidence of any clear change in subsistence strategy from the Salinar, however, human skeletal remains suggest that there was a large increase in agricultural production (Gagnon and Wiesen 2011). This is evidenced from data collected from the teeth of skeletal samples from the Gallinazo phase, which show an increase in indicators of agricultural food consumption.

There is clear continuity between the Moche and Gallinazo occupations of the Moche valley, and it appears that the Southern Moche state arose out of the Gallinazo polity at Cerro Oreja (Billman 1999). The Moche (Bawden 1995), beginning during the Early Intermediate period (Bawden 1995) and lasting all the way into the Middle Horizon (Quilter 1990), existed from AD 100-800 (Donnan 2004).

During the Early Moche phase, Cerro Oreja was maintained as the political center (Billman 1999). However, quite different from the Salinar and Gallinazo occupations, the Southern Moche state shows a significant shift towards ideology as a method for social integration as evidenced by the construction of public monuments. The Southern Moche state also maintained a strong military regime, which led to many military conquests, and the establishment of a state exceeding any that had preceded it, in terms of size. Although the Moche had sites along the northern coast of Peru, as the state began to expand, the state established its capital at Huaca del Sol and Huaca de la Luna, also called the Huacas de Moche (Millaire 2010). This site includes two large platform mounds, which were used for civic and ceremonial rituals, separated by a spans of land in between the two, which served as the urban sector where residents lived and went about their daily activities. The Huacas de Moche was the dominant political and urban center in the Moche valley from AD 200-800, which includes the climax of the Moche civilization.

The continuity between the Gallinazo culture and Moche culture can be seen in

the mound structures, the segmented architecture style and evidence of community based labor, the similar configuration of ceremonial centers, the use of irrigation systems, and the burial practices; however, there are some major differences between the two civilizations which can be seen primarily in the art (Bawden 1995). Moche art is much more formal and complex, with a focus on iconography. In fact, it is through this complex artwork that most of the Moche culture is studied and understood. The Moche civilization was also highly centralized, with a standardized system of weights and measures, as well as a system for counting (Quilter 2002). Although it did not have a written language, it did have an established spoken language called Muchik. Most importantly, however, the culture was characterized by its elaborate art, which decorated ceramics, structures, and its famous pyramids, called huacas (Quilter1990 and 2002). The history of the Moche civilization is outlined in two different models to define the stages and phases of the civilization. The most common theory is the five phase ceramic sequence. This divides the Moche history into five phases: Moche I, Moche II, Moche III, Moche IV, and Moche V (Bawden 1995). These phases are characterized by the spout used on stirrup spout vessels, and the decorations used (Chapdelaine et al. 2001). The exact dates for each phase has never been established, but it is assumed that each phase lasted somewhere between100 and 200 years (Donnan 2004). In this model, the Moche IV phase is considered the climax of the civilization, with the Moche III phase marking the expansion of the civilization (Chapdelaine et al. 2001). In fact, transition between the Moche III and Moche IV phases is so rapid, that the differences are difficult to distinguish.

The other model proposed for the Moche civilization history is three-division model, comprised of an Early, Middle, and Late phase(Chapdelaine et al. 2001). Although this model is different from the five phase ceramic sequence, the five phases overlap fairly consistently with the three phases. The Early phase encompasses Moche I and Moche II; the Middle phase includes Moche III and Moche IV, and the Late phase spans the same phase as Moche V.

The political structure of the Moche civilization is not know for sure, due to the debated interpretations of the Moche artwork. The first model is the single state model, which states that the Moche was one large and expansive state (Quilter 2002). This political model also supports the argument that the Moche civilization was a conquest state, and that the violent warfare depicted in their art is political rather than ritual. Opposing the single state model is the argument that there was no centralized authority among the Moche. Rather, each Huaca was a separate political court, and encompassed its own ruling area. This theory is not as strongly supported as the single state model,

only because the exact purpose of the Huacas is not known for sure. There is some evidence that they were used for sacrificial rituals; some have argued that they were used as tombs, and still others, such as those supporting the separate states model, have stated that the Huacas were political centers.

In addition to those two theories, there are other models that have some empirical support. The first is the federation model, which is similar to the single state model, although it states that the Moche civilization is actually a group of states that came together for a period of time to form a federation (Quilter 2002). However, using this model makes it difficult to determine whether or not the Moche was a conquest state. The other model has to do with geographical separation. It states that there were two distinct Moche regions that existed separately of one another. The first state was the Southern Moche state, which consisted of the Moche and Chicama Valleys (this includes the Viru, Chao, Santa, Nepaña valleys), and the second was the Northern Moche, which included Jequetepeque, Lambayeque, and Piura. In addition to geographical differences, the Northern Moche state also had its own three phase ceramic sequence. However, because there is controversy over exactly how far the Moche civilization extended, it is difficult to support the geographical separation model. It is commonly believed that the Moche spread up and down the coast, and therefore had a significant distinction between north and south. Some argue that the civilization was simply a group of small polities all inhabiting one valley and its surrounding area, which supports the single state political model.

The Moche also had a complex economic system which shows a continuation on the subsistence strategies that began in the Salinar phase (Pozorski 1979). By the time the Moche occupation of the Moche valley began, there was an efficient subsistence system that relied almost exclusively on inland meats, as opposed to the subsistence strategies during the Salinar phase, which still included some protein gathered from the surrounding ocean. Billman (2002) also found archaeological evidence of canals used for irrigations, began earlier, and were expanding during the Salinar phase. However, it appears that these canals provided insufficient amounts of water to meet the needs of the Moche state, and were therefore rebuilt during the Middle Moche phase.

Although the Moche people no longer relied on the ocean for protein, they still relied heavily on its expanding irrigation system for agriculture, which in turn meant they still remained dependent upon the surrounding sources of water. It was the Moche economic system's heavy reliance on the oceans for irrigation that seems to have been their biggest weakness (Quilter 2002). The variable climate of the coast due to El Niño made their economy very unstable. The entire civilization was thrown into turmoil

during times of natural disaster, and had to undergo major rebuilding in the aftermath. The powerful Wari empire may have taken advantage of the weakened government during and immediately following natural disasters, making repeated attempts to conquer the Moche.

The social structure of the Moche civilization was a hierarchical, highly unequal social system (Quilter 2002). These great inequalities were between the rich and the poor, with a high degree of social tension between the two different classes. This social distinction was so intense that walls were built to physically separate those of different social classes, and there was constant internal conflict between the two. It appears that the combination of natural disasters, internal revolts, and external attacks led to the eventual downfall of the Southern Moche state, and made way for the rise of the Chimu empire.

The End of the Moche State

One hypothesis for the fall of the Moche state asserts that it was brought about predominately by conquests from highland peoples (McEwan 1990). There are clear changes in architecture, art style, and burial practice that support the conquest hypothesis. Most notable, is the amount of Wari influence in these structural changes, as seen by changes in burial positions from extended to flexed, the ceramic style from the distinctive Moche style to Wari style, and the maiming of and replacement of Moche murals with Wari murals. While it is believed that the Chimu eventually replaced the Moche, there is a 400-year gap between the fall of the Moche and the rise of the Chimu. It appears that the Wari, who were dominant in central Peru during this gap, made conquests on the northern coast as well.

With the rise of the Chimu, in AD 800, came the end of the Wari conquest on the northern coast of Peru (McEwan 1990). The center of the Chimu empire was located at Chan Chan, however the occupation dominated the entire northern coast from AD 800-1530 (Keatinge 1973).Chimu architecture is made up of cuidadelas, as opposed to the Moche huacas, which are large structures that include courts, plazas, burial mounds, and corridors, all surrounded by incredibly large adobe brick walls (Keatinge 1974). These cuidadelas housed the administrative centers of the Chimu empire, where the rulers and elite lived. With the rise of the Chimu came another transition in subsistence strategies in the Moche valley (Pozorski 1979). Archaeological evidence suggests that llamas became the main source of meat for people living outside of the state centers, but that the Chimu employed subsistence strategy more similar to those used during the Salinar phases, and the phases preceding it. The use of marine animals became popular again, and llama meat was merely used to supplement protein coming from the ocean.

Based on their subsistence strategies, it is clear that the Chimu empire was characterized largely by its focus on land and water. The Chimu employed a hierarchical socio-economic system, where the rulers maintained ownership over its prized land and resources, especially water and the irrigation systems, and exploited laborers throughout the Moche valley (Keatinge 1973 and 1974). Even the structure of the corridors in the cuidadelas suggest that access and the circulation of people within them was strictly controlled by the ruling and elite class (Keatinge 1973). Although the Chimu were centered at Chan-Chan, evidence of Chimu burials have been uncovered on the platforms of Huaca de la Luna, suggesting that the Huacas de Moche were utilized during the Chimu occupation as a cemetery. In the 1500s the Incas came into power and began to expand their empire up and down the entire coast of Peru, bringing an end to the Chimu empire.

IV. Materials and Method

Materials

A total of 106 individuals were used for this study, however, due to insufficient preservation not all could be aged based on both long bone growth and dental development, thus only 97 individuals could be characterized by the difference between SA and DA (skeletal age and dental age, respectively). The age-at-death for every individual is represented in Appendix 1 and Appendix 2. Each individual was grouped based on the specific phase during which he or she lived, which includes the Salinar, Pre-structural Gallinazo, Structural Gallinazo, Post-structural Gallinazo, Early Moche, Middle Moche, or Chimu. As well as his or her overall larger cultural division, which consists of Salinar, Gallinazo, Moche, or Chimu, and the site from where he or she was excavated, which includes Cerro Oreja or Huaca de la Luna.

There are a total of 77 individuals from Cerro Oreja, and 29 individuals from Huaca de la Luna (Figure 3). Representing Cerro Oreja are a total of 10 individuals from the Salinar phase, 31 individuals from the Pre-structural sub-phase of the Gallinazo, 21 individuals from the Structural sub-phase of the Gallinazo, three individuals from the Post-structural phase of the Gallinazo, and one individual from the Early Moche phase (Figure 4). Representing Huaca de la Luna are 21 individuals from the Middle Moche phase, and seven individuals from the Chimu phase (Figure 4). There are 10 individuals from the Salinar division, 66 individuals from the Gallinazo phase,22 individuals from the Moche phase, and eight individuals from the Chimu phase (Figure 5). Breaking down the occupation phases at the sites, we find that the sample sizes from each phase and location vary quite a bit, which made comparing the samples difficult, and at times certain phases could not be included in the calculations due to too small of a sample,

including the Post-structural sub-phase of the Gallinazo phase, the Early Moche phase, and the Chimu phase.

Skeletal Development

In order to determine the age of individuals, using post-cranial and cranial bones, both bone measurements and epiphyseal fusion were collected. Johnston (1962) correlates bone length measurements in millimeters to ages, ranging from the fetal stage to five and a half years of age (Table 1). The post-cranial bones of individuals greater than five and a half years were not used. The long bones measured include the three leg bones, the femur, tibia, and fibula, and the three arm bones, the humerus, radius, and ulna. Not all bones were present or measurable in each individual, but every complete long bone was used when possible. The epiphyseal fusion of both the proximal and distal ends of the long bones was also used when measurements were insufficient for aging an individual.

The only cranial bone used to determine age was the basilar portion of the occipital bone. The basilar portion is a separate unfused portion of the occipital bone, located inferiorly near the foramen magnum. Both the width, which measures from the anterior to the posterior end, and the length, which measures perpendicular to the width, were used. Scheuer (1994)correlates the basilar portion measurements in millimeters to ages ranging from two weeks to just over four and a half years (Table 2). The basilar portion, due to its small size, is difficult to recover and not always present in individuals; however, the basilar portion was present and measureable, and therefore used to aid in the aging of 56 of the 105 individuals, a little more than 50% of the populations studied. Individuals older than five years of age were aged solely on cranial suture closure.

Dental Development:

The original method for dental aging was developed by Gustafson (1939) and involved an analysis of six areas of dentition, including: attrition, periodontosis, secondary dentine, cementum apposition, apical resorption, and translucency of the tooth root. Gustafson's method was later modified by Lamendin et al. (1992), who turned the focus primarily to periodontosis and translucency of the tooth root, and relating it to the height of the tooth. Periodontosis involves the wearing away of the tissue around the tooth, and can be observed just below the enamel, on the root of the tooth. This regression of the soft tissue increases with age. The translucency of a tooth's root begins to appear around age 20, and is therefore useful in determining sub-adulthood.

However, neither of these methods is very exact in determining actual ages of subadults. Therefore, Ubelaker (1989) established a method for aging subadults based on dental calcification and eruption. Dental calcification involves the formation of the tooth,

and stage of growth. Eruption involves determining how far the tooth has emerged from the gum after it has formed. Based on these two factors, Ubelaker (1989)identified the sequencing of various stages of the formation and eruption of teeth up to 35 years of age (Figure 2). Although teeth generally stop growing around age 20, which is when microscopic markers on the teeth start to appear, and become the main methods used for aging.

V. Results

When possible, the SA (skeletal age) and DA (dental age)ranges, in months, were calculated for each individual, and then the midpoint for each individual was determined. The mean SA and the mean DA was the determined for each phase, cultural division, and site. When comparing differences between phases, individuals six from the Gallinazo phase who could not be dated to a specific sub-phase, and the one individual from the Early Moche phase were excluded, but they were included in cultural division and site level analysis. The means and medians of both the SA and DA where then determined for each phase, cultural division, and site, and compared to one another. By calculating both means and medians, the affect of outliers on the overall age differences was observed.

The difference between an individual's SA and DA was also determined and compared by phase, cultural division, and site. In order to make these comparisons, box plots were used. The box plot illustrates the lower and upper quartiles, any possible outliers, as well as the median. Therefore, any significant difference between any of the populations would be easily seen by very little overlap of the quartiles, as well as a large distance between the medians.

Figure 6 shows a comparison of the mean SA and DA for each phase, and shows a slight difference between mean SA and DA, with the DA being higher, in almost every phase, with the exception of the Post-structural Gallinazo phase. However, the Post-structural phase also had the smallest sample size, which may have contributed to the mean SA and DA being almost the same. The median SA and DA was also determined based on phase, cultural division, and site in order to eliminate the possibility of outliers affecting the mean. Figure 7 illustrates a comparison of the median SA and DA for each phase. The median SA and DA for each phase shows a similar pattern to the means except that they are all much lower. However, it is the SA that varies much more without a consistent, recognizable pattern. The median SA is overall younger than the mean SA, suggesting that there are a number of outliers that are affecting the mean. The median DA is much older than the median SA in almost every phase, with the exception of the

Salinar, Post-structural Gallinazo, and Middle Moche phases, where the median SA is actually greater than the median DA.

Figure 8 shows the comparison of the difference between the DA and SA medians for each phase. Based on the overlap between the quartiles, and similarity of the median, there does not appear to be a significant variation in the difference between DA and SA among any of the phases. However, in each Figure, the median difference for the Salinar and Chimu phases are older than every other phase. There are also a number of outliers for each phase, which would provide an explanation for the large differences between Figure 6, which represents means, and Figure 7, which represents medians.

Figure 9 illustrates a comparison of the mean SA and DA for each cultural division. Figure 9 shows consistency in the differences between mean SA and DA in each division, with the DA always being slightly higher. This suggests that the inconsistency of the Post-structural phase in Figure 6 had very little affect on the overall differences between the mean SA and DA for the entire Gallinazo division. Figure 10 shows a comparison of the median SA and DA for each cultural division. Figure 10 shows a similar pattern to Figure 9 when comparing the median SA and DA by division. The median SA is still greater in the Salinar and Moche phases, however not as much as in Figure 7. The median DA remains consistently greater than the median SA in the Gallinazo and Chimu phases, similar to the pattern shown in Figure 9.

Figure 11 shows the comparison of the difference between the DA and SA for each cultural division. Figure 11 is similar to Figures 8, except that the Moche children have slightly younger ages, suggesting that there is little difference between the phases and cultural divisions. Individual who are outliers are also consistent between the phase and cultural division analysis.

Figure 12 is a comparison of the mean SA and DA for the two sites. Figure 12, similar to Figure 9, also shows that the SA is still slightly below the DA. Figure 13 is a comparison of the median SA and DA from each site. In contrast with Figures 7 and 10, Figure 13 shows DA to be consistently older than SA. Figure 14 shows the median difference between DA and SA for each site. The medians, as well as the upper and lower quartiles overlap almost entirely. Because the sites include larger populations, there are a number of individual outliers, however, the individuals are the same as the outliers in Figures 8 and 11.

Statistical calculations were also done in order to understand the significance of differences in the calculated ages between the groups. The analysis of variance (ANOVA), with Sheffe's test, failed to identify differences among phases, cultural divisions, or sites in the average difference between DA and SA.

Pearson's *r* was calculated to measure association between SA and DA for each phase, cultural division, and site (Table 4).The results of Pearson's *r* calculations were then used to calculate FZT, to determine if there were any significant differences in the level of association of SA and DA. Table 5 shows the results of FZT comparing Pearson's *r* for each phase to one another, Table 5 shows the FZT results comparing Pearson' *r* for each cultural division to one another, and Table 6 shows the results of the FZT comparing Pearson's *r* for the two sites.

All of the Pearson's *r* values are high for each phase, cultural division, and site, suggesting that there is a strong, positive correlation between SA and DA. However, the FZT analyses show that the Middle Moche phase and Moche cultural division are significantly less strongly associated than all other phases and cultural divisions. The most significant difference appears to be between the Middle Moche phase, and the Pre-structural Gallinazo and Salinar phases.

VI. Discussion

For the most part, there are little statistical significances among the different populations, at the phase, cultural division, or site level. This is possibly the result of the overall small sample size. I hypothesize that larger sample sizes would yield a larger statistical significance, based on the small differences that are seen between the populations. In Figure 6, the mean DA is almost always greater than the mean SA, with the exception of the Post-structural Gallinazo phase, which had a very small sample size (N=3). However, Figure 7 has much more variation when comparing the median DA to the median SA. This suggests that there are a number of outliers that are affecting the mean.

When looking at Figure 6, it is clear that median DA is older than median SA in most cases, with the exception of the Salinar phase, where the SA was quite a bit older. This suggests that during the Salinar phase, there was little environmental stress, and quite possibly surplus and abundance, which allowed for rapid skeletal growth. The Pre-structural Gallinazo phase had the greatest difference between SA and DA, with the DA being much larger. This would imply that the Pre-structural Gallinazo phase was a time of great environmental stress, which affected skeletal growth.

However, when looking at Figure 9 and Figure 10, which compare mean and median SA and DA for each cultural division, the results are quite different. Figure 6 illustrates that the mean DA is, in all cases, older than the mean SA. However, Figure 10 indicates that during the Salinar and Moche cultural divisions, the median SA is older than the median DA. Similar to Figure 7 though the Salinar phase has a higher median SA than DA. Also consistent with Figure 7, Figure 10 suggests that the Structural Gallinazo and Chimu phases were similar in the difference between SA and DA.

Overall, Figures6, 7, 9, and 10 seem to suggest that the Salinar phase had the least amount of environmental stress, and may have, considering that the median SA is older than the median DA, experienced abundance. The data also suggest that the Gallinazo and Chimu phases had the most environmental stress, with the Pre-structural Gallinazo phase having slightly more environmental stress than the Structural and Post-structural Gallinazo phases, and the Chimu phase.

The box plots show little significant difference when comparing the different populations. The most noticeable difference can be seen in Figure 8 and Figure 11where the median difference between DA and SA for the Salinar and Chimu are slightly higher than all of the other phases and cultural divisions. However, all of the quartiles overlap, and so these differences are not significant. However, Figures7and 10, which show that the direction of difference in Salinar and Chimu samples is not the same. In the Salinar the median SA is older, whereas in the Chimu the median DA is older.

In addition to looking at the overlap of the medians, the box plots are also useful in identifying the outliers, of which there are a large number. This explains the differences between the bar graphs comparing the mean SA and DA (Figure 6 and Figure 9) and median SA and DA (Figure 7and Figure 10).It is also interesting to note that the individuals who are the outliers are consistent among phase, cultural division, and site level analyses.

The largest number of outliers occur during the Gallinazo phase, specifically the Pre-structural phase, and most significantly, the Cerro Oreja population. This suggests that there is more variability in the experience of children during this phase, than during others.

The significance of these differences, however, can be seen in the ANOVA, Pearson's *r*, and FZT calculations. ANOVA suggests that there are no statistically significant differences in the mean of the difference between DA and SA. Pearson's *r* shows a strong association between SA and DA, however, when FZT is calculated using Pearson's *r* there are some statistically significant differences between some of the groups. Table 4 shows that there is a significant difference when the Moche phase is compared to every other phase with sufficient sample size. The same can be seen in Table 5, where the Moche population shows a significant difference when compared to all of the other divisions. This suggests that there was a large amount of environmental stress affecting individuals from the Moche phase, and more specifically, the Middle Moche. However, there is no significant difference between the two sites, which suggests that the significant differences are not necessarily related to the exact environment, but rather to the phase and culture in which the individuals lived.

VII. Conclusions

Overall, according to both the bar graphs and box plots comparing the SA and DA of individuals from the different phases, cultural divisions, and sites it appears that the Salinar phase had the least amount of environmental stress, compared to the Gallinazo phase, especially the Structural Gallinazo and Chimu phases, which had the most amount of environmental stress. According to the statistical analyses of the data, however, it appears that the Moche, and especially the middle Moche, had the most statistically significant difference in SA and DA suggesting that they suffered from the most environmental stress.

It seems that overall, it is difficult to analyze the data due to the small sample sizes, especially with regards to the two sites, where the Cerro Oreja population is almost three times as large as the Huaca de la Luna sample. This can likely be the cause of the inconsistency between the graphs and the statistical analyses of the data. The statistics, however, seem to follow a pattern, which suggests that with a larger sample size, a more statistically significant difference would be seen among populations that are already showing a slight significant difference. The Chimu phase, because it only consists of eight individuals, most likely is not consistent with the total population, and with a larger sample size, would produce very different results. The Gallinazo phase is actually one of the larger sample sizes, however, it does not show an incredibly large difference considering the sample size of the populations.

It is hypothesized that with larger and more similar sample sizes from all of the populations, including phase, cultural division, and site, the Gallinazo and Chimu phases would have less difference between SA and DA, and the Moche would show even more statistically significant difference, suggesting a large amount of environmental stress at Huaca de la Luna. The Moche already showed the most statistically significant difference with populations of the largest sample sizes, including the Salinar and Gallinazo phases, and therefore, were the sample sizes for all populations larger, it is likely that the differences would become even more statistically significant.

However, the fact that the Salinar, the earliest phase, suffered from the least amount of environmental stress, and the Moche phase, one of the later phases, and the first phase to develop a state-level society, suffered from the most environmental stress has a number of implications with regards to the sociopolitical and economic structures of each phase. In the Salinar phase people began shifting towards agriculture, however, they still relied on inland animals for meat, whereas the Moche people expanded their irrigation system and relied almost entirely on agriculture for food. This heavy reliance on a irrigation system, especially in an environment where there were periods of drought,

may have led to a more stressful lifestyle, than the mixed agriculture lifestyle of the Salinar people.

Even more important to note, however, is the development of the state which came about contemporaneously with the start of the Moche phase. The Moche was a strong, conquest state, centered at Huaca de la Luna, which was often engaged in warfare. Almost all of the Moche remains studied in the sample were excavated from Huaca de la Luna, suggesting that life at the capital of the state was very stressful. This study provides insight into the amount of environmental stress from which the citizens of a powerful and developed state suffered. With the development of state-level society also came and increase in stress among the people of the state, especially those residing at the political center.

VIII. References

Baker, Brenda, with Tosha Dupras and Matthew Tocheri. 2005 *The Osteology of Infants and Children*. Texas: University Anthropology Series.

Bawden, Garth. 1995 The Structural Paradox: Moche Culture as Political Ideology. *Latin American Antiquity* 6(3):255-273.

Billman, Brian R. 1999 Reconstructing Prehistoric Political Economies and Cycles of Political Power in the Moche Valley, Peru. *In Settlement Pattern Studies in the American: Fifty Years Since the Viru*. Brian Billman and Gary Feinman, eds. Pp. 131-159. Washington: Smithsonian Institution and Press.

Billman, Brian R. 2002 Irrigation and the Origins of the Southern Moche on the North Coast of Peru. *Latin American Antiquity* 13(4):371-400.

Buisktra, Jane, Lyle Konigsberg, and Jill Bullington. 1986 Fertility and Development of Agriculture in the Prehistoric Midwest. *American Antiquity* 51(3):528-546.

Chapdelaine, Claude, Victor Pimentel and Helen Bernier. 2001 A Glimpse of the Moche Phase III Occupation at the Huacas of Moche Site, Northern Peru. *Antiquity* 75:361-372.

Donnan, Christopher. 2004 *Moche Portraits from Ancient Peru*. Texas: University of Texas Press.

Gagnon, Celeste Marie. 2008 Bioarchaeological Investigations of Pre-State Life at Cerro Oreja. *In Arqueologı a Mochica: Nuevos Enfoques*. L.J. Castillo, H. Bernier, G. Lockard, and J. Rucabado eds. Pp. 173–185. Lima: Pontificia Universidad Cato lica del Peru.

Gagnon, Celeste Marie and Chris Wiesen. 2011 Using General Estimating Equations to Analyze Oral Health in the Moche Valley of Peru. *International Journal of Osteoarchaeology*.

Gonzalez-Colmenares, G, M Botella-Lopez, G Moreno-Rueda and J Fernandez-Cardenete. 2007 Age Estimation By a Dental Method: A Comparison of Lamendin's and Prince & Ubelaker's Technique. *Journal of Forensic Science* 52(5):1156-1160.

Gustafson, Gosta. 1950 Age Determination on Teeth. *Journal of The American Dental Association* 40(1)45-54.

Hillson, Simon. 1996 *Dental Anthropology*. Great Britain: University Press, Cambridge.

Hoppa, Robert. 1992 Evaluating Human Skeletal Growth: An Anglo-Saxon Example. *International Journal of Osteoarchaeology* 4(2):275-288.

Johnston, Francis. 1962 Growth of the Long Bone of Infants and Young Children at Indian Knoll. American *Journal of Physical Anthropology* 20(3):249-254.

Keatinge, Richard. 1974 Chimu Rural Administrative Centers in the Moche Valley, Peru. *World of Archaeology* 6(1):66-82.

Keatinge, Richard and Kent Day. 1973 Socio-Economic Organization of the Moche Valley, Peru, during the Chimu Occupation of Chan Chan. *Journal of Anthropological Research* 29(4):275-295.

Lamendin, H, E Baccino, JF Humbert, JC Tavernier, RM Nossintchouk and A Zerilli. 1992 A Simple Technique for Age Estimation in Adult corpses: The Two Criteria Dental Method. *Journal of Forensic Sciences* 37(5):1373-1379.

McEwan, Gordon. 1990 Some Formal Correspondences Between the Imperial Architecture of the Wari and Chimu Cultures of Ancient Peru. *Latin American Antiquity* 1(2):97-116.

Millaire, Jean-Francois. 2010 Primary State Formation in the Viru Valley, North Coast of Peru. *Proceedings of National Academy of Sciences of the United States of America* 107(14):6186-6191.

Pozorski, Shelia and Thomas Pozorski. 1979 An Early Subsistence Exchange System in the Moche Valley, Peru. *Journal of Field Archaeology* 6(4):413-432.

Quilter, Jeffrey. 1990 The Moche Revolt of the Objects. *Latin American Antiquity* 1(1):42-65.

Quilter, Jeffrey. 1997 The Narrative Approach to Moche Iconography. *Latin American Antiquity* 8(2):113-133.

Quilter, Jeffrey. 2002 Moche Politics, Religion, and Warfare. *Journal of World History* 16(2):145-195.

Reppien, Kirsa, Brigitte Sejrsen and Niels Lynnerup. 2006 Evaluation of Post-Mortem Estimated Dental Age Verses Real Age: A Retrospective 21-Year Survey. *Forensic Science International* 159:S84-S88.

Scheuer, Louise and Sue McLaughlin-Black. 1994 Age Estimation from the Pars Basilaris of the Fetal and Juvenile Occipital Bone. *International Journal of Osteoarchaeology* 4:377-380.

Ubelaker, Douglas H. 1989 *Human Skeletal Remains: Excavation, Analysis, Interpretation*. Washington: Smithsonian Institution.

Uceda, Santiago, E. Mujica, and R. Morales. 1997 *Proyecto Arqueologico Huacas del Sol y de la Luna*. Trujillo: Facultad de Ciencias Sociales Universidad Nacional de Trujillo.

Walker, Paul. 1969 The Linear Growth of Long Bones in Late Woodland Indian Children. *Proceedings of the Indiana Academy for Science 1968* 78:83-87.

Table 1- Long Bone Measurements for Children Birth to Five and a Half Years

Estimated Age in Years	Humerus	Radius	Ulna	Femur	Tibia	Fibula
Fetal	56.78	47.2	54.8	61.68	55.5	50
NB-.5	67.77	55.05	63.7	78.84	69.28	65.38
.5-1.5	93.14	73.96	82.86	115.63	96.87	92.44
1.5-2.5	113.57	91.33	99.2	148.13	120.57	113.8
2.5-3.5	125.64	97.86	18	166.73	138.2	137.17
3.5-4.5	136.78	108.5	120.63	183.82	154.3	144.71
4.5-5.6	154.67	120	132.75	213.67	178.43	171.67

Johnston (1962)

Table 2- Basilar Portion Measurements for Children Two Weeks to Four Years Seven Months

Documented Age	Width	Sagittal Length
2 Weeks	14.5	11.3
3 Weeks	16.9	12.7
4 Weeks	25.6	12.6
7 Weeks	15.5	11.6
3 Months	15.4	13.8
5 Months	18.4	13.4
8 Months	21	13.8
9 Months	20.5	13.9
11 Months	22.3	14
1 Year	18.3	13.9
1 Year 1 Month	22.1	14.8
1 Year 2 Months	22.7	15.8
1 Year 3 Months	23.6	16.8
1 Years 4 Months	18.6	14
1 Year 6 Months	21.9	15.5
1 Year 8 Months	22.6	15.7
1 Year 9 Months	22.7	16.8
2 Years 3 Month	24.4	18.1
2 Years 5 Months	25.8	17.5
2 Years 6 Months	24.2	17.5
2 Years 7 Months	25.9	17.4

2 Years 9 Months	24.2	16.4
3 Years 2 Months	23.2	16.6
3 Years 4 Months	27.6	16.6
3 Years 5 Months	26.1	18.1
3 Years 7 Months	27.8	17.5
3 Years 8 Months	27.3	15.5
4 Years 3 Months	25.9	16.4
4 Years 7 Months	26.2	15.3

Scheuer (1994)

Table 3- Pearson's *r* Values

Phase	Pearson's *r* for SA and DA	Division	Pearson's *r* for SA and DA	Site	Pearson's *r* for SA and DA
Salinar	*.993	Salinar	*.993	Cerro Oreja	*.976
Pre-structural Gallinazo	*.982	Gallinazo	*.972		
Structural Gallinazo	*.966				
Post-structural Gallinazo	*.756				
Early Moche	n/a	Moche	*.875		
Middle Moche	*.878			Huaca de la Luna	*.968
Chimu	*.994	Chimu	*.995		

* Designates Significance- **p < .01**

Table 4- FZT Calculations for Phase

Phase	Salinar	Pre-structural Gallinazo	Structural Gallinazo	Middle Moche	Chimu
Salinar		1.056	1.691	*3.115	.109
Pre-structural Gallinazo	1.056		1.66	*3.310	.909
Structural Gallinazo	1.691	1.066		*2.012	1.402
Middle Moche	*3.115	*3.310	*2.012		*2.473
Chimu	.109	.909	1.402	*2.473	

* Designates Significance- **p < .01**

Table 5- FZT Calculations for Division

Division	Salinar	Gallinazo	Moche	Chimu
Salinar		1.626	*3.122	.395
Gallinazo	1.626		*2.854	1.676
Moche	*3.122	*2.854		*2.968
Chimu	.395	1.676	*2.968	

* Designates Significance- **p < .01**

Table 6- FZT Calculations for Site

Site	Cerro Oreja	Huaca de la Luna
Cerro Oreja		.62
Huaca de la Luna	.62	

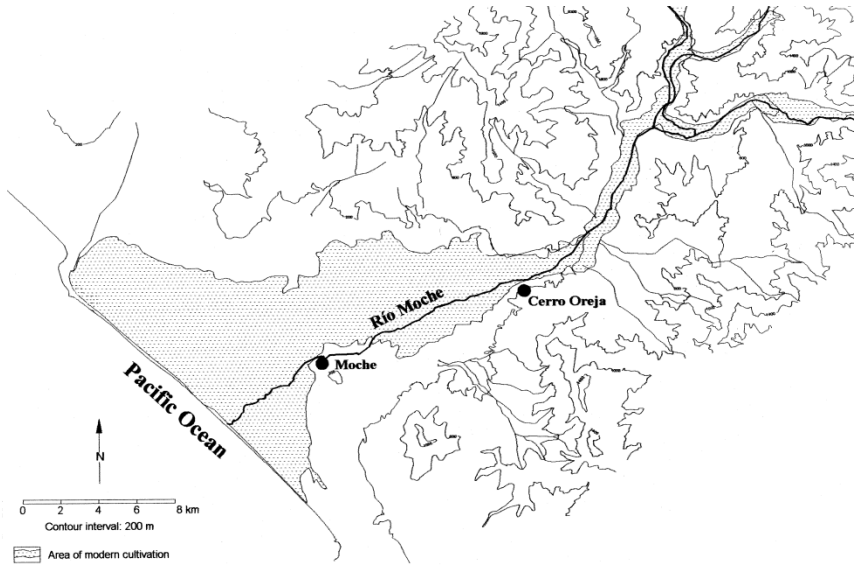

Figure 1- Map of the (Cerro Oreja and Huacas de Moche Marked) Moche Valley (Courtesy of Billman)

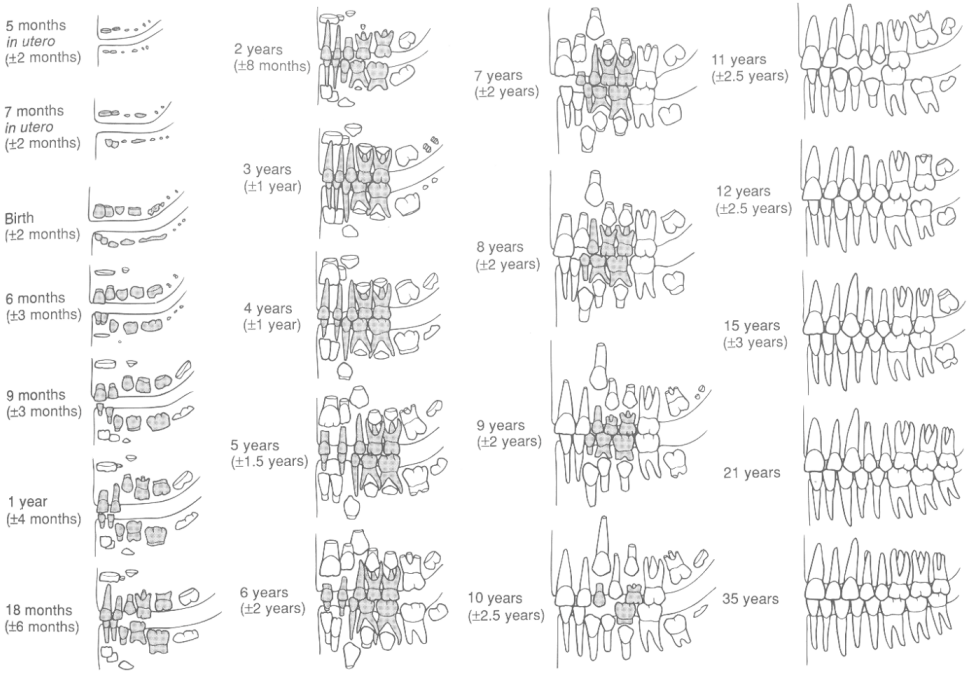

Figure 2- Dental Development for People Aged Five Months to 35 Years (Ubelaker 1989)

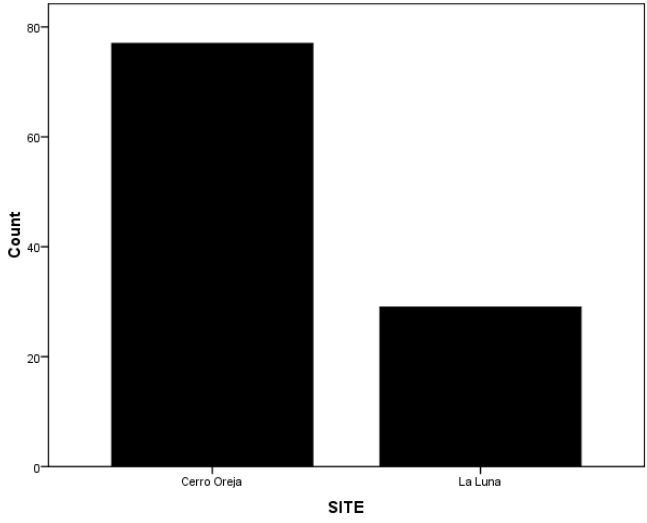

Figure 3- Number of Individuals by Site

Period # Key		Division Key
1-Salinar	5- Unknown Gallinazo	A- Salinar
2- Pre-Structural Gallinazo	6- Early Moche	B- Gallinazo
3- Structural Gallinazo	7- Middle Moche	C- Moche
4- Post-Structural Gallinazo	8- Chimu	D- Chimu

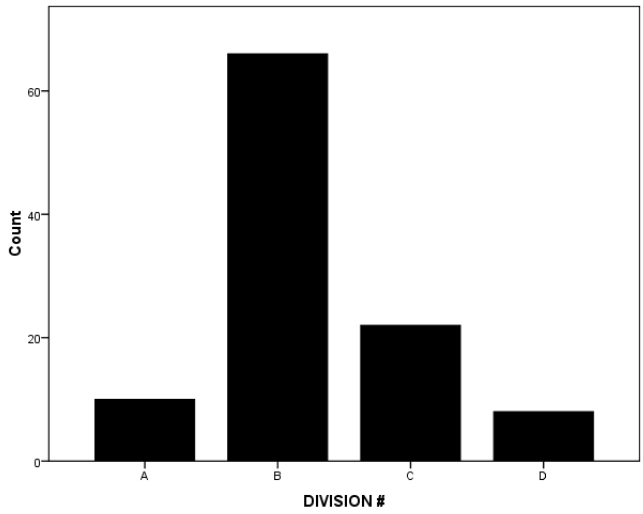

Figure 4- Number of Individuals by Phase

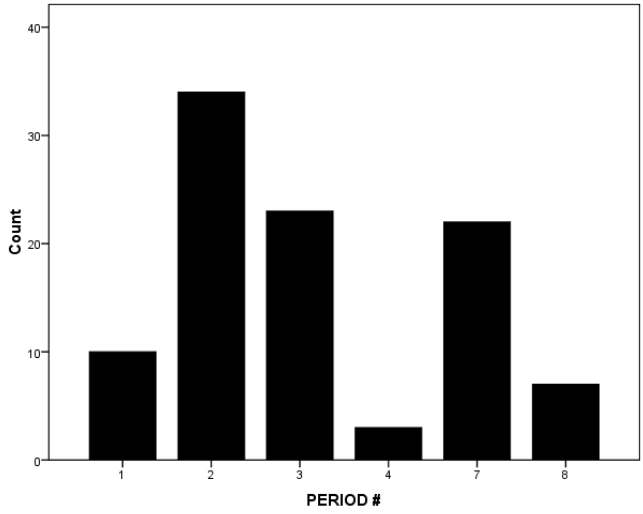

Figure 5- Number of Individuals by Division

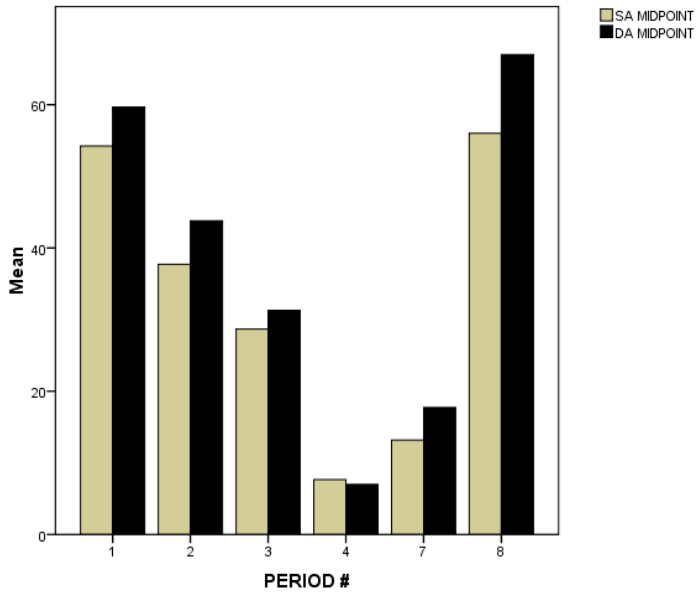

Figure 6- Mean SA and DA by Phase

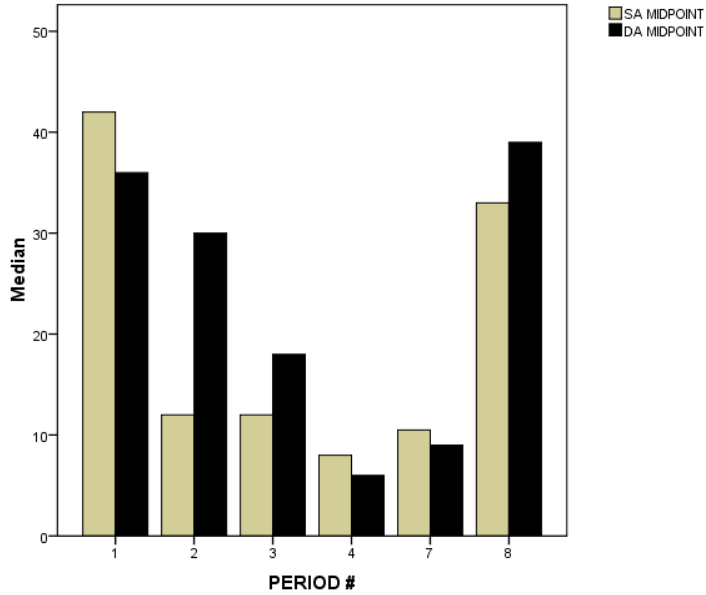

Figure 7- Median SA and DA by Phase

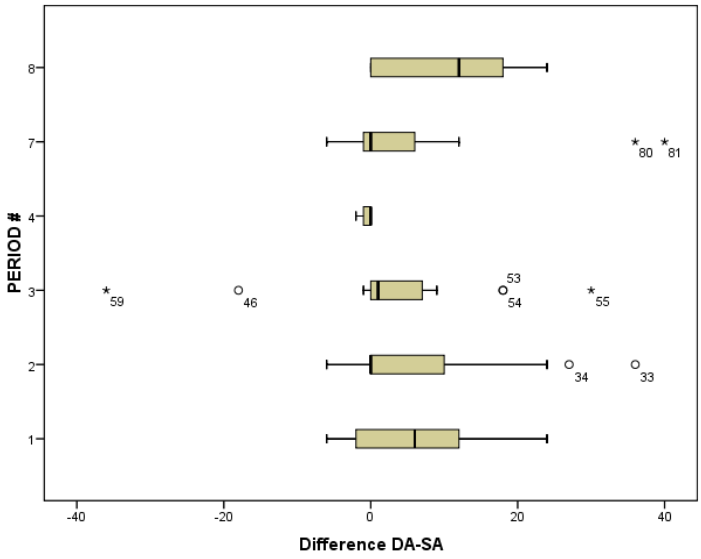

Figure 8- Difference Between DA and SA Medians by Phase

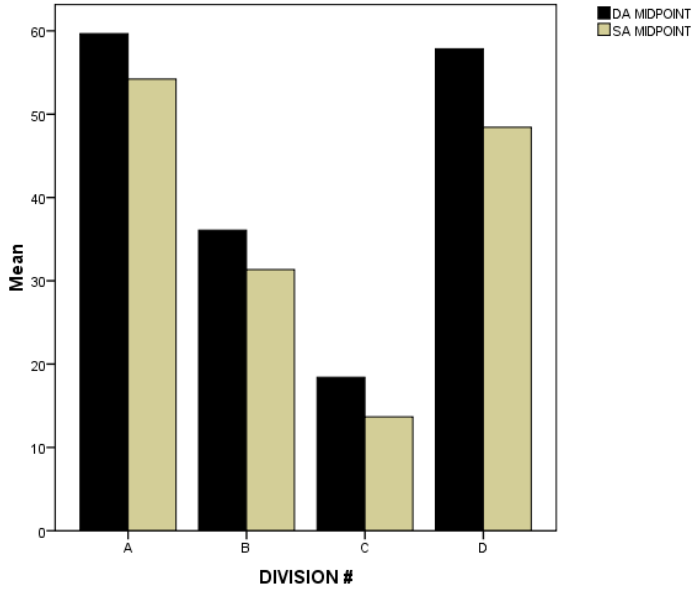

Figure 9- Mean SA and DA by Division

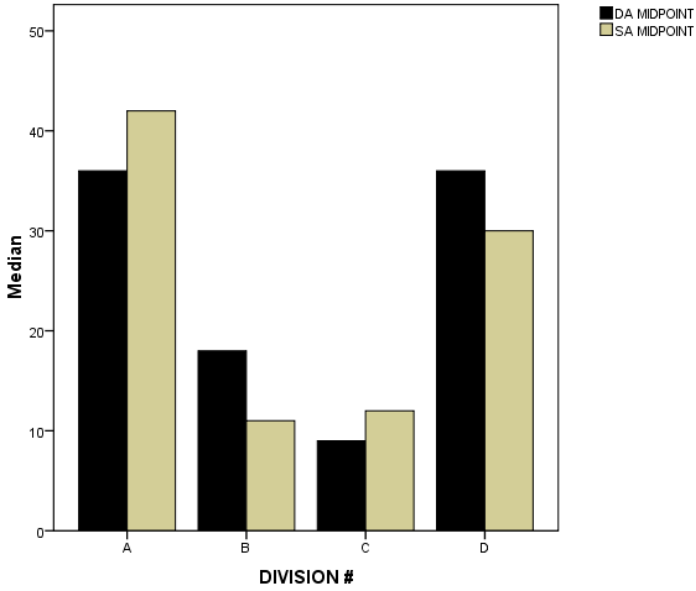

Figure 10- Median SA and DA by Division

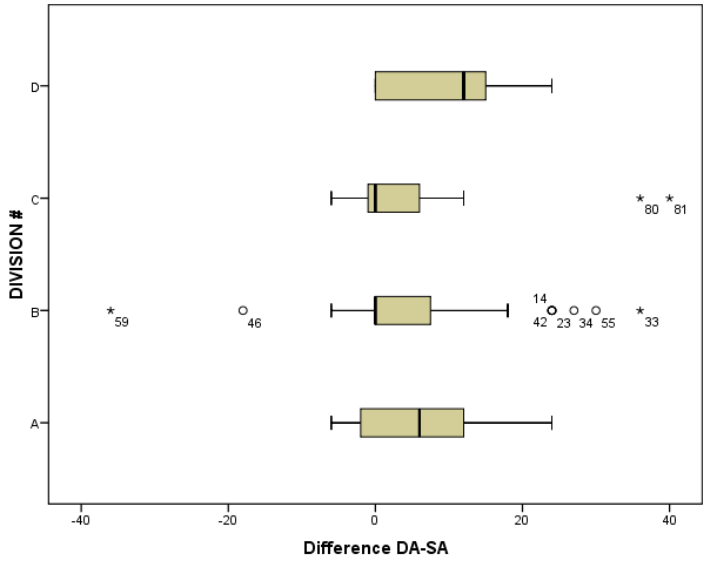

Figure 11- Difference Between DA and SA Medians by Division

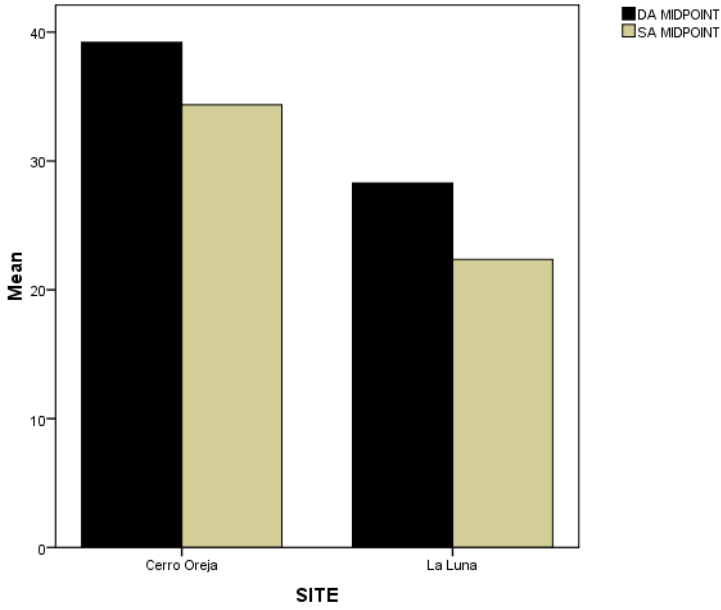

Figure 12- Mean SA and DA by Site

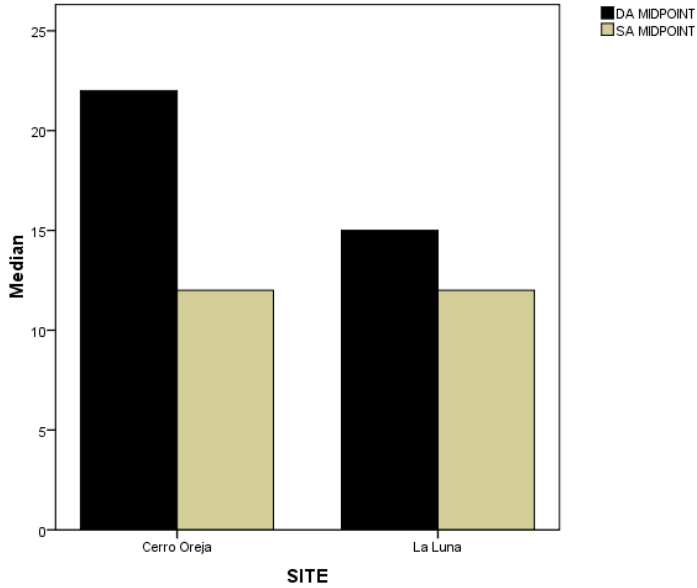

Figure 13- Median SA and DA by Site

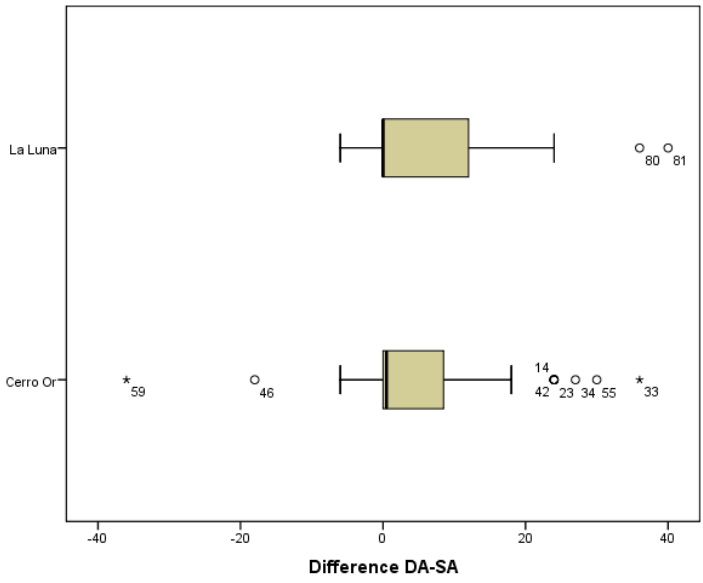

Figure 14- Difference DA and SA Medians by Site

Appendix 1- Skeletal Age (SA)

SPEC	BURIAL	IND	SITE	DIVISION	PHASE	CRANIAL	SUTURE CLOSURE	POST-CRANIAL	SA in Months	SA MIDPOINT
P-193	351	1	Cerro Oreja	Salinar	Salinar	None	Yes- Used	Tibia	69 + 6	69
P-196	629	1	Cerro Oreja	Salinar	Salinar	None	Yes- Used	Femur, Humerus, Radius, Ulna	8 + 2	8
P-208	671	1	Cerro Oreja	Salinar	Salinar	None	Yes- Used	Femur, Tibia, Humerus, Radius, Ulna	42 +_6	42
P-190	739	1	Cerro Oreja	Salinar	Salinar	None	Yes- Used	Femur, Tibia, Fibula	204 + 12	204
P-212	855	1	Cerro Oreja	Salinar	Salinar	BO	Yes- Used	Radius	12 +_3	12
P-204	857	1	Cerro Oreja	Salinar	Salinar	None	Yes- Used	Humerus, Radius, Ulna	54 +_12	54
P-016	865	1	Cerro Oreja	Salinar	Salinar	BO	Yes- Used	Humerus, Radius, Ulna	24 +_3	24
P-017	872	1	Cerro Oreja	Salinar	Salinar	None	Yes- Used	None	< 216	
P-219	883	1	Cerro Oreja	Salinar	Salinar	None	Yes- Used	Humerus, Radius, Ulna	69 +_6	69
P-265	899	1	Cerro Oreja	Salinar	Salinar	BO, PF, LO	Yes- Not Used	Humerus, Radius, Ulna	9 +_3	9
P-255	172	1	Cerro Oreja	Gallinazo	Pre-Structura	None	Yes- Used	None	216 + 24	216
P-325	278	1	Cerro Oreja	Gallinazo	Pre-Structural	BO	None	None	9 +_1	9
	279	1	Cerro Oreja	Gallinazo	Pre-Structural	BO	None	Radius, Ulna	4 +_1	4
	279	2	Cerro Oreja	Gallinazo	Pre-Structural	None	Yes- Used	Tibia, Humerus	60 +_3	60
P-039	307	1	Cerro Oreja	Gallinazo	Pre-Structural	None	Yes- Used	Tibia	48 +_6	48
P-240	391	1	Cerro Oreja	Gallinazo	Pre-Structural	None	Yes- Used	None	12 +_6	12
P-241	392	1	Cerro Oreja	Gallinazo	Pre-Structural	BO, F, LO	Yes- Not Used	Femur, Tibia, Humerus, Radius	9 LM +_1 LM	3
	393	1	Cerro Oreja	Gallinazo	Pre-Structura	None	Yes- Used	None	> 12	
P-242	394	1	Cerro Oreja	Gallinazo	Pre-Structura	None	Yes- Used	None	> 36	
P-243	396	1	Cerro Oreja	Gallinazo	Pre-Structura	BO	Yes- Not Used	Radius, Ulna	6 +_2	6
P-247	410	1	Cerro Oreja	Gallinazo	Pre-Structural	BO	Yes- Used	Ulna	45 + 3	45
P-248	411	1	Cerro Oreja	Gallinazo	Pre-Structural	BO	Yes- Not Used	Femur, Humerus	5 +_1	5
P-249	415	1	Cerro Oreja	Gallinazo	Pre-Structural	None	Yes- Used	Femur, Tibia, Fibula, Humerus, Radius, Ulna	48 +_12	48
P-327	416	1	Cerro Oreja	Gallinazo	Pre-Structural	None	Yes- Used	None	> 72	72
P-328	417	1	Cerro Oreja	Gallinazo	Pre-Structural	BO	Yes- Used	Femur, Tibia, Radius	6 +_3	6
P-329	418	1	Cerro Oreja	Gallinazo	Pre-Structural	None	Yes- Not Used	Humerus, Radius, Ulna	2 +_2	2
P-330	419	1	Cerro Oreja	Gallinazo	Pre-Structura	BO, PF, LO	Yes- Not Used	Femur, Tibia, Fibula, Humerus, Radius	2 +_3	2
P-245	472	1	Cerro Oreja	Gallinazo	Pre-Structura	None	Yes- Used	Ulna	60 +_6	60
	520	2	Cerro Oreja	Gallinazo	Pre-Structura	BO	Yes- Not Used	None	4 +_1	4
P-335	525	1	Cerro Oreja	Gallinazo	Pre-Structural	None	Yes- Not Used	Humerus, Ulna	4 +_2	4
P-254	544	1	Cerro Oreja	Gallinazo	Pre-Structural	BO	None	Tibia, Humerus	6 +_3	6
P-337	590	1	Cerro Oreja	Gallinazo	Pre-Structural	BO	Yes- Used	None	11 +_2	11
P-338	597	1	Cerro Oreja	Gallinazo	Pre-Structura	None	Yes- Used	None	168 +_12	168
P-172	683	1	Cerro Oreja	Gallinazo	Pre-Structura	None	Yes- Used	Humerus, Radius	15 +_3	15
P-258	687	1	Cerro Oreja	Gallinazo	Pre-Structural	None	Yes- Used	Fibula	180 +_12	180

P-257	695	1	Cerro Oreja	Gallinazo	Pre-Structural	BO	Yes- Not Used	None	4 +_ 1	4
	704	?	Cerro Oreja	Gallinazo	Pre-Structural	None	Yes- Used	None	> 24	
P-264	755	1	Cerro Oreja	Gallinazo	Pre-Structural	BO	Yes- Used	None	30 +_ 6	30
P-159	789	1	Cerro Oreja	Gallinazo	Pre-Structural	BO	Yes- Used	Humerus, Ulna	30 +_ 2	30
P-160	739	2	Cerro Oreja	Gallinazo	Pre-Structural	BO	Yes- Used	Humerus	42 +_ 2	42
P-268	796	1	Cerro Oreja	Gallinazo	Pre-Structural	BO	Yes- Used	None	10 +_ 2	10
P-210	809	1	Cerro Oreja	Gallinazo	Pre-Structural	None	None	Humerus	12 +_ 6	12
P-004	823	1	Cerro Oreja	Gallinazo	Pre-Structural	BO	Yes- Not Used	Femur, Tibia, Fibula, Humerus, Radius, Ulna	6 +_ 2	6
P-010	843	1	Cerro Oreja	Gallinazo	Pre-Structural	None	Yes- Used	Humerus, Ulna	48 +_ 8	48
P-280	261	1	Cerro Oreja	Gallinazo	Structural	BO	Yes- Not Used	Radius	6 +_ 3	6
	422	1	Cerro Oreja	Gallinazo	Structural	None	Yes- Used	None	36 +_ 12	36
P-315	457	1	Cerro Oreja	Gallinazo	Structural	None	Yes- Used	None	< 180	
P-319	466	1	Cerro Oreja	Gallinazo	Structural	BO	Yes- Not Used	None	3 +_ 1	3
P-295	479	1	Cerro Oreja	Gallinazo	Structural	BO	Yes- Used	None	42 +_ 3	42
P-296	486	1	Cerro Oreja	Gallinazo	Structural	BO	Yes- Not Used	None	4 +_ 2	4
P-167	487	1	Cerro Oreja	Gallinazo	Structural	BO	Yes- Used	Femur, Humerus	24 +_ 4	24
P-302	505	1	Cerro Oreja	Gallinazo	Structural	BO	Yes- Used	None	24 +_ 3	24
P-289	506	'	Cerro Oreja	Gallinazo	Structural	BO	Yes- Used	None	18 +_ 2	18
P-303	506	'	Cerro Oreja	Gallinazo	Structural	BO	Yes- Used	None	36 +_ 12	36
P-204	511	1	Cerro Oreja	Gallinazo	Structural	None	Yes- Used	None	24 +_ 12	24
P-306	529	1	Cerro Oreja	Gallinazo	Structural	BO, LC	None	Femur, Tibia, Fibula, Humerus, Radius	10 UM +_ 2	0
P-307	533	1	Cerro Oreja	Gallinazo	Structural	None	Yes- Used	Humerus, Radius	69 +_ 6	69
P-306	538	1	Cerro Oreja	Gallinazo	Structural	BO	None	None	8 +_ 4	8
P-311	565	1	Cerro Oreja	Gallinazo	Structural	None	Yes- Used	None	216 +_ 24	216
P-046	635	1	Cerro Oreja	Gallinazo	Structural	BO	None	None	10 +_ 3	10
P-315	642	1	Cerro Oreja	Gallinazo	Structural	BO	Yes- Used	None	10 +_ 3	10
P-316	644	'	Cerro Oreja	Gallinazo	Structural	BO	Yes- Not Used	Radius, Ulna	5 +_ 2	5
P-126	652	2	Cerro Oreja	Gallinazo	Structural	None	Yes- Used	None	> 72	
P-153	757	'	Cerro Oreja	Gallinazo	Structural	BO	None	Radius, Ulna	7 +_ 3	7
P-222	765	'	Cerro Oreja	Gallinazo	Structural	None	Yes- Used	Femur, Tibia, Fibula, Humerus, Radius, Ulna	48 +_ 8	48
P-023	768	'	Cerro Oreja	Gallinazo	Structural	BO	None	Femur, Radius, Ulna	NB +_ 2	0
P-183	801	1	Cerro Oreja	Gallinazo	Structural	None	Yes- Used	None	> 12	12
P-226	2	1	Cerro Oreja	Gallinazo	Post-Structural	None	Yes- Used	Femur, Tibia, Humerus, Radius, Ulna	8 +_ 2	8
P-229	19	1	Cerro Oreja	Gallinazo	Post-Structural	None	Yes- Used	None	9 +_ 3	9
P-231	200	1	Cerro Oreja	Gallinazo	Post-Structural	None	None	Fibula, Humerus, Radius	6 +_ 3	6
P-232	152	'	Cerro Oreja	Gallinazo	Gallinazo	None	None	Fibula	24 +_ 6	24

P-233	209	1	Cerro Oreja	Gallinazo	Gallinazo	None	Yes- Used	Humerus, Ulna	9 +_3	6
P-234	315	1	Cerro Oreja	Gallinazo	Gallinazo	BO	None	Radius, Ulna	5 +_2	5
P-207	455	1	Cerro Oreja	Gallinazo	Gallinazo	BO	None	None	17 +_1	17
P-035	532	2	Cerro Oreja	Gallinazo	Gallinazo	None	Yes- Used	None	> 36	
P-209	852	1	Cerro Oreja	Gallinazo	Gallinazo	None	Yes- Used	None	< 180	
	324	1	Cerro Oreja	Moche	Early Moche	None	Yes- Used	None	< 12	
P11-578	T2	1	La Luna	Moche	Middle Moche	BO	Yes- Used	Fibula, Humerus, Radius, Ulna	12 +_3	12
P11-580	T2	2	La Luna	Moche	Middle Moche	None	Yes- Used	Humerus	12 +_6	12
P11-564	T8	3	La Luna	Moche	Middle Moche	None	Yes- Used	Femur, Tibia, Radius, Ulna	48 +_12	48
P11-561	T7	2	La Luna	Moche	Middle Moche	None	Yes- Used	None	20 +_6	20
P11-545	T11	1	La Luna	Moche	Middle Moche	BO	Yes- Not Used	Femur, Tibia, Humerus	6 + 2	6
P11-544	T12	1	La Luna	Moche	Middle Moche	BO	Yes- Used	Femur, Tibia, Fibula, Humerus	15 +_3	15
P11-577	T13	1	La Luna	Moche	Middle Moche	BO	Yes- Not Used	Humerus, Radius, Ulna	9 +_3	9
P11-574	T14	2	La Luna	Moche	Middle Moche	BO	Yes- Used	Fibula, Humerus, Radius, Ulna	9 +_3	9
P11-575	T14	3	La Luna	Moche	Middle Moche	BO	Yes- Used	Femur, Tibia, Humerus	9 + 3	9
	T15	1	La Luna	Moche	Middle Moche	BO	Yes- Not Used	Humerus	NB +_2	0
	T16	1	La Luna	Moche	Middle Moche	BO	Yes- Not Used	Femur, Tibia, Fibula, Humerus, Radius, Ulna	NB +_2	0
P11-551	T18	1	La Luna	Moche	Middle Moche	BO	Yes- Used	Femur, Tibia, Fibula, Humerus, Radius, Ulna	24 +_12	24
P11-552	T19	1	La Luna	Moche	Middle Moche	BO	Yes- Used	Femur, Tibia, Fibula, Humerus, Radius	9 +_3	9
P11-548	T21	1	La Luna	Moche	Middle Moche	BO	Yes- Used	Femur, Tibia, Fibula, Humerus, Radius, Ulna	27 +_3	27
P11-553	T22	1	La Luna	Moche	Middle Moche	BO	Yes- Used	Tibia, Fibula	12 +_9	12
	T23	1	La Luna	Moche	Middle Moche	BO	Yes- Not Used	Femur, Tibia, Fibula, Humerus, Radius, Ulna	NB +_2	0
P11-546	T24	1	La Luna	Moche	Middle Moche	BO	Yes- Used	Radius, Ulna	9 +_3	9
P11-543	T25	1	La Luna	Moche	Middle Moche	BO	Yes- Used	Femur, Tibia, Fibula, Humerus, Radius, Ulna	24 +_3	24
	T7	1	La Luna	Moche	Middle Moche	PP, Z BO, LO	Yes- Not Used	Femur, Tibia, Fibula, Humerus, Radius, Ulna	NB +_2	0
P11-582	T1	1	La Luna	Moche	Middle Moche	None	Yes- Used	None	24 + 6	24
P11-585	T7	1	La Luna	Moche	Middle Moche	None	Yes- Used	None	18 +_6	18
	E5	1	La Luna	Chimu	Chimu	BO	Yes- Not Used	Femur, Humerus, Radius, Ulna	3 +_2	3
P11-593	E7	1	La Luna	Chimu	Chimu	None	Yes- Not Used	Femur, Tibia, Fibula, Humerus, Radius, Ulna	60 +_12	60
P11-594	E8	1	La Luna	Chimu	Chimu	BO	Yes- Used	Femur, Tibia, Humerus, Radius	30 +_12	30
P11-589	E13	1	La Luna	Chimu	Chimu	None	Yes- Used	None	180 +_24	180
P11-600	E14	1	La Luna	Chimu	Chimu	None	Yes- Used	Femur, Tibia, Humerus	36 + 6	36
P11-601	E15	1	La Luna	Chimu	Chimu	BO	Yes- Used	Femur, Tibia, Fibula, Ulna	12 +_6	12
P11-602	E16	1	La Luna	Chimu	Chimu	BO	Yes- Used	Femur, Tibia, Humerus, Ulna, Radius	18 +_6	18
P11-607	E19	1	La Luna	Chimu	Chimu	None	Yes- Used	None	180 + 24	180

Appendix 2- Skeletal and Dental Age

SPEC	BURIAL	IND	SITE	DIVISION	PHASE	SA in Months	SA MIDPOINT	DA in Months	DA MIDPOINT	Difference DA-S
P-193	351	1	Cerro Oreja	Salinar	Salinar	66 +_ 6	66	60 +_ 16	60	-6
P-198	629	1	Cerro Oreja	Salinar	Salinar	8 +_ 2	8	6 +_ 3	6	-2
P-208	671	1	Cerro Oreja	Salinar	Salinar	42 + 6	42	36 +_ 12	36	-6
P-130	739	1	Cerro Oreja	Salinar	Salinar	204 + 12	204	228 +_12	228	24
P-212	855	1	Cerro Oreja	Salinar	Salinar	12 +_ 3	12	20 +_ 6	20	8
P-204	857	1	Cerro Oreja	Salinar	Salinar	54 +_ 12	54	60 +_ 16	60	6
P-016	866	1	Cerro Oreja	Salinar	Salinar	24 + 3	24	36 +_ 8	36	12
P-017	872	1	Cerro Oreja	Salinar	Salinar	< 216		216 +_ 36	216	
P-219	883	1	Cerro Oreja	Salinar	Salinar	69 +_ 6	69	84 +_ 24	84	15
P-265	939	1	Cerro Oreja	Salinar	Salinar	9 +_ 3	9	7 +_ 3	7	-2
P-235	172	1	Cerro Oreja	Gallinazo	Pre-Structural	216 +_ 24	216	210+_30	210	-6
P-325	276	1	Cerro Oreja	Gallinazo	Pre-Structural	9 +_ 1	9	9 +_ 3	9	0
	279	1	Cerro Oreja	Gallinazo	Pre-Structural	4 +_ 1	4	3 +- 2	3	-1
	279	2	Cerro Oreja	Gallinazo	Pre-Structural	60 +_ 6	60	84 +_ 24	84	24
P-039	307	1	Cerro Oreja	Gallinazo	Pre-Structural	48 + 6	48	48 +_ 12	48	0
P-240	391	1	Cerro Oreja	Gallinazo	Pre-Structural	12 +_ 6	12	30 +_ 12	30	18
P-241	392	1	Cerro Oreja	Gallinazo	Pre-Structural	9 LM +_ 1 LM	0	NB + 2	0	0
	393	1	Cerro Oreja	Gallinazo	Pre-Structural	> 12		24 +_ 8	24	
P-242	394	1	Cerro Oreja	Gallinazo	Pre-Structural	> 36		60 +_ 16	60	
P-243	398	1	Cerro Oreja	Gallinazo	Pre-Structural	6 +_ 2	6	6 +_ 3	6	0
P-247	410	1	Cerro Oreja	Gallinazo	Pre-Structural	45 +_ 3	45	60 + 16	60	15
P-248	411	1	Cerro Oreja	Gallinazo	Pre-Structural	5 +_ 1	5	4 +_ 3	4	-1
P-249	415	1	Cerro Oreja	Gallinazo	Pre-Structural	48 + 12	48	72 + 24	72	24
P-327	416	1	Cerro Oreja	Gallinazo	Pre-Structural	> 72	72	72 +_ 24	72	0
P-328	417	1	Cerro Oreja	Gallinazo	Pre-Structural	8 +_ 3	8	9 +_ 3	9	1
P-329	418	1	Cerro Oreja	Gallinazo	Pre-Structural	2 +_ 2	2	3 +_ 3	3	1
P-330	419	1	Cerro Oreja	Gallinazo	Pre-Structural	2 + 3	2	2 +_ 2	2	0
P-245	472	1	Cerro Oreja	Gallinazo	Pre-Structural	60 +_ 6	60	54 + 12	54	-6
	520	2	Cerro Oreja	Gallinazo	Pre-Structural	4 +_ 1	4	6 +_ 3	6	2
P-333	525	1	Cerro Oreja	Gallinazo	Pre-Structural	4 +_ 2	4	3 +_ 2	3	-1
P-334	544	1	Cerro Oreja	Gallinazo	Pre-Structural	6 +_ 3	6	6 +_ 3	6	-2
P-337	560	1	Cerro	Gallinazo	Pre-	11 +_ 2	11	11 +_ 4	11	0

			Oreja Cerro		Structural Pre-					
P-338	697	1	Oreja Cerro	Gallinazo	Structural Pre-	168 + 12	168	204 +_12	204	36
P-172	683	1	Oreja Cerro	Gallinazo	Structural Pre-	15 +_3	15	42 +_12	42	27
P-256	687	1	Oreja Cerro	Gallinazo	Structural Pre-	180 +_12	180	180 + 36	180	0
P-257	693	1	Oreja Cerro	Gallinazo	Structural Pre-	4 + 1	4	6 +_3	6	2
	704	2	Oreja Cerro	Gallinazo	Structural Pre-	> 24		6 +_3	6	
P-264	755	1	Oreja Cerro	Gallinazo	Structural Pre-	30 +_6	30	36 + 12	36	6
P-159	789	1	Oreja Cerro	Gallinazo	Structural Pre-	30 + 2	30	36 +_12	36	6
P-160	789	2	Oreja Cerro	Gallinazo	Structural Pre-	42 +_2	42	48 +_12	48	6
P-268	796	1	Oreja Cerro	Gallinazo	Structural Pre-	10 +_2	10	24 + 8	24	14
P-210	809	1	Oreja Cerro	Gallinazo	Structural Pre-	12 + 6	12	36 +_12	36	24
P-004	829	1	Oreja Cerro	Gallinazo	Structural Pre-	6 +_3	6	6 +_3	6	0
P-010	848	1	Oreja Cerro	Gallinazo	Structural Pre-	48 +_6	48	48 +_12	48	0
P-280	261	1	Oreja Cerro	Gallinazo	Structural	6 +_3	6	6 +_3	6	0
	429	1	Oreja Cerro	Gallinazo	Structural	36 +_12	36	18 +_8	18	-18
P-318	457	1	Oreja Cerro	Gallinazo	Structural	< 180		> 120		
P-319	458	1	Oreja Cerro	Gallinazo	Structural	3 +_1	3	3 +_2	3	0
P-295	479	1	Oreja Cerro	Gallinazo	Structural	42 +_3	42	48 + 12	48	6
P-298	486	1	Oreja Cerro	Gallinazo	Structural	4 + 2	4	4 +_3	4	0
P-167	487	1	Oreja Cerro	Gallinazo	Structural	24 +_4	24	24 +_8	24	0
P-302	505	1	Oreja Cerro	Gallinazo	Structural	24 +_3	24	24 +_8	24	0
P-299	506	1	Oreja Cerro	Gallinazo	Structural	18 + 2	18	36 +_12	36	18
P-303	509	1	Oreja Cerro	Gallinazo	Structural	36 +_12	36	54 +_12	54	18
P-304	531	1	Oreja Cerro	Gallinazo	Structural	24 +_12	24	54 +_12	54	30
P-306	529	1	Oreja Cerro	Gallinazo	Structural	10 LM +_2	0	NB +_2	0	0
P-307	533	1	Oreja Cerro	Gallinazo	Structural	69 +_6	69	78 +_24	78	9
P-308	538	1	Oreja Cerro	Gallinazo	Structural	8 +_4	8	9 +_3	9	1
P-31*	565	1	Oreja Cerro	Gallinazo	Structural	216 + 24	216	180 +_36	180	-36
P-048	635	1	Oreja Cerro	Gallinazo	Structural	10 +_3	10	9 +_3	9	-1
P-315	642	1	Oreja Cerro	Gallinazo	Structural	10 + 3	10	18 +_6	18	8
P-316	644	1	Oreja Cerro	Gallinazo	Structural	5 +_2	5	6 +_3	6	1
P-126	653	2	Oreja Cerro	Gallinazo	Structural	> 72		102+_18	102	
P-153	757	1	Oreja	Gallinazo	Structural	7 + 3	7	12+_4	14	7

P-322	765	1	Cerro Oreja	Gallinazo	Structural	48 + 6	48	54 + 12	54	6
P-023	768	1	Cerro Oreja	Gallinazo	Structural	NB +_ 2	0	NB +_ 2	0	0
P-183	801	1	Cerro Oreja	Gallinazo	Structural	> 12	12	18 +_ 6	18	6
P-228	2	1	Cerro Oreja	Gallinazo	Post-Structural	8 + 2	8	6 +_ 3	6	-2
P-229	19	1	Cerro Oreja	Gallinazo	Post-Structural	9 +_ 3	9	9 +_ 3	9	0
P-231	200	1	Cerro Oreja	Gallinazo	Post-Structural	6 +_ 3	6	6 +_ 3	6	0
P-232	152	1	Cerro Oreja	Gallinazo	Gallinazo	24 +_ 6	24	48 + 12	48	24
P-233	209	1	Cerro Oreja	Gallinazo	Gallinazo	9 +_ 3	9	9 +_ 3	9	0
P-234	315	1	Cerro Oreja	Gallinazo	Gallinazo	5 +_ 2	5	6 +_ 3	6	1
P-207	455	1	Cerro Oreja	Gallinazo	Gallinazo	17 +_ 1	17	30 +_ 8	30	13
P-035	532	2	Cerro Oreja	Gallinazo	Gallinazo	> 36		36 +_ 12	36	
P-209	852	1	Cerro Oreja	Gallinazo	Gallinazo Early	< 180		132 +_ 30	132	
	324	1	La Oreja	Moche	Moche Middle	< 12		NB + 2	3	
P11-579	T2	1	La Luna	Moche	Moche Middle	12 +_ 3	12	9 +_ 3	9	-3
P11-580	T2	2	La Luna	Moche	Moche Middle	12 +_ 6	12	9 +_ 3	9	-3
P11-554	T6	3	La Luna	Moche	Moche Middle	48 +_ 12	48	84 +_ 24	84	36
P11-561	T7	2	La Luna	Moche	Moche Middle	20 +_ 6	20	60 +_ 18	60	40
P11-545	T11	1	La Luna	Moche	Moche Middle	6 + 2	6	6 + 3	6	0
P11-544	T12	1	La Luna	Moche	Moche Middle	15 +_ 3	15	18 +_ 6	18	3
P11-577	T13	1	La Luna	Moche	Moche Middle	9 +_ 3	9	9 +_ 3	9	0
P11-574	T14	2	La Luna	Moche	Moche Middle	9 +_ 3	9	9 +_ 3	9	0
P11-575	T14	3	La Luna	Moche	Moche Middle	9 + 3	9	9 + 3	9	0
	T15	1	La Luna	Moche	Moche Middle	NB +_ 2	0	NB +_ 2	0	0
	T16	1	La Luna	Moche	Moche Middle	NB + 2	0	NB +_ 2	0	0
P11-551	T18	1	La Luna	Moche	Moche Middle	24 + 12	24	18 +_ 6	18	-6
P11-552	T19	1	La Luna	Moche	Moche Middle	9 +_ 3	9	6 +_ 3	6	-3
P11-549	T21	1	La Luna	Moche	Moche Middle	27 +_ 3	27	24 +_ 6	24	-3
P11-553	T22	1	La Luna	Moche	Moche Middle	12 +_ 9	12	12 +_ 4	12	0
	T23	1	La Luna	Moche	Moche Middle	NB +_ 2	0	3 + 2	3	3
P11-548	T24	1	La Luna	Moche	Moche Middle	9 +_ 3	9	8 +_ 3	8	-1
P11-543	T25	1	La Luna	Moche	Moche Middle	24 +_ 3	24	36 +_ 12	36	12
	T7	1	La Luna	Moche	Moche	NB +_ 2	0	7 +_ 2	7	7
P11-582	T1	1	La	Moche	Middle	24 +_ 6	24	30 +_ 10	30	6

			Luna		Moche					
			La		Middle					
P11-585	T7	1	Luna	Moche	Moche	18 +_ 6	18	30 +_ 10	30	12
			La							
	E5	1	Luna	Chimu	Chimu	3 +_ 2	3	3 +_ 3	3	0
			La							
P11-593	E7	1	Luna	Chimu	Chimu	60 +_ 12	60	72 +_ 24	72	12
			La							
P11-594	E8	1	Luna	Chimu	Chimu	30 +_ 12	30	42 +_ 12	42	12
			La							
P11-599	E13	1	Luna	Chimu	Chimu	180 +_ 24	180	180 +		
			La							
P11-600	E14	1	Luna	Chimu	Chimu	36 + 6	36	36 +_ 12	36	0
			La							
P11-601	E15	1	Luna	Chimu	Chimu	12 +_ 6	12	30 +_ 12	30	18
			La							
P11-602	E16	1	Luna	Chimu	Chimu	18 +_ 6	18	18 +_ 6	18	0
			La							
P11-607	E19	1	Luna	Chimu	Chimu	180 + 24	180	204 +_ 12	204	24

Stock Fading

Ryan Van Spronsen (Business)[1]

Stock fading is a trading strategy that looks to capitalize on short-term opportunities in the market. These opportunities have an optimal closing window of ten business days, as shown by data analysis. The most advantageous fading opportunities are created by daily price percentage gainers driven by 1) financial news, 2) the release of an SEC form 8-K, or 3) no apparent reason for the price breakout, and 4) price percentage losers caused by financial news. Following breakouts of this nature, short positions should be opened for durations of ten business days. Beyond ten days, the correlation between the initial breakout and the current stock price deteriorates due to many additional factors, rendering the strategy unreliable.

The idea behind fading is that when a breakout happens, the emotions of investors cause a run on the market, pushing the stock price past the actual valuation. Following the perfect markets theory, this overvaluation should return back to equilibrium, creating an advantageous opportunity to profit on the discrepancy. This research project's findings suggest that by following these four opportunities, fading will produce an average of 12.68% return every ten days. Compounding this rate of return for the twenty-five periods of this length in a fiscal year, an idealistic 1,608.25% can be returned annually. However, this number does not account for limitations caused by insufficient volume or availability of the securities. Stock fading has concrete supporting data that is rooted in theoretical concepts from both fundamental and technical analysis, which makes it a viable short-term investment strategy for the exceptionally risk tolerant investor.

I. Introduction

Stock fading is a term referring to a seldom talked-about stock trading strategy. The basic idea is that the most outstanding price percentage gains or losses from the previous day will reverse their fortunes in the days following their breakout. My hypothesis is that there is a trend to be uncovered concerning the activity of the market's top price percentage movers in the days following their breakout, based on the publicized news why they spiked in the first place.

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[1] Research performed under the direction of Dr. Cathyann Tully in partial fulfillment of the Senior Program requirements.

II. Methodology and Data Collection

The methodology used was manual data entry for each business day of July 2011 in which the name of the firm, their ticker symbol, the reason for the breakout, closing price, and closing price for the trailing business days 1, 2, 3, 5, and 10 following the breakout were recorded. Data was retrieved using Yahoo! Finance, and the Wall Street Journal Online US Market Statistics page. During a data test group in February of 2011, a similar method was used. This trial indicated possible relationships between relevant news for the breakout compared to stock price movements. Furthermore, it suggested that the correlation between breakout reason and subsequent days' closing price deteriorated beyond ten business days due to new information and developments relevant to each firm. Therefore, the trailing business days one, two, three, five, and ten following the breakout were used for the July 2011 analysis. The top five price percentage movers on both the gainers and losers side for twenty business days produced 100 sets of sample data for both sides, of which 90 gainers were usable and 95 losers were usable. The unusable points are due to the de-listing of stocks for various reasons such as mergers and acquisitions, failing to meet exchange requirements, or privatization. These unusable points did not provide data for some or all of the business days trailing the stock price breakout, so they create a possible hole in the validity of the overall data. One of the major shortcomings is that the number of usable data points for gainers (90) and losers (95) are different, so the overall results cannot be fairly compared. Averaging the price percentage movements in the following days was the next most accurate method of comparison, but still failed to take the weights of the different data points into account.

III. Previous Research

Previous research includes several articles discussing various stock trading strategies and methods. From this wealth of knowledge, basic principles are derived to support the theory behind stock fading and the potential financial gains to be made. Overall, there is a lack of information pertaining strictly to stock fading. This could be for two reasons: 1) the strategy has been tested and holds no validity and has been rendered useless, or 2) nobody publishes their stock fading method because their opportunity to profit would be lost.

Art Collins describes the use of fading the eight-day moving average to exploit biases in stock indexes. He conjectures that "Unlike the Japanese yen, which can trend for months or even years, the [American markets] tend to be mean-reverting. That is, they tend to come back off overextended high or low levels." (Collins, 1) The eight-day method involves taking large deviations from the most recent eight-day's average price of

the stock, then assuming that the volatile spike will revert back towards the eight-day moving average rather than continuing further away from it.

A study conducted by stock researchers in Taiwan used a method of Data Envelopment Analysis to find that they could classify stocks into four categories: Value, Monitor, Speculative, and Avoidance. The most interesting point from their research is as follows:

> The value of a stock purchase depends on whether its price is rational, which is determined by assessing the gap between the stock price and the true stock value. When the stock price exceeds true stock value, it indicates that the stock is overvalued and thus it is not worthwhile to purchase it; conversely, when the stock price is below the true value, the stock is undervalued and so its purchase is worthwhile. Whether a stock price is above or below its true value is a relative concept, and is determined by a firm's financial performance and stock price performance relative to comparable firms and stocks. (Shiuh-Nan, Wang-Ching, Yi-Chieh, 2)

As it pertains to stock fading, the concept of analyzing the gap between market value and true value is very important. It is not logical to assume that a top price percentage mover's true value will change along with the change in market price. Therein will be a gap that can be capitalized on for a profit. The idea that the true value of a firm will change as drastically as their market share price in the same one day period is incorrect, because the market price is influenced by human factors such as supply, demand, and human emotion while the true value of an organization is not. Thus, the previous stock price is a more accurate representation of the true value, rather than the closing price after the volatile spike. Furthermore, an average from multiple previous closing prices, such as the eight-day moving average mentioned previously, will be an even more accurate representation of the firm's true value. Ergo, a spike in stock price does not accurately reflect an equal spike in the firm's true value, which is likely closer to the moving average from previous days. Ceteris Paribus, the market should theoretically correct itself after a spike in price to reflect the true value over time, which will entail a reversion closer to the previous moving average instead of further volatility. This is where fading comes in; buying stocks that were large one-day losers to profit on their return up to the moving average, and short selling stocks that were large one-day winners to profit on their decline back towards the moving average. A study from Ahmed, Schneible, and Stevens of Syracuse University provided evidence of the effects of online trading on stock price and trading volume reactions to quarterly earnings announcements. Their study found that online trading brought an increase of naïve and uneducated investors to

the market, which caused a decrease in average investor competency and therefore more volatility in the overall market. The study's most relevant finding concerning stock fading was that:

> A firm's stock price reaction to their quarterly earnings announcement depends on two major factors: (1) the average precision of pre-disclosure or prior information, and (2) the precision of the earnings. The greater the average precision of predisclosure information, the lower the expected price reaction to the earnings announcement. Intuitively, traders with more precise prior information rely less on the announced information. (Ahmed, Schneible, Stevens, 8)

The reaction severity of the stock price following an earnings announcement depends on investor's prior knowledge, known information, and the precision of the earnings in accordance with professional analyst projections. This means that as more and more investors join the online trading arena, there is an increase in proportionate naive and uneducated investors, which causes a larger reaction to quarterly earnings. The result is a panicked scramble by uneducated investors following out of the ordinary quarterly announcements, which causes human factors such as trading volume, supply, and demand factors to distort the stock price change and amplify the percentage change. This causes a wider gap between market price and true value of the company, as aforementioned. During this process, a wider gap for potential financial gain is created by widening the market-true value spread. Reverting back to the principle that markets correct themselves over time, this gap should be closed over time, which will pull the spiked price back closer to the previous day's moving average. This research reinforces the idea that stock fading theoretically works by taking the human factors of uneducated investors into account, and hints that the advantageous gaps created by uninformed investors will expand as the easily accessible online personal investing industry grows.

IV. Timing

In terms of data collection, the sources and dates have already been discussed. After gathering data, each trailing day was compared to the close on the original day of unusual activity using the formula ((T+n)/T)-1 where T is the closing stock price on the breakout day, n is the number of business days following the breakout, so (T+n) represents the closing price on the business day 'n' days following the breakout. The result is a decimal indicating a percentage change in the stock on the day T+n compared to T. A positive number indicates how much the stock has increased, whereas a negative number indicates how much the stock has decreased compared to T. Upon completion of

the spreadsheet, totals are added and then divided by the number of usable data points (90 gainers, 95 losers) to show the average increase or decrease for each time period. Immediately, a trend can be seen in Figure 1.

	Gainers	Losers
Day 1	0.72%	0.28%
Day 2	-0.27%	-0.32%
Day 3	-0.50%	-0.71%
Day 5	-3.81%	-2.51%
Day 10	-10.83%	-6.95%

Figure 1: Average Returns

Upon breakout, average prices hover within a percent of their breakout price before falling; regardless of whether their breakout was on the positive (gainer) or negative (loser) side. An average decrease of 3.81% and 2.51% are seen on day five by gainers and losers, respectively. More alarming is the average decrease of 10.83% and 6.95% on day ten which suggests there is considerable money to be made by short selling price percentage gainers or losers with a short term focus of ten business days. Again, trial data indicates that a timeframe longer than ten days allows new information and developments to affect the price, so this strategy should only be used within ten business days of the price percentage breakout.

V. Causes of price Jumps

Breaking down the averages shown in Figure 1 into the various reasons for price breakouts provides a clearer picture of advantageous opportunities to invest in. Following completion of the data tables (Tables 1 and 2), five clear reasons appeared to be the driving forces behind the majority of price percentage breakouts: 1) the release of a Securities and Exchange Commission (SEC) form 8K, 2) Quarterly financial releases, 3) Mergers and Acquisitions (M&A) announcements, 4) Drug study results, and 5) drastic price changes driven by no apparent or publicly available news. Typically, stocks that showed a large price percentage increase also had spikes in volume on the same day, but that is due to the scramble of investors mentioned earlier reacting to publicized information that caused the price change. One such recent example of a scramble is the run of investors and customers alike away from Netflix, the popular media-streaming company, after an unfavourable press release concerning customer retention. Analyst

Michael Corty of Morningstar says that "certain stocks dazzle investors because they don't seem to ever go down. But as soon as there's even a whiff of bad news, investors run". (Krantz) He continues to say that "Investors may have bought Netflix because they liked the service. But that strategy often disregards the critical step of valuation, or how much you pay for the shares. The idea that you like the product so you buy the stock is a silly idea. Some people are finding that out for the first time". (Krantz) This is a perfect example of uneducated or uninformed investors causing the market to be more volatile by mass-selling Netflix stock and causing a saturated supply in the market; forcing the price down. Had the public been more aware of the information on a gradual basis or been aware of the decline in Netflix clientele during the one month period leading up to the press release, the price would have decreased gradually instead of 35% in one day because the sudden influx of supply on the market would have been avoided.

Returning to the five main reasons that caused stocks to show extraordinary price percentage changes in July, a summary of the average percentage change on the tenth day following the breakout signals a development of trends in the marketplace following breakouts. Since the tenth day was shown to be the most drastic day of deviation from the spiked closing price, the tenth day is used to compare results of different causes for breakouts.

The first section is news concerning drug studies because it contains the least amount of data points. Of the two stocks that changed due to press releases concerning drug studies, both prices were adversely affected after their breakout day, and both continued their downward trend following the negative breakout. Their average decline after the tenth day is 14.5%, as shown in Figure 2. The probable cause for the continued decline is because market stock prices represent the value of all current earnings and those to come in the foreseeable future. Negative drug trials severely impact the future financial outlook of their company, so this explains the continued decline in stock price.

	% Change	(Tenth day)	% Change	(Tenth day)
Reason	**Gainers**	**Data Points**	**Losers**	**Data Points**
Form 8K	**-11.70%**	13	**-4.29%**	8
Financials	**-14.37%**	19	**-11.40%**	30
M&A	0.94%	19	**-4.95%**	2
Drug	0.00%	0	**-14.50%**	2
No Reason	**-13.27%**	24	**-0.84%**	32

Figure 2: More Average Returns

The second section is stocks that posted large percentage changes for no apparent reason. No information or press releases were available on multiple websites. The trend for gainers in this section is to continue to decline, 13.27% on average, by the tenth day following the breakout. This trend is not nearly as severe when the initial breakout is on the losing side, with less than a percent average decrease by the tenth trailing business day. In terms of stock fading, the 24 data points in the gainers section provides a comparatively solid basis to conjecture that if a stock shows a large percentage gain for no reason, there is a data-supported opportunity to profit by short selling the stock and covering the position after the tenth trailing day. While the thirteen percent is merely an average of the 24 data points, only four of those stocks showed further gains after ten days, which mitigates the risk of taking a loss on the short position.

The third section is mergers and acquisitions causing a large price percentage change. The losers only contained 2 data points, averaging to a 5% loss, but there are too few data points on which to base an argument for effective fading. On the gainers side, 19 data points averaged to an increase of almost one percent by the tenth day, which is not sufficient deviation from the breakout price to justify a short-term investment that contains so much risk. The risk-reward principle suggests that a stock fader's money could be invested more productively elsewhere.

The fourth section is financial news and press releases. Overall, the majority in this section was due to second quarter results because the data was collected in July. This is the most outstanding section as it relates to stock fading. In the gainers section, 19 data points averaged to a 14.37% decrease by the tenth trailing day. Such a large decrease is supported by a high ratio of data points to overall data points, and creates a solid basis to fade stocks by short selling breakout gainers on financial data. If an investor is able to make a fourteen percent gain for themselves every ten days, the yearly return on this strategy is astronomical, and will be shown later. On the financial news losers side, thirty data points averaged an 11.4% loss on the tenth trailing day, which also provides an advantageous opportunity for stock faders. While the average potential to gain is less, this is supported by more data points and adds increased security on which faders can base their investments. Macroeconomic factors may be one of the main underlying causes for the results in the financials section. The current economy seems to be in limbo, and many organizations released Quarter 2 financial data in July that showed profits, but fell short of expectations. This shortcoming causes market prices of stocks to decline because the previous market price or moving average was partially influenced by analyst projections for the fiscal period. The final section prevalent in the data was abnormal price percentage changes due to the release of an SEC form 8K.

VI. SEC Form 8-K

The Securities and Exchange Commission (SEC) form 8-K is "the 'current report' companies must file with the SEC to announce major events that shareholders should know about." (USSEC) In addition to filing quarterly reports, corporations must also disclose certain material corporate events on a more current basis. This increases the transparency of our financial system. Examples of events requiring the filing of an 8-K form are financial information, registrant's business and operations, trading markets, matters related to accounts, corporate governance, asset-backed securities, and financial statements. While this seems like an overload of reports to be filed, the purpose of the 8-K is to report major changes in organizations and pertinent information which will have an effect on investor's behavior. In this way, aggregate market volatility is reduced because quarterly reports do not contain an overload of information causing mass sell-offs or runs on specific stocks. It is critical that organizations maintain compliance by filing the 8-K forms because it keeps investors current on important material events that impact the organization's outlook for the foreseeable future.

VII. Advantageous Opportunities

On the gainers side, an average loss of 11.7% was shown by 13 data points by the tenth day. In terms of the breakout losers, a further decline of 4.29% on average was produced by eight data points. While there is less evidence to support this section than two previous sections, there is still a large enough reward for shorting the breakout gainers to justify the increased risk of less data points. In terms of losers, eight data points may not be worth the potential average gain of four percent compared to higher potential and more supporting evidence found in other sections.

In summary, certain reasons for breakouts provide more concrete supporting data and higher returns that appear to justify the risk a fading investor would take on. Three of the four opportunities appear after a stock posts a large price percentage increase. On average, 11.7% can be made in ten days by shorting gainers driven by the release of an 8K form. Similarly, 14.37% can be made in the same timeframe by shorting gainers due to financial news. Lastly, 13.27% can be made by shorting gainers with no apparent reason or information pertaining to the gain. These are all perfect examples of stock fading that now have empirical evidence to support the theory. The final opportunity to make money is by shorting price percentage losers driven by financial news. This case is contrary to the stock fading theory, because the losing trend is continued. However, with this evidence of sustained decline in market price, there is still an opportunity to profit from capitalizing on the proven trend. The data suggests that an

average of 11.4% can be made from short selling the price percentage losers driven by financial news within a timeframe of ten stock exchange trading days.

VIII. Sector Conclusions

To conclude the sector discussion, the best time to initialize a stock fading strategy is immediately following a price breakout, whether on the gaining or losing side. From the breakout day's closing price, the largest price percentage movements are found, on average, ten business days following the breakout. This tenth day is the optimal point to close out the fading position. There are four main advantageous opportunities to profit from fading stock breakouts. All four are capitalized on by taking short positions. If there is a positive breakout driven by the release of an SEC form 8-K, financial news, or no apparent reason, or if there is a negative breakout driven by financial news, shorting any of these breakouts will result in investor profit after ten days. The average return gained by each reason is outlined in figure 2, and the average return of those four averages is 12.68%. The implications of this number are significant; following the four strategies outlined above will produce a 12.68% return every ten days. This figure is astronomical compared to the S&P 500 index's average annual return of 8-10%. As long as the correct information is available pertaining to the primary reason for a price breakout in either direction, a stock fader has the opportunity to profit on the forecasted price movements in the following days. Fading will not always produce the desired results. However, the four reasons for price breakouts previously discussed will produce the most credible data for maximizing the consistency of a short-term return. If these four methods are invested in equally, fading has the potential to produce an average of 12.68% return in each ten business day period. Noting that these results are not consistent is important when considering the sample calculation about to be shown, because compounding the different returns will inflate or deflate the final annual return, depending on each ten days' results.

IX. Potential Return

If 12.68% return every 10 business days holds true for an annual fiscal period, there are 25 turnover periods in a year containing 10 business days. For example, if an investor started with $1,000, and paid the typical online trading fee of $9.99 per trade, they would multiply their money by 12.68% , or 1.1268 every period (minus the trading fees). After 25 compounding periods with this decimal, the original thousand dollars will be worth $16,082.5, for an annual return of 1,608.25%. This is an unheard of annual return. If the same holds true and no money is withdrawn from the account, the original thousand dollars grows to $316,404.27 after the second year. These are obviously optimal

numbers; therefore an alternative calculation was created for a worst-case scenario. Instead of using idealistic numbers, the worst case numbers according to the data are used for the alternative calculation. A ten-day return of 11.40% is combined with a double online brokerage fee of $9.99; once for opening the position, and once for closing. The results remain staggering compared to traditional annual market returns. The one-year return is 1,093.29%, and after two years the original value of $1,000 is valued at an astounding $159,797.50. Notice the magnitude of the difference between the two scenarios. The best-case is almost double the worst-case after only two years. This discrepancy underscores one of the flaws of stock fading; an unknown factor of investor return, which hinders investor ability to plan for the future, and therefore represents risk in and of itself. This point leads to further limitations of the strategy.

X. Limitations

The shortfalls associated with stock fading are few, but they are imminently present within most fading opportunities. Due to the nature of the initializing price jump, it is far more likely that smaller and lesser-known organizations' stock prices make out-of-the-ordinary price percentage changes in one day. This is because they are less "sturdy" stocks, and generally have lower prices. This makes significant news very influential on the stock price, and low-volume stocks can be overwhelmed with demand, which exacerbates the price inflation. Since many price percentage leaders are penny stocks- stocks with a market price under $5 per share, there are often very low levels of relative trading volume held by these stocks. This can hinder an investor's ability to open positions of the desired magnitude in these stocks. One example is WowJoint Holdings Ltd, trading under the symbol BWOWU. This stock has an average daily trading volume of 1873 shares per day and a trading price consistently under 60 cents per share (wsj.com), thereby limiting investors to opening maximum positions of around $1,000. This increased volume alone will have an effect on the price. Volume limitations such as BWOWU are common amongst the penny stocks that appear in the top five price percentage daily movers. Therefore, the theoretical opportunities outlined previously are bound by these constraints. Stock faders must select their positions with this in mind, which limits the traders' options. The availability of these smaller stocks is also an issue, as large stakes purchased in small cap corporations may cause the investor to become one of the larger investors in the company, which some boards have restrictions in place to prevent. If majority shareholder status is gained by opening a large position in a small cap company, the fader would essentially take control of the stock price for the short term ten day period intended to close the position. Ergo, stock faders must be aware of the volume of stocks that appear on the price percentage movers list, and select their opportunities

accordingly. Higher volume means easier accessibility and freedom to close the trade at will, and keep the effects of the fading position minimal in terms of shareholder percentage.

XI. Connecting Fundamental and Technical Analysis

Historically, advocates of fundamental analysis have never gotten along with advocates of technical analysis. Fundamentalists look at the inner workings or corporate organizations. “Also known as quantitative analysis, this involves looking at revenue, expenses, assets, liabilities, and all the other financial aspects of a company.” (McClure) On the other hand, technical analysis ignores the ‘value’ of a stock. Instead, technical analysts “are only interested in the price movements in the market. Despite all the fancy and exotic tools it employs, technical analysis really simply studies supply and demand in a market in an attempt to determine what direction, or trend, will continue in the future.” (Janssen, Langager, and Murphy) The difference in methodology creates a friction between the two groups of thought, and many fundamentalists view technical analysis as ‘hocus-pocus’, due to the lack of quantitative evidence to support investment decisions. Technical supporters attempt to understand the emotions behind the market by studying the overall market, rather than individual market components or corporations.

The underlying principles of stock fading are rooted in both of these analytical methods. On the fundamental side, large price breakouts are not supported by fundamental analysis because it is impossible for the long-term valuation of a stock to be upwards of 25% different from day to day. The valuation grows over time; not overnight. Therefore large price percentage increases are not supported by quantitative evidence, so the fading notion should hold true: gainers should come back down, and losers should regain a portion of their loses. On the technical side, breakouts are driven partly by news developments, and partly by the emotions of investors making a run on a particular stock. Due to the emotional factor, market sentiment changes on a day-by-day basis, so breakouts should reverse their fortunes in subsequent trading days as the initial ‘honeymoon’ factor of the breakout wears off. Furthermore, one of the tools that technical analytics employs is the use of Bollinger Bands, which are indications of “whether prices are high or low on a relative basis.” (Bollinger) This ‘relative basis’ is important because it relates each stock to other stocks in the industry, as well as previous performance. A combination of horizontal and vertical analysis, the Bollinger Bands suggest that as stocks ‘push the envelope’ of the bands in either direction, they will recede to a less extreme position in the near future. The Bollinger Bands also give a visual aide that shows a trading range for each stock. There is a band on the top and a band on the bottom of this range, suggesting a limit to the stock’s relative value. The

nature of breakouts tracked for fading purposes almost always pushed the market value of the stocks beyond this limit, so it was no surprise when the fortunes were reversed and the stocks fell back into the Bollinger trading range. (wsj.com) Day-to-day valuation consistencies and Bollinger Bands are a great example of how stock fading blends the theoretical concepts from fundamental and traditional analysis to show daily advantageous opportunities in the stock market.

XII. Conclusion

In conclusion, stock fading is a short-term trading strategy that capitalizes on discrepancies between actual valuations of organizations and the ramifications of overall investor emotions. The optimal time period to execute a fading strategy is ten business days from opening to closing a position. Specific reasons for price breakouts are the determining factor when deciding which opportunities should be pursued. If price percentage gainers for a given day are driven by the release of an SEC form 8-K, financial news, or the breakout occurred for no apparent reason, then stock fading should be initialized by opening a short position in the equity. Similarly, if a negative price percentage leader is driven by financial news, a short position should be opened. Essentially, current market conditions and macroeconomic health indicate that most financial releases undercut analysts' predictions, which is why stocks driven by financial news see a significant aggregate decline in the ten days following the press release. This research project shows that by basing a trading strategy on these four opportunities, stock faders can receive an average return of 12.68% every ten business days. By compounding this figure for the twenty-five ten-day periods in a business year, this strategy returns an idealistic 1,608.25% in annual return. A less optimistic calculation still returns 1,093.29% annually, which means that stock fading is a strategy that should not be overlooked. While the strategy has limitations such as availability and volume constraints, it remains a viable option because it has concrete supporting data that is theoretically rooted in both fundamental and technical analysis.

XIII. References

Ahmed, A. S., & Schneible, R. A., & Stevens, D. E. (2003). "An Empirical Analysis of the Effects of Online Trading on Stock Price and Trading Volume Reactions to Earnings Announcements." *Contemporary Accounting Research*, 20(3), 413-439. Retrieved from EBSCO*host*.

Bollinger, John. "Trading Bands". *Bollinger.com*. Article, Available Online. Dec. 4, 2011: http://www.bollingerbands.com/services/bb/

Collins, A. (2008). “Going with one average, fading another.” *Futures: News, Analysis & Strategies for Futures, Options & Derivatives Traders*, 37(13), 36-39. Retrieved from EBSCO*host*.

Diether, K. B., Lee, K., & Werner, I. M. (2009). “Short-Sale Strategies and Return Predictability.” *Review of Financial Studies*, 22(2), 575-607. Retrieved from EBSCO*host*.

Jacob, N. L., & Smith, K. V. (1972). The Value of Perfect Market Forecasts in Portfolio Selection. *Journal Of Finance*, *27*(2), 355-369.

Janssen, Langager, and Murphy. “Technical Analysis: Introduction”. *Investopedia Article*. Available Online. Dec. 4, 2011: http://www.investopedia.com/university/technical/#axzz1fUkmDTZ8

Krantz, Matt. News article: “Netflix stock plummets 35%.” *USA Today.* October 26, 2011.

McClure, Ben. “Fundamental Analysis: Introduction.” *Investopedia Article*. Available Online. Dec. 4, 2011: http://www.investopedia.com/university/fundamentalanalysis/#axzz1fUkmDTZ8

Shiuh-Nan, H., Wang-Ching, C., & Yi-Chieh, C. (2010). “Formulate Stock Trading Strategies Using DEA: A Taiwanese Case.” *INFOR*, 48(2), 75-81. doi:10.3138/infor.48.2.075

USSEC Staff. “Form 8-K”. *United States Securities and Exchange Commission.* Corporate Website. Available online. Nov. 30, 2011: http://www.sec.gov/answers/form8k.htm.

XIV. Daily Manual Data Retrieval

Wall Street Journal. U.S. Indices Historical Market Stats. Record of price percentage gainers. Available online, July-August 2011: http://online.wsj.com/mdc/public/page/2_3021-gainnysegainer.html?mod=topnav_2_3000

Wall Street Journal. U.S. Indices Historical Market Stats. Record of price percentage losers. Available online, July-August 2011: http://online.wsj.com/mdc/public/page/2_3021-losenyse-loser.html?mod=topnav_2_3021

Yahoo! Finance. Daily summary of largest price % gainers on all U.S. stock indexes. Available online, July-August 2011: http://finance.yahoo.com/gainers?e=us

Yahoo! Finance. Daily summary of largest price % losers on all U.S. stock indexes. Available online, July-August 2011: http://finance.yahoo.com/losers?e=us

Section IV:
Critical Essays

Antoni's Touch: The Body and The Family in Janine Antoni's Work

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A chewed chunk of lard, a bucket of hair dye, an imprint of a nipple, a silver cast sculpture of the mouth: Janine Antoni uses such objects, along with meticulous analysis of the body, to convey messages about family, femininity, and the role of motherhood. Some of her productions, including *Gnaw* (1992), *Loving Care* (1993), *Wean* (1990), *Momme* (1995), *Cradle* (1999), and *Umbilical* (2000) are particular manifestations of Antoni's use of the body or view of family. It is evident through these oftentimes personal works that she is not critical of the gender role ascribed to women by society, but rather embraces the position she holds as a woman and mother in contemporary culture. Contemporary women artists have often been categorized as essentialist or constructionist; Janine Antoni, in fact, belongs to neither of these categories. A reading of her works with a concentration on themes of the body, family, and gender roles reinforces such an assertion.

Antoni's unique perspective was shaped by her early life circumstances. Born in Freeport, Bahamas in 1964, the artist was raised in a Catholic home with her parents. Her mother, an investment consultant, and father, a plastic surgeon, supported her in various artistic pursuits, including 11 years of dance classes (Larson 1). After being sent to a Catholic boarding school in Florida in 1977, Antoni attended Sarah Lawrence College in New York, where she received a Bachelor of Fine Arts degree (Heartney 15) (Dreishpoon 1). Following her undergraduate career, she studied at the Rhode Island School of Design. In 1989, she received the Masters of Fine Arts in sculpture from the Rhode Island school. Throughout these formative years, Antoni became absorbed in the issues surrounding contemporary women and the female body. The artist recurrently deals with ideas of femininity by taking quotidian objects and actions that are easily identifiable as cultural and gender signifiers and redefining them for her own use (Lindner 3). Currently, she lives in New York City with her husband, contemporary artist Paul Ramirez Jonas, and continues to explore art in innovative ways. After giving birth to a daughter in 2004, Antoni has been even more concentrated on family dynamics and femininity today

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(Dreishpoon 1-3). From her earliest work to her present day undertakings, these themes have been consistently confronted in her art.

Continually recognized for her contribution to the art world, Antoni cites several past cutting-edge women artists as inspirations for her own creations within performance, sculpture, and photography. Feminist performance art of the 1970s and onward, feminism, conceptualism, abstract expressionism, classicism and minimalism have acted as stimuli for the artist's oeuvre. Specifically, artists Louise Bourgeois, Eva Hesse, Barbara Kruger, Sherrie Levine, Ana Mendieta, Cindy Sherman, and Hannah Wilke have been cited by Antoni as influential (Lindner 11). Similarly, many of their works, like that of Antoni, demonstrate their concerns with the body, femininity, and beauty (10). Antoni acknowledges the artistic and social choices she can now decide upon were unavailable to her predecessors and this matrilineage has permeated the concepts in her own work. For example, such a connection can be seen in her *Loving Care* (1993) performance, frequently compared to Ukele's 1969 *Maintenance Art* (Lindner 13).

Over the course of her career, the artist has presented internationally; Antoni has displayed solo exhibitions in North America and Europe and been a part of group shows in North America, Europe, Asia, and Africa. She has been featured in the Whitney Biennial, New York City, the Venice Biennale, International Istanbul Biennial, Museum of Contemporary Art Biennial, South Korea, and Johannesburg Biennale, South Africa, among others. Antoni is a recipient of the MacArthur and Guggenheim fellowships and is internationally regarded as one of the most important contemporary artists (Dreishpoon 1).

The Body

It is apparent through Antoni's present oeuvre that the utilization of the body has been essential in the production of the artist's work. Through bodily examination and experience, the artist has created *Gnaw* (Figure 1) and *Loving Care* (Figure 3), two of several pieces which analyze the capability of the body. For Antoni, the body is a tool; "By setting up situations that force her body into lithe contact with malleable materials and spaces, she establishes tongue, eyelashes, and hair as evocative replacements for chisels, pencils, and brushes," (Horodner 48). In many instances, Antoni has attempted to "push the body to physical limits" and for the aforementioned work *Gnaw*, was intrigued by the "bite because it's both intimate and destructive" (Weintraub 125 & 126). Furthermore, the artist prefers to use the body because it provides an opportunity for self-revelation throughout the art-making process. She states:

> When my work takes my body to a physical and sometimes psychological extreme, it becomes a complex relationship. It makes me face certain things about myself which are hard to deal with; I find

> something incredibly valuable about bringing the body to that edge. Something happens physically in the work, but also psychologically that I believe in and count on. There is a point where I'm actually feeling the repercussions of the object on my body. My hope is to have that happen psychologically as well. Then it's almost like the ideal relationship- not only in art. […] Because my work is repetitive and accumulative, many people ask me "When do you know something is done?" It has nothing to do with the way it looks or formal composition. It's done when the work embodies the complex relationship (Horodoner 51).

Gnaw, executed in 1992, is a quintessential manifestation of Antoni's work with the body. When describing the execution of *Gnaw*, she stated that "rather than describing the body, I would use the body, my body, as a tool for making art," (Lindner 22). As Figure 1 demonstrates, the sculptural artwork has been altered by Antoni's persistent gnawing. Two bulky 600 pound cubes, one of chocolate and the other of lard, function as representations of the artist's body. Although Antoni does not literally depict the physical body, the traces of missing chunks and bite marks remind the audience of the body's presence and effort. As Findlay describes, Antoni's "warm trace reveals the body yet conceals it" (14). The work was an arduous process, involving the construction of the blocks through stacking, heating, and cooling thin layers of each material. Naturally after the construction process, Antoni "carved" the media using her mouth as her primary utensil (Weintraub 125).

"She navigates between a raw, female, primal desire to gnaw as a means of knowing (as a baby puts things in its mouth to explore them, and as Eve bit the apple) and as a culturally structured expression of (sexual) desire in candies and red shiny lips" (Heon 5). *Gnaw* highlights the body and extends its function to cultural and social discourse. After Antoni gnawed at the chocolate and lard, she decided to use the chewed remnants to form 45 heart-shaped packages for chocolate and 400 lipsticks made with pigment, beeswax and chewed lard, removed from the lard cube (Luhring Augustine Gallery). Called *Lipstick/Phenylethylamine Display* (Figure 2), Antoni was not necessarily critiquing notions of beauty and contemporary rituals, but calling attention to the irony of consumer culture, which "chews up and then spits out what it values and discards what it does not" (Lindner 19). The lipstick symbolizes the cultural expectations of beauty, its social value, great appeal, and practice that accompany its existence. In contrast, the unattractive cubes of lard and chocolate are undesirable materializations of things bordering on the grotesque. "There is a tension, a friction if you like, between what attracts and what disgusts" (Findlay 15).

Another work which uses the body to a great extent is *Loving Care* (1993) (Figure 3), a performance piece. The work involved the artist mopping the gallery floor with her own hair, which had been dipped in hair dye. When interviewed about the performance, she said she was interested in figurative sculpture and decided that instead of "just describing the body," she would use the body as a tool (Larson 1). Like *Gnaw,* the remnants of *Loving Care*- a painted floor- are indicative of her bodily presence. In terms of performance and using the body, the artist wanted to "think in terms of dance," specifying that the act of mopping the floor "is the opposite of ballet." The artist does not prefer doing performance art because of its vulnerability and power, but appreciates the energy of executing such a piece. Antoni is intrigued by the imagination of the viewer, which was certainly sparked by *Loving Care* (Lindner 8). About the performance, Antoni asserted it was "about trying to be the model and the master at the same time." Moreover, she alluded to the notion of "painting with the model" instead of "painting the model" (1 &2).

Some have also interpreted *Loving Care* as a manipulation of an ideal of beauty or a greater statement about the mark of a woman (Zeglin Brand 6). Antoni stated: "It's really important you look at my work and know a woman did it" (Larson 1). *Loving Care* also pays homage to contemporary women artists before her, like the pioneers of feminist performance art- Caroline Schneeman, Hannah Wilke, and Mierle Laderman Ukeles. Antoni notes "I'm aware I'm not from the generation of women that mopped the floor…I'm getting choices now that they didn't have" (2). Perpetually tying her creations to femininity and even family, the artist chose a dye shade which matched her mother's own hair color, "Natural Black." Furthermore, the brand matches the title of the work, a fitting name for the link between the work, the artist's mother, and the domestic action (Lindner 16).

One of the important and sometimes overlooked aspects of Antoni's perspective derives from her religious background. Raised with Catholic affiliation, Antoni's primary lessons about the body were established from the conservative religion. She has stated: "I grew up Catholic and have been studying my whole life. I've secretly felt that all my art at some level came from that place" (Horodoner 53). The themes she addresses- birth, motherhood, and transformation- are each found in the narrative of the religion's scripture and teachings. Antoni has noted an affinity for bodily function in terms of Catholicism. "I like the idea of eating, the notion of incorporation and for that matter, communion…Then there is the washing, which brings us to Baptism and holy water, not to mention Mary Magdalene drying the feet of Christ with her hair" (Heartney 15). Though not a direct impact, the omnipresence of Catholicism in Antoni's life can

undoubtedly be observed within her art. The tactile act of consuming communion, the matrilineage of Mary and Anne, and Mary Magdalene's hair can be compared to consumption in *Gnaw,* family in *Momme*, and hair in *Loving Care.*

Antoni's work tends to overlap the overarching themes of the body, femininity, and family. In *Gnaw* and *Loving Care,* the intervention of the body is obvious, however there are latent ideas about beauty and connections with Antoni's mother beneath the chocolate and hair dye. It is important to note that the artist's focus on the bond between mother and child acts as a reminder that a child's first connection to the outside world is through the mother's body. Through non visual sensations, such as touching, suckling, and smelling- all senses Antoni acts upon in the aforementioned and proceeding works- a child is first introduced to the world. Antoni's work is in large a measure to return to this kind of knowing, a knowledge of the world through the body (Heartney 18). Touch is the earliest sense formed in the human embryo, and our ability to relate through touch allows for a deeper connection with the works that Antoni has touched (Findlay 15). *Wean, Momme, Cradle,* and *Umbilical* all encompass some form of bodily intervention, and deal with notions of motherhood and birth on an even greater scale.

Birth, Motherhood and Family

Wean (1990) (Figure 4) is a display of negative imprints made from plaster impressions displayed on a wall. There are six evolutionary imprints: the first from the left is an imprint of the artist's breast. The next is of her nipple and the three following are impressions from the artificial latex nipple of a baby bottle. Finally, the sixth imprint is an imprint of the package of the baby bottle nipple from the side- a sort of "cross-section" impression. Considered by Antoni as her "first major breakthrough," *Wean* provides commentary about motherhood through unsurprising utilization of the body (Horodoner 8). The artist explores the separations from our own bodies, exhibiting the process of "weaning" from the mother's nipple to the artificial baby bottle (Findlay 15). The concept is reinforced by the negative impressions; they emphasize the absence of the breast, nipple, and artificial nipple.

Although the separation process can be depicted in a number of ways, Antoni carefully chose the breast, a typically sexualized body part to express the abstraction. *Wean* presents an image women are able to easily recognize, encouraging them to "create…a matrilineage outside of their own, outside the privilege of the phallus and patriarchal culture" (Lindner 58). Rooted in feminism, the sculpture was primarily produced for the female population. Only a mother could truly identify with the experience of birthing, nursing, and the physical independence and codependence

associated with each event. *Wean* is considered one of the most crucial of Antoni's creations because it is often acts as a reference point for subsequent pieces, namely *Cradle* and *Umbilical*.

Antoni's 1995 photograph *Momme* (Figure 5) is a unique piece which addresses motherhood and the overall parent-child relationship. *Momme*, measuring 35" X 29 1/3," appears at first glance to be a very serene piece (Luhring Augustine Gallery). The composition consists of an image of a woman, Antoni's mother, seated on a refined settee in a plainly decorated room. She looks out a window that provides a great deal of sunlight into the room, a light only matched by the quiescent, white floor length dress Antoni's mother wears. It is the attention to the dress which startles the viewer and distorts the sedate nature of the picture. Peeking out of the subject's dress are three feet: two belong to the artist's mother and the other belongs to the artist. Eerie and unnatural, Antoni's foot is not the only allusion to matrilineage; on the table alongside the subject's seat is a frame which displays the artist's maternal grandmother (Heartney 16).

Momme presents quite a clear message about the eternal need for the mother; the artist, although fully grown, still hides underneath her mother's dress as a child might do. The mother and daughter are reunited physically and psychologically, almost in the same way they were united for nine months of pregnancy. The notion is again mirrored in Antoni's mother's display of a picture of her own mother. Embedded in the matrilineage portrayed in the image is the theme of femininity. While describing the piece, Antoni has revealed her attraction toward the theme: "There's always the temptation to hide behind…femininity because it still works" (Princenthal 127). *Momme* epitomizes Antoni's exploration of the roles of motherhood and childhood in the same setting.

Cradle (1999) exemplifies a different approach to familial commentary. Created from two tons of steel, the work is a bulldozer bucket filled with six subsequently smaller "scooping" objects such as shovels and spoons. Each object is cradled and cradles the next smaller object. *Cradle* (Figure 6) was made from a construction tractor bucket cut in half, with one half forming the outer vessel and the other eight parts made from the melted down metal of the other half. Paradoxically, the artist alters an object that functions to destroy, into an object of nurture. "Each piece acts as the host for the previous piece, and each symbolically represents the functions of carrying, holding, giving, serving, and feeding—all of which closely parallel the caregiving actions of motherhood" (Lindner 62). According to Princenthal, Antoni here focuses on "themes- like birth for example- that cry out for viscera and spilt blood" (125). *Cradle* demonstrates the artist's "avoidance of mess" despite the expression of such organic and emotional content through cold metal material.

Not unlike *Wean*, *Cradle* confronts notions of separation and nurture. The smallest of the objects is a baby spoon, certainly an allusion to nurture. The cast objects are an agricultural bucket, an escalator bucket, a snow shovel, a garden shovel, a fireplace shovel, a serving spoon, a soupspoon, and a baby spoon (Lindner 62). As the objects progress in size, motherly assistance is no longer necessary; the baby spoon makes way for the soupspoon, therefore connoting independence of the individual and separation from the mother. It can even be suggested that *Cradle* is a continuation of *Wean* in the development of the child. From breast feeding to bottle feeding to the use of a spoon, the development of a child lessens the bodily connection to the mother.

Umbilical (2000) is probably the most obvious representation of the mother-child relationship. Shown in Figure 7, the work is a cast of the artist's mother's hand imprint attached to a spoon, attached to Antoni's mouth. Produced from silver, the sculpture outwardly represents one of a mother's most important tasks and displays the physical connection which symbolizes the emotional and familial bond as well; it can even be considered a magnification and extension of *Cradle*. The expensive and durable medium too conveys the significance of a mother feeding her child. Described by Lindner as a "relic," *Umbilical* can be likened to fossil cast in silver; it is also compared to precious family keepsakes (63).

Umbilical is a combination of the artist's personal history, art history, psychology, and biology (Princenthal 125). The spoon is actually a replica of a piece of family silverware, finished with the family pattern and monogram, suggesting the ever-present theme of family lineage. The title reminds its viewers of the physical, and even emotional, connection between the mother and child. Lindner proposes that *Umbilical* is about independence: "As the biological umbilical is cut, and the child is weaned and learns to feed itself, it becomes independent of the mother. While the physical bonds weaken, the emotional bonds strengthen; made manifest in silver, the bonds are durable and cannot be severed; her mother's willingness to participate is also notable in its affirmation of this bond's strength (63-64)."

Essentialism and Constructionism

A thorough examination of Antoni's work that most predominantly encounters themes of mother-child relations, femininity, and the body, proves that Antoni does not stand as an essentialist or constructionist. According to Heartney, the 1980s marked an era when the approach to feminist art split into two discernible categories (10). Since then, contemporary women artists have often been placed into the "Essentialist" or "Constructionist" groups. Either group differed in their perspective on gender and the

political implications of the body (11). The essentialists pursued the existence of a "distinctive female nature grounded in women's unique relationship to her body" whereas the constructionists were founded in the belief that "gender was simply a 'social construct,' and that the assertion of a unique female identity actually reinforces social conventions that contribute to societal conventions of female inferiority" (11). Although Antoni seems to confront these issues, especially because feminism has acted as a root for her artwork, she does not take a clear stance on women's position in society. She has appeared to accede to the role ascribed to the gendered population.

Antoni is not an essentialist. Essentialists supported the celebration of female sexuality through positive images of the female body created by female artists (Heartney 11). Antoni does celebrate the female body and, as exhibited, has used it multiple times to convey various rather positive messages. She does not, however, ever really delve into the glorification of female sexuality. In fact, she has substituted the function of traditionally sexualized body parts to act for non-sexualized purpose. This transformation is distinct in *Wean. "*The breast—a conspicuously objectified symbol of woman—is represented in *Wean* as the human, functional body part it is, alongside its machine-made substitute" (Lindner 57). If the impression of the breast and the nipple are at first viewed in a sexual way, that very viewpoint is immediately re-contextualized when the latex nipples come into view. The natural breast and nipple act as a contrast to the latex nipples and their packaging, "which put cultural signifiers of the sexualized feminine and the nurturing maternal in conflict with each other" (57). This allows viewers to speculate about their own notions of what symbolizes Woman and Mother, and why society usually separates the two roles (57). Furthermore, Antoni rarely explicitly depicts the body, abandoning the actual female form and replacing it, rather, with traces of its presence.

Antoni is not a constructionist; she does not confront the issue of women as the inferior, as Heartney's definition indicates. It can even be argued that she depicts women with great reverence, especially alluding often to her mother and the significance of a woman's role. The artist's work does not align with Poovey's explanation as well. Poovey has written that deconstruction, in its simplest terms, states that "woman" is only a social construct that has no basis in nature, that "woman," in other words, is a term whose definition depends upon the context in which it is being discussed and not upon some set of sexual organs or social experiences (52). Antoni, in fact, does define "woman" and explores the many physical, emotional, and gender role aspects of the term. She even shares a concern for her peers; about *Gnaw* she revealed "I satirize the women at home binging. I laugh at myself. It is important to release that…I'm enacting what I'm worried about in my society" (Weintraub 127). Lindner asserts that constructionists were

"afraid of the biologistic implications and dangers of the body" (26). The artist certainly does not "shy away" from the potential of the body, as can be extracted from any of the aforementioned works. Antoni is fully interested in the biological aspects of the body, as shown most prevalently in *Gnaw*, *Wean,* and *Umbilical* specifically. The artist is welcoming of the potential "dangers" of the body too; binge eating, for example, associated with *Gnaw* was embraced by the artist despite its negative connotation.

Conclusion

How, then, can Janine Antoni's art be categorized? It certainly can be situated under the larger umbrella of feminism, however, it would be an over-simplification to adopt any one label for the dynamic artist. She concentrates on the role of women, but does not necessarily criticize inequality or make arguments against societal norms, as an essentialist or constructionist might seek to do. Her artwork celebrates matrilineage and the feminist artists who have worked before her. Antoni has verbalized a belief in female equality (Heartney 21). Progressively, she has stated "I am looking at the split between my mother's generation and mine…She was a victim of certain ideas of beauty. I am trying to dispel them because they are a problem in my life" (Weintraub 127). Antoni has affirmed her debt to early feminist artists: "The humor, the process, the emphasis on performance, the intensely visceral quality of their work. It was necessary for the 80s feminists to exist for me to 'return' to the 70s. The 80s feminists used a language that was already respected, and they put their content in it, whereas the 70s feminists were much more extreme, and they paid for it by being dismissed" (Lindner 11). Undoubtedly, the artist will continue to carry on with an overall feminist agenda.

From the beginning of her career, Janine Antoni has expressed an interest in the body, femininity, and familial roles. The endless cycle of chewing and spitting out in *Gnaw* and the execution of a traditional domestic chore in a completely novel way in *Loving Care* exemplify the innovative ways in which the artist has produced artwork. In addition to paying homage to earlier contemporary women artists, these works comment on femininity in our contemporary culture in the same way Antoni's *Wean*, *Momme*, *Cradle,* and *Umbilical* do. Paired with the recognition of the significant job of motherhood and the mother-child connection, these themes seem to perpetuate the artist's present oeuvre. Through the lens of Catholicism, Antoni's work can be understood on a religious level and assists in the understanding her own comprehension of the body.

The impulse to categorize the contemporary works of Janine Antoni is futile because her work seems to refute any clear definition of "essentialist" and "constructionist." Her work is fundamentally feminist and not representative of any sub-class of the movement.

Widely celebrated and internationally displayed, Janine Antoni still remains unpredictable and only time will reveal the new methods she will use to discover femininity, family, and unquestionably, the body. In regards to her future works, Antoni has left us with the following:

> The thing I am interested in right now is the experiential. I am exploring how to communicate through experience…My goal is to work in the broadest way possible, so that people won't have expectations as to what material or form I work with. I want to have the biggest breadth of possibilities, whatever form is appropriate for what I have to say. Also, I work in a variety of contexts so that I reach different audiences. Context encourages me to make different kinds of work; it's another way to stretch (Horodoner 51).

Works Cited

Antoni, Janine and Stuart Horodner. "Janine Antoni." *BOMB* (1999): 48-54. Print.

Dreishpoon, Douglas. "Janine Antoni." *Art in America* (2009): 1-3. Print.

Findlay, Judith. "Press me, push me, feel me, find me: Judith Findlay discusses the lingering senses of Janine Antoni." *Women's Art Magazine* (1995): 14. Print.

Heartney, Eleanor. "Thinking through the Body: Women Artists and the Catholic Imagination." *Hypatia* (2003): 3-22. Print.

Heon, Laura. "Janine Antoni's Gnawing Idea." *Gastronomica: The Journal of Food and Culture* (2001): 5-8. Print.

Lindner, Stacie M., "Janine Antoni: Finding a Room of Her Own" (2006). Art and Design Theses. Paper 9. http://digitalarchive.gsu.edu/art_design_theses/9 \

Poovey, Mary. "Feminism and Deconstruction" *Feminist Studies* (1988): 51-65.

Princenthal, Nancy. "Janine Antoni: Mother's Milk." *Art in America* Sept. 2001: 125-129. *Academic OneFile*. Web. 2 Apr. 2012.

Sacasa, Natalia. *Janine Antoni.* Luhring Augustine. Web. 28 Mar. 2012.

Weintraub, Linda. *Art on the Edge*. Litchfield: Art Insights, Inc., 1996.

Zeglin Brand, Paul. "Beauty Matters." *The Journal of Aesthetics and Art Criticism* (1999): 1-10. Print.

Figure 1. *Gnaw.* 1992. 600 lbs. of chocolate and 600 lbs. of lard, 24 x 24 x 24 inches, http://www.pbs.org/art21/artists/antoni/art_sculpture.html.

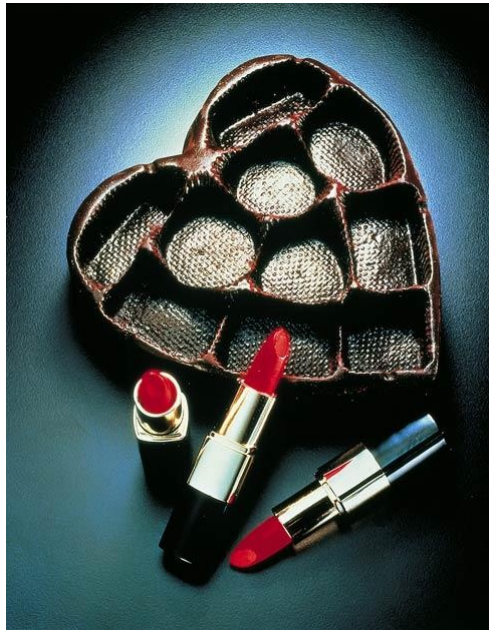

Figure 2. *Lipstick/Phenylethylamine.* 1993. 45 heart-shaped packages made from chewed chocolate and 400 lipsticks made with chewed lard, pigment, and beeswax, http://www.pbs.org/art21/artists/antoni/art_sculpture.html.

Figure 3. *Loving Care.* 1993.

Figure 4. *Wean.* 1990. Plaster impressions in the wall, http://www.sitesantafe.org/exhibitions/exhibitfr.html.

Figure 5. *Momme.* 1995. Cibachrome print, 35 x 29 1/3 inches, http://www.luhringaugustine.com/index.php?mode=artists&object_id=64.

Figure 6. *Cradle.* 1999. Two tons of steel, 60 x 60 x 60 inches, http://www.luhringaugustine.com/index.php?mode=artists&object_id=64

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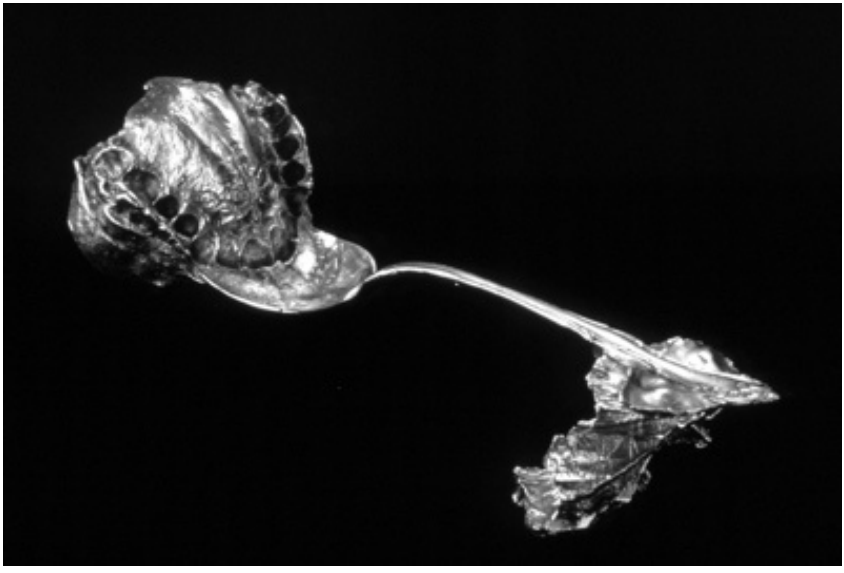

Figure7. *Umbilical.* 2000. Sterling silver, 3 x 8 x 3 inches, http://www.luhringaugustine.com/index.php?mode=artists&object_id=64.

The Fantastic Travels and Travelers of Remedios Varo

Alexis Makwinski (Spanish)[1]

English Abstarct

Remedios Varo was a surrealist painter born in Anglés, Spain, on December 16, 1908. From a very young age, she became an experienced traveler as her family relocated on numerous occasions throughout Europe and Northern Africa, due to her father's job as a hydraulic engineer. The family eventually settled in Madrid, where Varo attended strict Catholic schools, although she was eventually allowed to formally study Art. At the onset of the Spanish Civil War in 1936, Varo fled to Paris, where she became acquainted with many writers and artists that had formed the Surrealist movement. As the political situation in Europe began to deteriorate, Varo decided to settle in Mexico, where she remained for the rest of her life. It was during her years in exile that she painted some of her best works. This paper focuses specifically on Remedios Varo's representation of travel and female travelers. Her paintings depict voyages – both real and imaginary – with magnificent images of modes of transportation that allow her female protagonists to discover new worlds or, on the contrary, entrap them within the vehicles themselves.

Viajes pictóricos: la vida y los viajes de Remedios Varo a través de su obra

> "She said she didn't have to go to the trouble of traveling because the best and the most beautiful travel was within her imagination."
>
> Walter Gruen, esposo de Remedios Varo

La artista María de los Remedios Varo y Uranga nació el 16 de diciembre de 1908 en Anglés, España, hija de Don Rodrigo Varo y Zejalbo y Doña Ignacia Uranga y Bergareche. Varo nunca llegó a sentir una conexión profunda con su lugar de nacimiento, ni con cualquier otra región en España. Su familia empezó a desplazarse desde la época de su infancia, debido el trabajo de Don Rodrigo como ingeniero hidráulico. Sus obligaciones llevaron a la familia a varias regiones de España y también a los países del Norte de África. Varo creció por lo tanto viviendo en sitios diversos y aprendió mucho acerca de culturas diferentes desde una edad temprana. Su infancia era una magnífica colección de espacios exóticos diversos. A pesar de las dificultades que

[1] Written under the direction of Dr. Katica Urbanc for SP400: *Spanish Expository Writing*.

presuponía el trabajo de Don Rodrigo Varo para la familia, esta figura tuvo una influencia importante tanto en las ideas como en el estilo de la futura artista.

En 1917, la familia se desplazó a Madrid hasta 1923, época durante la cual Varo asistió a escuelas religiosas y recibió una estricta formación católica. Su madre era una católica devota, mientras que su padre era mucho más liberal. Aunque los ideales de su madre pueden percibirse a través de su arte, especialmente en sus primeros cuadros, Varo fue más influida por su padre, quien le enseñó las habilidades del dibujo mecánico y la llevaba a museos y galerías para que conociera varios estilos de arte. En 1924, asistió a la Escuela de Arte y Oficios en Madrid, y más tarde, a la Real Academia de Bellas Artes de San Fernando, donde tomó una clase de dibujo científico. Llegó a conocer el movimiento surrealista a través de una serie de conferencias y a través de las obras de Salvador Dalí, Luis Buñuel, y Federico García Lorca. En 1936 empezó una relación con el poeta surrealista Francés Benjamin Péret, y ese mismo año, con la llegada de la Guerra Civil, empieza también su vida en el exilio.

Varo, quien apoyaba fuertemente al bando republicano, huyó a París después del asesinato del poeta Federico García Lorca. Allí, gracias a su relación con Péret, se hizo miembro del círculo de surrealistas y conoció a Joan Miró, Max Ernst, André Breton ,y la pintora Leonora Carrington. En 1941, Varo y su esposo fueron encarcelados: Péret, por negarse a ingresar al ejército, y Varo, por razones desconocidas. Dada la situación en Europa, la pareja decidió huir a México. Varo y Péret se casaron en 1946, lo cual le permitió a Varo viajar libremente a través de América Latina. Después de la Segunda Guerra Mundial, Péret decidió regresar a Francia, pero Varo viajó a Venezuela para poder trabajar, y se reunió allí con su madre y con su hermano Rodrigo. Regresó a México en 1950 y empezó a trabajar en el arte comercial. Conoció allí a Walter Gruen en 1952, un refugiado australiano con el cual se casaría más tarde. En 1956 tuvo con gran éxito su primera exhibición de arte en la Galería Diana. Regresó a París en 1958 para visitar a Péret, quien estaba enfermo, y volvió a México, ya de manera definitiva. Varo murió de un ataque al corazón el 8 de octubre de 1963 a la edad de 54 años. A través de su vida, la artista llegó a explorar una gran variedad de temas, especialmente en el exilio. De hecho, fueron precisamente los viajes y los desplazamientos en su vida que le influyeron en su arte. Todas las experiencias vitales de Varo le influyeron en la creación de cuadros a través de los cuales expresaba sus ideas y sentimientos en torno al viaje, el exilio, y la posición social de la mujer. Remedios Varo creó cuadros autobiográficos que revelan tanto su fascinación por el viaje y el descubrimiento de mundos nuevos, como su miedo profundo al desplazamiento.

El exilio de un artista, especialmente en el caso de Varo, da lugar a una nueva vida. En esta vida, Varo pudo ser su propia persona y expresarse libremente sin las restricciones políticas, religiosas y sociales que había enfrentado en Europa. Como bien señala la crítica Linda Nochlin, el exilio abre nuevos horizontes y permite la transformación del individuo:

> Migration can generate new perceptions of place and, in some cases, of the relationship between places. The same dislocation can also facilitate personal transformation, which may take the form of 'rewriting' the self, discarding the lifelong habits of a constraining social education and discovering new forms of self-expression (318-19).

Esta cita describe bien la influencia del exilio en un artista, y se aplica específicamente al caso de Remedios Varo al exiliarse a México. Aunque no fue una transición fácil, Varo descubrió allí su estilo pictórico tan singular. La propia artista describe esta experiencia y el importante papel que tuvo en su vida: "Soy más de México que de ninguna otra parte. Conozco poco España: era yo muy joven cuando viví en ella. Luego vinieron los años de aprendizaje, de asimilación en París, después la guerra (…) Es en México donde me he sentido acogida y segura." (14)

No cabe duda de que los padres de Varo le presentaron perspectivas muy diversas acerca del mundo: su madre era una católica devota, mientras que su padre tenía una mentalidad mucho más abierta hacia el mundo. A pesar de estas diferencias, Varo recibió una educación católica y se sintió atrapada en "[a] world of routines – routines of meals, of classes, of prayers, of group sewing and group confessions [that eventually] triggered rebellion." **(**Kaplan, 16) Hizo una serie autobiográfica de tres cuadros que representan la época de su infancia en estas escuelas, hasta la hora del escape de la rutina a través del casamiento con su primer esposo. Completó esta serie en México en 1961,

> "… produc[ing] her most autobiographical work, reflecting on the restrictive atmosphere of those early years in Spain and on her rebellious schoolgirl yearning to escape. Using characters bearing features as emblems for herself, she humorously mocked the constraints of convent education in a revealing series of three paintings that she thought of as a triptych." (Kaplan, 18)

Hacia la torre (1961) (fig 1) es el primer cuadro de esta serie y contiene un grupo de niñas idénticas que pasean en bicicleta, alejándose de una misteriosa torre que se parece a una colmena. En este caso, el edificio en forma de colmena representa "childhood in Europe, in Spain, in the beehive structure created by thousands of enthusiastic souls, working hard to prolong traditions, to perpetuate" (Kaplan, 18). En la vida de Varo, el peso de su familia y de las normas sociales la encerraron en las

tradiciones católicas de España. En el cuadro, Varo y sus "gemelas" salen de la colmena hacia la aventura de una posible vida nueva. Los tonos grises y azules del cuadro transmiten un sentimiento sombrío, representativo del mundo tedio y rutinario de una vida tradicional. Sin embargo hay una niña que se destaca del resto del grupo. Situada directamente detrás de la monja, no tiene la misma mirada perdida que sus compañeras. Esta niña, que desafía al mundo con una mirada que se centra en el espectador, es una auto representación de Varo, es decir un ser rebelde que desafía las reglas y el poder de la tradición.

En la segunda pieza de la serie, *Bordando el manto terrestre* (1961), (fig 2), Varo hace alusión a su vida mientras estudiaba en un convento católico. En el cuadro se perciben seis mujeres en una torre. Hacia el centro, una misteriosa figura autoritaria las vigila de cerca. Las mujeres cosen en un tejido que va creando la tierra debajo de la torre, lo cual es irónico, porque éstas están atrapadas en la propia torre. Aunque van creando "vida" para los demás, se mantienen aisladas y al margen de esta vida. Igual que la mujer en *Hacia la torre*, hay en este cuadro una mujer que no se enfoca en su trabajo como las demás. Ella cose una imagen secreta en el tejido: dos amantes entre los árboles. Esta imagen representa una forma de libertad sexual que no conocen las demás mujeres en la torre. El líder en el centro no tiene control sobre esta mujer, ni sobre lo que está creando. Otra vez, se demuestra una forma de rebeldía a través de una mujer que no sigue las reglas del convento, sino que crea su propio camino. El papel de la mirada en ambos cuadros es significativo porque demuestra la posibilidad de contemplar otra dirección en la vida y de llegar a una forma diversa de ver y entender el mundo. Esta nueva dirección, abierta a ideas liberales, se opone a la tradición que Varo rechazó a lo largo de su vida. Esta obra es la segunda de la serie porque representa la rebeldía en el convento y demuestra la posibilidad de otro mundo. La fuga definitiva aparece en la última obra de la serie.

La huida (1961) es la conclusión de esta historia, y representa el triunfo final de la mujer que se escapa del convento y de la vida restringida. Volando por el aire en lo que parece ser un gigantesco paraguas, su amante la lleva a las montañas a través de la niebla. Esto nos recuerda la vida de Varo porque cuando tuvo 21 años, se escapó del convento al casarse con su primer esposo, Gerardo Lizarraga, en 1930. Esta boda fue un paso hacia la independencia dada la ley en España según la cual las mujeres solteras, como Varo, sólo podían viajar con sus padres. Su matrimonio con un artista le dio la oportunidad de conocer el progreso social y la libertad en todos los sentidos. El hombre en el cuadro es la representación perfecta de Lizarraga, porque aparece como un ángel de la guardia que lleva a la mujer a la salvación. Las tres piezas representan la historia del

encierro y del escape en la vida de Varo, y el comienzo de una vida nueva. Al huir de Europa en 1941, Varo empieza a explorar a fondo el tema del viaje y del viajero en sus obras.

Exploración de las Fuentes del Río Orinoco (1959) (fig. 4) es el retrato de una mujer solitaria que explora el río para descubrir "la fuente". El magnífico vehículo rojo representado en el cuadro tiene alas con una cadena atada a la chaqueta de la mujer, limitándola al espacio del vehículo. La mujer tiene una expresión seria, y se enfoca directamente en el río en frente de ella. Encuentra "la fuente" dentro del árbol, una copa de vino en una mesa simple que escupe un líquido mágico y crea el río. Este viaje es parecido al viaje de Varo a un bosque que fue inundado por el Orinoco en Venezuela, donde se unió a una expedición para buscar oro. Los árboles parecen de oro, una substancia importante porque representa la transformación en el mundo de los alquimistas. Por lo tanto, este viaje puede percibirse como un viaje espiritual, representado por la copa de vino, la sangre de Cristo, y por la idea del oro como transformación en la vida espiritual. Sin embargo, a pesar del tema aventurero del cuadro, la mujer está atrapada en el extraño vehículo por la cadena. Varo representa en esta obra su viaje espiritual, así como el viaje real que hizo a Venezuela.

Para Remedios Varo, México fue el primer país con el cual se sintió realmente identificada; allí tuvo la oportunidad de florecer libremente como artista. Una vez establecida en México, sin embargo, dejó de viajar: "Once settled in Mexico City, she developed a terrible fear of moving and rarely strayed outside of her neighborhood" (Nichlin, 319). En sus propias palabras, "I am hopelessly superstitious, …so much so that when I go out, even to a nearby place, I return as quickly as possible to shut myself in the house as if someone were following me" (Kaplan, 155). Durante sus años en México pintó dos cuadros, *Caminos Tortuosos* (1957) (fig.5) y *Locomoción Capilar* (1959) (fig 6), donde se hallan mujeres atrapadas en el bigote o en la barba de un hombre. Estos cuadros revelan el miedo al viaje de Varo.

En *Caminos Tortuosos* (1957), la mujer se ha convertido en máquina, con una enorme rueda de bicicleta en lugar de sus piernas. Se percibe mucha angustia y tensión en su cara mientras el hombre intenta atraparla con su largo bigote blanco. Sabemos que Varo le tenía miedo al peligro de las calles, donde cualquier cosa podía suceder cuando uno menos se lo esperaba. Es interesante que la artista haya tratado también el tema del miedo en uno de sus cuentos cortos, descubierto en un cuaderno de dibujo: "Doña Milagra is afraid of the dark. She is never sure that a grasping hand won't dart out of some place, grab her by her ankle and keep her nailed to the spot while a devouring fire runs up her ankle to the rest of her body turning into a pile of ashes (Kaplan, 155). Estas

palabras demuestran los sentimientos de miedo que sentía Varo. Además, el cuento puede relacionarse perfectamente con el cuadro; el hombre le agarra el brazo a la mujer desde el otro lado de la pared, y tiene la intención de controlarla completamente. La mujer, por otro lado, está preparada para defenderse con un paraguas en forma de arma. En un cuadro parecido, Varo demuestra a una mujer mucho más indefensa andando por las calles.

Locomoción Capilar (1959) (fig. 6) demuestra a una mujer con la mirada preocupada y el cuerpo rígido. El hombre en la ventana tiene el control sobre ella porque ésta no tiene otra forma de transporte que sus pies. La quiere secuestrar, y no hay manera de escaparse. Las aves en esta obra son símbolos de la libertad a la cual aspira Varo. Estos animales tienen la libertad de escaparse a cualquier lugar, sin restricciones físicas. En el cuadro, las aves representan la posibilidad de libertad y de escape frente a una vida patriarcal asociada con el miedo, la violencia, y el poder absoluto. En definitiva, las aves representan la idea del viaje libre, feliz e inocente.

El miedo desempaña un papel importante en la vida de Remedios Varo, y se refleja en sus obras con la representación del anti-viaje. Para Varo, México fue la destinación final y declaró que ya no quería viajar: "Una vez en México dejé dos veces el país, una para ir a Venezuela en 1947, la última hacia Europa en 1957" (Varo, 133). Además, para Varo, "searching for peace in a war-town world, exile meant, quite literally, the end of all travel" (Nochlin, 319). El miedo al viaje se refleja en muchas obras que representan a mujeres pasivas encerradas en ambientes domésticos. Aunque Varo luchó de joven para deshacerse del papel pasivo tradicionalmente asociado con la mujer, al llegar a México sintió la necesitad de encerrarse en sí misma. Sus obras desde el exilio reflejan esta decisión consciente, a la vez que denuncian los peligros de la pasividad para la mujer.

Mimetismo (1960) es una obra que demuestra perfectamente los peligros de la pasividad y de la vida doméstica de una mujer. Es irónico que los muebles en esta obra tengan vida, mientras que la mujer, un ser vivo, parece casi muerta. Los muebles interactúan entre sí: la silla explora el armario mientras que la cesta para la costura extiende su pierna alrededor de la pierna de una silla, y viceversa. Toda la actividad y la energía del cuadro se perciben a través de los muebles y el tejido en la cesta. La mujer, sin embargo, está perfectamente inmóvil, mientras el gato en el suelo expresa su sorpresa ante la situación absurda. No sólo tiene la silla un control total sobre ella, sino que además, la propia mujer se va transformando a su vez en silla. Su cara, sus manos y sus pies han ido adquiriendo las formas y el patrón del mueble. Se siente paralizada y

atrapada en un mundo en que cual no puede hacer nada excepto quedarse sentada y observar. La pasividad femenina es, sin duda, una trampa peligrosa:

> "[this is] an unsettling case of mimesis; this woman is lost in her thoughts and has remained motionless for so long that she is turning into the armchair, her flesh has become just like the cloth on the chair and her hands and feet are already turned wood, the furniture gets bored […] and the cat, which went out to hunt, is frightened and astonished upon returning as he sees the transformation" (Kaplan, 159).

Desde la época de su niñez en Europa, las experiencias vitales de Remedios Varo están íntimamente asociadas con la idea del viaje. Pinta su vida a través de obras que reflejan en una primera etapa el viaje como aventura y apertura, pero que más tarde irán convirtiéndose en una fuente de miedo profundo. Durante la época de su exilio en México, el viaje físico se convierte en un fabuloso viaje imaginario repleto de personajes y espacios mágicos y místicos. El arte de Remedios Varo floreció durante sus años en el exilio y llegó a adquirir una gran profundidad y originalidad. En sus obras aparecen magníficos vehículos que llevan a otro mundo, o al contrario, hacen que el escape sea imposible. Podemos también pensar que la trayectoria de su carrera artística es un viaje en sí, desde los horrores de la guerra en Europa hasta las tierras acogedoras del paisaje mexicano.

Obras consultadas

Cándenas, Inés F. "Reconfiguring the Surrealist Gaze: Remedios Varo's Images of Women." *Bulletin of Hispanic Studies* 88 (2011): 455-68.

Cueto, Mireya. "Remedios Varo. Artes plásticas." *Revista de la Universidad de México* 4 (1964) 30-31.

Duran, Gloria. "The Antipodes of Surrealism: Salvador Dalí and Remedios Varo." *Symposium* 42 (1989): 297-311.

Haynes, Deborah J. "The Art of Remedios Varo: Issues of Gender Ambiguity and Religious Meaning." *Woman's Art Journal* 16 (1995): 26-32.

Kaplan, Janet A. "Remedios Varo: Voyages and Visions." *Woman's Art Journal* 1 (1981):13-18.

___. "Remedios Varo." *Feminist Studies* 13 (1987): 38-48.

___. *Remedios Varo: Unexpected Journeys*. New York: Abbeville, 2000.

Kornbluh, Felicia. "Heretics of Surrealism." *The Women's Review of Book* 8 (1991): 9-11.

Mancebo, Fernanda. "La cultura del exilio." *Fundación Instituto de Historia Social* 13 (2004): 49-64.

Nochlin, Linda. "Art and the Conditions of Exile: Men/Women, Emigration / Expatriation." *Poetics Today* 17 (1996): 317-37.

Orenstein, Gloria F. "Art History and the Case for the Women of Surrealism." *The Journal of General Education* 27 (1975): 31-54.

Raaij, Stefan Van., Joanna Moorhead, and Teresa Arcq. *Surreal Friends: Leonora Carrington, Remedios Varo and Kati Horna*. Farnham: Lund Humphries, 2010.

Varo, Remedios. *Cartas, sueños y otros textos*. Ciudad de México, Ediciones Era, 2000.

Zamora, Lois P. "The Magical Tales of Isabel Allende and Remedios Varo." *Comparative Literature* 44 (1992): 113-43.

Figura 1: *Hacia la torre (1961)*

Figura 2: ***Bordando el manto terrestre (1961)***

Figura 3: *La huida* (1961)

Figura 4: *Exploración de las fuentes del Río Orinoco* (1959)

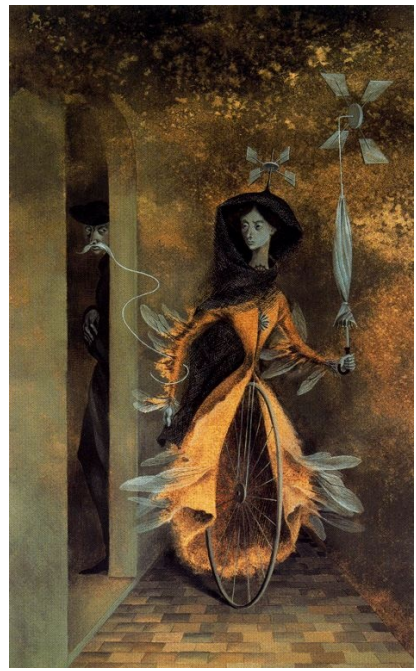

Figura 5: *Caminos tortuosos* (1957)

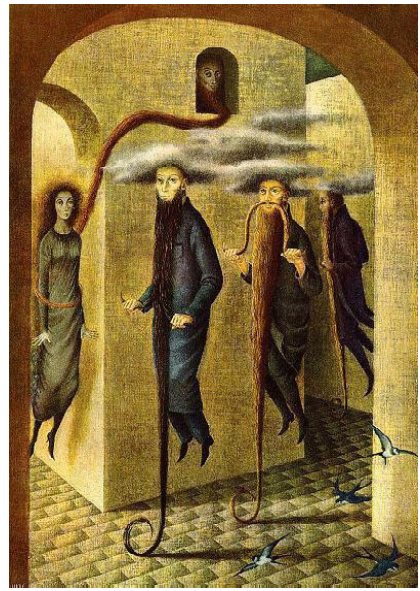

Figura 6: *Locomoción capilar* (1959)

Figura 7: *Mimetismo* (1960)

Starvation for a Cause:
Religious Fasting During the Crusades

Antoinette McCarty (Arts Administration)[1]

Fasting by definition is to abstain from all or some kinds of food or drink, especially as a religious observance. By examining the history and psychological factors behind fasting one can see the power struggle between Christianity and Islam during the Crusades. This paper explores the origin of food traditions between these two religions through their link to Judaism as well as the relationships built between them from this. Christianity and Islam both harbor similar religious habits and beliefs (e.g. fasting to express piety). However, the foods they limit themselves to, when they do it and for how long, differs.

Christians and Muslims believe that fasting shows pureness, forgiveness and faithfulness to God. The Crusades, for both religions, were a series of wars for the Holy Lands and who had the 'God given' right to these lands. The Crusades became a pivotal and important battle for religious power. Fasting was one facet of displaying power and "from the religious concept of inspiration, or a 'divine source' of desire for change, …a sense that such changes are really a matter of individual will, or a 'will to power'…."[2] Both Christians and Muslims use religious eating habits to show dominance and strength both, intellectually and physically. From a religious point of view, since eating is a human necessity, being able to overcome human needs shows a closer connection to the divine. Having the will power to withstand petty human needs was a sign of a superior being. Therefore, fasting during the Crusades, as a form of power, becomes significant during this time period.

To understand why fasting became a valid source of power during the Crusades; one must understand the history that ties these two religions together. History has shown that these two religions draw their origins from Judaism. While this fact both related and alienated them, it also led to a power struggle that would continue for hundreds of years. Their similarities drove them towards the same goals and their differences stopped them

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[1] Written under the direction of Dr. Alison Smith for the Team Taught ILC entitled *From Table to Laboratory: Exploring Food Choice Past and Present*.

[2] Jo Nash, Mutant Spiritualities in a Secular Age: The 'Fasting Body' and the Hunger for Pure Immanence", *Journal of Religion and Health* 45, no. 3 (Fall 2006), 320.

from ever understanding each other. It is understood, in Christianity's relation to Judaism, "when early Christians used the term "Judaism," they did so to help define themselves—"Judaism," as they understood it, was necessary for them to tell the story of "Christianity.""[3] The Christian religion branches directly out of Judaism because the Old Testament is composed of the writings of Jewish martyrs, saints, and visionaries. Both Christianity and Judaism share many Bible stories that Christians celebrate and look towards for moral guidance. These stories include, Noah and the Flood and the stories of Abraham and Moses. Therefore, it is not surprising that they also shared certain rituals and forms of prayer. Specific food practices such as fasting were, "…essential to the religious life of Ancient Israel and the early Christian Church as an act of repentance, contrition, atonement, mourning, prayer, supplication and devotion."[4] The practices that Early Christians founded themselves on were based off Jewish practices, partially because this was the only strong religious model available to them. Judaism was also the only model with beliefs closest to their own. Since Judaism had such similar beliefs, Christianity was able to use Judaism to help them develop their own religious direction.

Islam also has ties to Judaism, especially in the early years of its founding. When Muhammad, the highest of all prophets in Islam, was still living he was friendly with the Jews of Medina. Before Muhammad established Islam's own rules of prayer, " …the Muslims prayed in the direction of Jerusalem, the central shrine of Judaism …"[5] alongside Jews. Though this came to change and Islam established their own central shrine, Mecca, the idea of praying towards a specific place commenced with the Jews. The Jews of Medina also influenced "…the establishment of Ramadan as the designated month for Islamic fasting."[6]

Christians and Muslims also shared religious figures as sources of information for the founding of their religion. Both groups of people share an emphasis on the angel Gabriel as a spiritual and religious figure. The angel Gabriel was said to be the one who brought Mother Mary the news that she would bear God's son, Jesus Christ. Gabriel also serves as a source of information in the writings of the Quran. It was the Angel Gabriel that first brought Muhammad to recite the first chapter or sura of the Quran. Gabriel

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[3] Michael L. Satlow, "Defining Judaism: Accounting for "Religions" in the Study of Religion", *Journal of the American Academy of Religion* 74, no. 4 (2006), 842.
[4] James E. Lindsay, Daily Life in the Medieval Islamic World. Westport: Greenwood Press, 2005, 150.
[5] Francis Robinson, The Cambridge Illustrated History of the Islamic World. Cambridge: University of Cambridge, 1996, 7.
[6] Lindsay, 151.

continued to appear in visions to bring him passages of the Quran until the day Muhammad died.

However, significant differences separated and defined Christianity and Islam as distinct religions and cultures. Dietary laws between these two groups of people were very different despite the fact that both groups believed in the practice of fasting. For though "there are many similarities between Islamic and Jewish dietary laws, Islamic dietary laws are generally less restrictive, than Jewish ones. (Most Christian traditions abandoned Jewish dietary laws completely.)"[7] Islam had specifically followed certain kosher rules, but called them halal. Christians, on the other hand, abandoned Jewish dietary rules and paved their own way in food traditions. In breaking their ties to Jewish dietary restrictions, they "… saw themselves "liberated" from the dietary practices and obligations … they also came to see themselves as *non*-Jews."[8] The idea of different dietary restrictions also leads into a difference in religions involving fasting. While Christians fast, they do not fully abstain from any food for the duration of ones whole life. They fast, "…. not to fear or disdain from any food but simply to abstain for the practical purpose of training one's body"[9] for religious purposes. Unlike Christians, Muslims have certain foods they must always abstain from eating. They include, blood, unjustly slaughtered meat, carrion, pork, certain types of fish, wine and other alcoholic beverages. These differences in diet come to make each religion view the other as foreign and barbaric. In the eyes of Christians, "the Muslims were held up to detestation as worshippers of false gods and idols."[10] While Islam participates in long fasts with a very limited amount of food, the Christians fast by limiting one food for a period of time. Islam's one big fast, Ramadan is "…kept with great strictness, and no food, and sometimes, even, no drink, is taken all day long, but after … sunset …the faithful are free to eat till the dawn of morning light."[11] Certain activities also could not take place during the day while fasting during Ramadan. Christians fast before Easter, known as the Paschal fast, which includes fasting on certain days, such as Friday and Saturday, in preparation for the Eucharistic meal. Unlike Ramadan, which lasts a month with

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[7] Lindsay, 131.
[8] Dianne M. Bazell, "Strife among the Table-Fellows: Conflicting Attitudes of Early and Medieval Christians towards the Eating of Meat" *Journal of the American Academy of Religion* 65, no. 1 (Spring 1997), 86.
[9] Bazell, 86.
[10] Dana C. Munro, "The Western Attitude toward Islam during the Period of the Crusades" *Speculum* 6, no. 3 (July 1931), 331
[11] Mary M. Patrick, "The Ethics of the Koran" *International Journal of Ethics* 11, no. 3 (April 1901), 325.

consistent fasting every day, the Paschal fast, allows regular activities to continue and only certain days are designated for fasting. Christians also differ in fasting from the Muslims because fasting is spread out over the religious year, breaking them up by season and celebration, whereas Ramadan is one long, large fast.

In examining religious fasts and other aspects of life, it becomes evident that food is a pivotal point of the crusades. Food, especially during medieval times, is celebrated. It is used to bring people together and is usually incorporated in to religious ceremonies. Christians and Muslims were not able to do this peacefully, causing further tension. Not being able to come together and see each other as equals in the eyes of God makes it hard for them to accept each other. Christians found themselves being led to battle by the words of Pope Urban II, saying things such as the Muslims, "… destroy the alters, after having defiled them with their uncleanness."[12] Religious figures of this time used descriptive, violent language to make Crusaders feel as though Islam was defiling Christian culture and beliefs. Muslims felt strongly as well; they felt as though their culture and beliefs were being threatened by an inferior race. An unknown Muslim poet reacts to the first crusade with this poem:

> "Do you not owe an obligation to God and Islam, defending
> thereby young men and old?
> Respond to God! Woe to you! Respond!"[13]

The words of this poet express the feeling of frustration, sadness, and confusion felt by the Muslims towards the Christians and their fight for religious dominance. The poem also shows the willingness of the Muslim community to fight for what they felt was rightfully theirs: devotional spiritual love from God and the power of being the one true religion.

Psychologically, during the Crusades, both Christianity and Islam intended to express piety through fasting and gain power through this feeling. They hoped to better themselves in battle and drew strength from their respective religions and God. In fasting, Christian crusaders showed discipline and devotion to God and their cause. History shows that, "An important factor in the development of the Christian idea of fasting was the stress laid on its meritorious character."[14] The Christians fought during the Crusades under the belief that they were working towards salvation. They believed that their souls

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[12] Munro, 330.
[13] Carol Hillenbrand, The Crusades: Islamic Perspectives. Edinburgh: Edinburgh University Press, 1999, 71.
[14] Rudolph Arbesmann, "Fasting and Prophecy in Pagan and Christian Antiquity." *Tradito* 7, (1949-1951), 39.

and their families' souls would be destined for heaven if Christianity regained the Holy Lands. Christians and especially, "late medieval mystics borrowed from Scripture … the notion of using images of food and eating to talk about the soul's desire for God" [15]. The Eucharist, Jesus and Mother Mary were all religious symbols for fasting during medieval times. The fasting comes to mean forgiveness and faithfulness to God and gives people a "hunger" to fulfill the ideal Christian model. The Eucharist, the body and blood of Christ, becomes this powerful image of soul fulfilling food. To survive on little to no food, but to feel satisfied, becomes a significant symbol for the medieval people and the Crusaders. Fasting is also seen as a way of purity and Christians believed that,

> "…fasting, prayer and almsgiving are the three outstanding duties of a Christian and that fasting, … like prayer and almsgiving was considered a preventative against the temptations of the devil." It is often mentioned in combination with prayer because it possesses the power of strengthening prayer."[16]

Fasting gave one the power to resist temptation and fight those who violated the Christian religion. Crusaders used fasting as a way to strengthen their souls against the temptations that the Muslim world offered. Purification through fasting was one way of battling evil; killing Muslims and reclaiming the Holy Lands went along this same idea of purification and forgiveness. Fasting became another way of fighting the Muslims as well as a way of preparing themselves for battle. While many religious ideals and symbols, such as Mother Mary, become feminine, there were those that stayed masculine. Earlier Christian writings express, "…old age notions that God, mind, and power are male …"[17] Christian crusades strongly identified themselves with these symbols. They believed men had the power to will their minds to fasting. Keeping this in mind, "fasting was most basically something that brought Christians together" and that, "man's choice of hunger is a choice of self-control, and it arouses in nature an answering self-control"[18] Christian crusaders felt unified under the idea of fasting and war. Their religious practices gave them the power to define themselves differently and against the other as, superior, stronger and closer warriors to God. The Christian crusaders found power in their religious identity and unity in their religious practices.

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[15] Caroline W. Bynum, Holy Feast and Holy Fast: The Religious Significance of Food to Medieval Women. Berkeley, California: University of California Press, 2010, 150.
[16] Arbesmann, 40.
[17] Bynum, 294.
[18] Bynum, 39.

The Muslims also drew power from religious inferences and fasting. Muslims, like the Christians, found themselves battling a people and religion they thought to be evil. As stated in the Quran 2:183-87, in reference to the fast of Ramadan,

> "Believers, fasting is decreed for you as it was decreed for those before you; perchance you will guard yourselves against evil … God desires your well being not your discomfort. He desires you to fast the whole month so that you may magnify God and render thanks to Him for giving you His guidance."[19]

This passage from the Quran shows how fasting grounded Islam to God and their faith. The Muslims believed that fasting brought them back to their morals and guided them in the light of Gods path, for "prayer and fasting and reciting the Koran are decided obligations of practical morality."[20] The ideas of the Koran also rest largely on justice, morality, and oneness with God. By applying these ideas to the everyday Muslim life, many Muslim crusaders felt a deep connection to their fellow community. When the Christians invaded the Holy Lands, the Muslims drew from their deep connection to their religion. Fasting was one source for this kind of power. It is also important to recognize that the Muslims did not have a separation of church and state. Their religion was also their law and their laws delegated power and established order among communities. It is clear that, "Mohammad knew no distinction between church and state and the laws which he gave as a revelation from God, were for the civil, and moral and religious development of his people, and have since been so regarded."[21] Having such rigid religious and civil beliefs made it hard for the Muslims to accept the Christians. Being intimately connected to the community and Islam only further posed the Christians to be viewed as others. The fast of Ramadan and general diet restrictions are a source of power because they show devoutness to God and Islam. Ramadan was their way of specifically defining themselves as special through their unique religious practices. Muslim people of the Middle Ages believed, "the moral importance of the fast as an act of worship and piety is amplified by a hadith according to which Muhammad said "Five things break the fast of the faster—lying, backbiting, slander, ungodly oath and looking with passion" …"[22] The Muslim people found strength in fasting to defend against these impure, sinful acts and the Christians. Power was drawn for the Muslim soldier from moral control and resilience. Islam found support within each other, and fasting was one way of uniting them in religious practices. Because of this, fasting becomes a relevant source of power

[19] Lindsay, 151.
[20] Patrick, 325.
[21] Patrick, 328.
[22] Lindsay, 153.

for this group of people during the Crusades.

As the Crusades demonstrated, religion has the power to bring people together as well as tear them apart. Food practices during the Middle Ages helped Christians and Muslims define themselves as individuals as well as, connect them to their culture and religion. Fasting was a way to unite oneself to fellow crusaders, as well as express piety and devotion to God. Both religious groups also used their food practices to differentiate themselves from the 'other'. These two groups of people allowed religion to define them, and fasting is one source for religious definition. By examining these people, their religion and culture, it becomes evident that fasting as a form of power is significant during the Crusades.

Works Cited

Arbesmann, Rudolph. "Fasting and Prophecy in Pagan and Christian Antiquity." *Tradito* 7, (1949-1951): 1-71.

Bazell, Dianne M. "Strife among the Table-Fellows: Conflicting Attitudes of Early and Medieval Christians towards the Eating of Meat." *Journal of the American Academy of Religion* 65, no. 1 (Spring 1997): 73-99.

Bynum, Caroline W. Holy Feast and Holy Fast: The Religious Significance of Food to Medieval Women. Berkeley, California: University of California Press, 2010.

Hillenbrand, Carol. The Crusades: Islamic Perspectives. Edinburgh: Edinburgh University Press, 1999.

Lindsay, James E. Daily Life in the Medieval Islamic World. Westport: Greenwood Press, 2005.

Munro, Dana C. "The Western Attitude toward Islam during the Period of the Crusades" *Speculum* 6, no. 3 (July 1931): 329-343.

Nash, Jo. "Mutant Spiritualities in a Secular Age: The 'Fasting Body' and the Hunger for Pure Immanence." *Journal of Religion and Health* 45, no. 3 (Fall 2006): 310-327.

Patrick, Mary M. "The Ethics of the Koran" *International Journal of Ethics* 11, no. 3 (April 1901): 321-329.

Robinson, Francis. The Cambridge Illustrated History of the Islamic World. Cambridge: University of Cambridge, 1996.

Satlow, Michael L. “Defining Judaism: Accounting for “Religions” in the Study of Religion.” *Journal of the American Academy of Religion* 74, no. 4 (2006): 837-860.

Intimate Partner Violence and Aggression Among Male Veterans with PTSD

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In recent years, attention has focused on the links between intimate partner violence and aggression and PTSD in military veterans. This literature review examines the phenomenon of intimate partner violence and aggression and the symptoms of PTSD associated with it, including avoidance/numbing and hyperarousal (Allen et al., 2010). Additionally, ways in which intimate partner violence and aggression can impact partners of veterans suffering with PTSD are explored, including the development of secondary trauma stress (STS) (Ahmadi et al., 2011). Negligence of partners within PTSD treatment plans is discussed and different forms of couples' therapy are explored within this paper. This examination of intimate partner violence and aggression among veterans with PTSD suggests the need for therapeutic intervention and recognition of the phenomenon in order to avoid the lasting and harmful consequences it can have on both victim and perpetrator.

Posttraumatic Stress Disorder (PTSD) is an anxiety disorder that arises after being exposed to extremely stressful and traumatic events (Wilcox, 2010, p. 175). Additionally, a diagnosis of PTSD can have a significant impact on the quality of intimate relationships considering that symptoms of the disorder include anxiety, anger, violence, and clinically significant levels of depression. Veterans who return from service with PTSD exhibit exceptionally high rates of intimate partner violence (IPV) as a population (Taft et al., 2009, p. 466). This violence and aggression is committed primarily by male veterans against their female, civilian counterparts. Intimate partner aggression can have profound and lasting consequences for both the perpetrator and victim and it is important that we expose the phenomenon in hopes of gaining greater understanding about why it occurs.

Allen, Rhoades, Stanley & Markman (2010) sought to investigate the relationship between active duty Army husbands married to civilian wives and effects of recent deployment, posttraumatic stress disorder (PTSD) symptoms, and marital outcome. They point out that when studying deployment and its effects on marriage, typical outcomes include divorce and domestic violence. Additionally, they attribute this

[1] Written under the direction of Dr. Steve Jenkins for PS212: Psychopathology.

negative effect on marriage to specific symptoms of PTSD including avoidance/numbing and hyperarousal, which can be difficult for both partners to adjust to (p. 281). Allen et al, (2010) sampled 434 couples and had them complete self-report measures separately and privately without communicating with one another to assess their relationship quality in relation to either their partner's or their own PTSD symptoms. Measures included deployment, PTSD symptoms, marital satisfaction, confidence, positive bonding, parenting, dedication, satisfaction with sacrifice and negative communication (p. 283). Results showed that husband's current PTSD symptoms were associated with higher levels of negative communication. This is useful in assessing the level of intervention needed in the lives of military couples when one is suffering from symptoms of PTSD.

The correlation between PTSD symptoms and negative communication patterns has been further studied by Ray and Vanstone (2009). Recognizing that the afflicted veteran's symptoms of emotional numbing/withdrawal and anger can negatively impact family relationships, they recommend that treatment for PTSD include support of the family (Ray & Vanstone, 2009, p. 846). Using interpretive phenomenology as their research method, Ray and Vanstone (2009) conducted in-depth interviews with veterans diagnosed with PTSD. Findings showed that emotional numbing as symptom of PTSD can negatively impact familial relationships and cause further emotional withdrawal (p. 844). Powerful testaments of symptoms given by the veterans included statements like "I was making my family and kids suffer with some physical and psychological abuse, I was still so closed up in my head" (p. 842). Such admittance supports evidence that links emotional numbing/withdrawal and intimate partner violence and aggression. Ray and Vanstone (2009) also point out that fear of spousal anger and violence is a common theme in the everyday experiences of women living with spouses who suffer from PTSD (p. 844). Unfortunately, this fear extends well beyond the sample studied by Ray and Vanstone (2009).

A nationally representative survey of Vietnam veterans showed that one third of PTSD-diagnosed male veterans were identified as violent toward their female partners (Taft et al., 2009, p. 462). This rate is almost three times higher than men without PTSD, and is extremely discerning (p. 462). Like Allen et al, (2010) and Ray & Vanstone (2009), this increased level of violence is attributed to symptoms of increased anger, anxiety and arousal that are particularly strongly associated with aggression among male veterans with PTSD (Taft et al., 2009, p. 462). Of 510 veterans surveyed, 33% of those in intimate relationships reported perpetrating partner physical aggression in the previous year, and 91% reported partner psychological aggression (p. 466). These elevated rates are consistent with the research of Teten et al., (2010), who found that veterans with

PTSD compared to veterans without PTSD were almost six times more likely to have a partner report sustaining an injury in the past year (p. 1620). Although they did not find a significant difference between levels of intimate partner violence and aggression between Vietnam veterans and Operation Iraqi Freedom (OIF) veterans, as a population, both samples exhibited significantly high rates of physical and psychological abuse when compared to civilian populations (Teten et al., 2010, p. 1614).

Recent research has focused on how intimate partners of veterans suffering from PTSD may influence the exacerbation of symptoms that correlate with violence and aggression within the relationship. Renshaw and Campbell (2011) sought to find whether partners' perceptions of service members' deployment experiences moderated the associations of severity of service members' overall PTSD with partners' psychological and relationship distress. Recognizing that spouses of veterans with PTSD are likely to suffer more psychological and relationship distress in general, they aimed to explore how partners' own perceptions of the veteran's experience may play a part (Renshaw & Campbell, 2011, p. 953). The sample for their study consisted of 206 active duty service members from the Utah National Guard and their spouses or romantic partners. A majority of the veterans had been deployed to Iraq (67%), while 19.9% had been deployed to Afghanistan, 6.8% to other locations in the Middle East, and 6.3% to other locations. Participants rated the severity of their PTSD symptoms using the PTSD checklist (PCL), a 17-item, 5 point Likert scale. Additionally, they completed the Relationship assessment scale (RAS), a 7-item Likert-type scale in response to questions about general relationship satisfaction, and the Depression, anxiety and stress scale (DASS), designed to measure depression, anxiety and stress within a weeks time (p. 955). Ultimately, bivariate analyses were performed and consistent with prior research, partners' relationship distress was positively associated with service members' PTSD symptoms, especially those of avoidance and numbing/withdrawal (p. 954). Additionally, this association was moderated by partners' perceptions of service members' deployment experiences (p. 954). In fact, negative association became nonsignificant and approached zero as wives perceived higher levels of combat (p. 954). This implies that the more understanding a spouse or intimate partner has of what their partner experienced, especially combat exposure, the less relationship distress they will experience as a unit.

Yet, despite efforts to understand what their partner may have experienced that led to the development of PTSD, in some cases, intimate partner violence and aggression still occurs. This violence can have devastating effects on intimate partners of veterans diagnosed with PTSD. Ahmadi et al., (2011) discusses how a veteran's diagnosis with PTSD can lead to the subsequent development of traumatic stress among their spouses,

who act largely as caregivers (p. 637). Like the previously discussed research conducted by Ray and Vanstone (2009), Ahmadi et al. (2011) conducted interviews with their subjects, the majority being spouses as opposed to afflicted veterans. One wife of a veteran diagnosed with PTSD explains she felt she had to "walk on eggshells" in fear of her husband's erratic explosions (Ahmadi et al., 2011, p. 637). This sense of hypervigilence in intimate partners is similar to what the veterans themselves feel as a symptom of PTSD. Ahmadi et al. (2009) explore secondary trauma stress (STS) by studying 100 veterans and their spouses using testing measures and questionnaires in order to understand the prevalence and symptomatology of STS among spouses of veterans with PTSD. They found that the duration of PTSD symptoms in intimate partners did predict the severity of secondary trauma stress in spouses (Ahmadi et al., 2011, p. 641). These results showed that spouses are often neglected within PTSD treatment and management plans, and that they often suffer at the hands of their afflicted partners.

To address the suffering of both veterans diagnosed with PTSD as well as their intimate partners, treatment is necessary. First and foremost, social support is a major factor in the success of treatment. In general, higher levels of support are associated with lower levels of PTSD in veterans (Wilcox, 2010, p. 175). Thus, it makes sense that couples therapy is often resorted to as a form of treatment, especially with the added threat of violence and aggression towards intimate partners that is so prevalent within the population studied. Two forms of couples therapy that have yielded positive results include Structured Approach Therapy (SAT) and Cognitive-Behavioral Conjoint Therapy (CBCT) (Sautter et al., 2011; Fredman, Monson & Adair, 2011). Although they are diverse approaches, both are aimed at preventing intimate partner violence and aggression among military couples coping with PTSD.

Structured Approach Therapy (SAT) focuses on promoting empathic communication in order to help couples improve their coping methods with the trauma and anxiety related to a diagnosis of PTSD (Sautter et al., 2011, p. 63). It also uses a multicomponent emotion activation program to help couples reduce symptoms of emotional numbing (p. 63). This couple-based approach is highly recommended in order to assist partners with discussing thoughts and feelings related to the deployment experience and to return intimacy into their lives.

Similarly, Cognitive-Behavioral Conjoint Therapy (CBCT) can help to address relationship difficulties that arise as a result of PTSD. CBCT consists of 15 sessions organized into three stages; 1. psychoeducation about reciprocal influences of PTSD symptoms and relationship adjustment and conflict management skills, 2.

behavioral interventions that improve dyadic communication, and 3. cognitive interventions designed to address maladaptive thinking patterns that maintain both PTSD symptoms and relationship difficulties (Fredman, Monson & Adair, 2011, p. 121). After taking part in CBCT, wives of veterans with PTSD reported significant improvements in their partner's symptoms and level of relationship satisfaction (p. 129). From a clinical perspective, whether SAT, CBCT, or another form of therapy is utilized, therapists must recognize the high risk rates of domestic violence in veterans suffering from PTSD, as well as the tendency for partners to empathize with their traumatized partners and come to believe the violence is a part of the diagnosis (Sherman et al., 2006, p. 487). This false belief may lead partners to rationalize or even excuse the violent behavior, and therefore, therapists must work to correct this notion.

Intimate partner aggression has harmful and lasting consequences for both victims and perpetrators. Family dissolution, incarceration, injury, and even death can result, exacerbating mental health issues and possibly even setting an intergenerational cycle of violence into motion (Teten et al., 2010, p. 1613). Given the large number of armed service members currently returning from Iraq and Afghanistan who could potentially suffer from PTSD and/or become perpetrators of intimate partner violence, it is a topic worthy of study.

Works Cited

Ahmadi, K., Azampoor-Afshar, S., Karami, G., & Mokhtari, A. (2011). The association of veterans' PTSD with secondary trauma stress among veterans' spouses. *Journal Of Aggression, Maltreatment & Trauma,20*(6), 636-644. doi:10.1080/10926771.2011.595761

Allen, E. S., Rhoades, G. K., Stanley, S.M., & Markman, H. J. (2010). Hitting home: Relationships between recent deployment, posttraumatic stress symptoms, and marital functioning for Army couples. *Journal Of Family Psychology, 24*(3), 280-288. doi:10.1037/a0019405

Fredman, S. J., Monson, C. M., & Adair, K. C. (2011). Implementing cognitive-behavioral conjoint therapy for PTSD with the newest generation of veterans and their partners. *Cognitive And Behavioral Practice, 18*(1), 120-130. doi:10.1016/j.cbpra.2009.06.007

Ray, S. L., & Vanstone, M. (2009). The impact of PTSD on veterans' family relationships: An interpretative phenomenological inquiry. *International Journal Of Nursing Studies, 46*(6), 838-847. doi:10.1016/j.ijnurstu.2009.01.002

Renshaw, K. D., & Campbell, S. B. (2011). Combat veterans' symptoms of PTSD and partners' distress: The role of partners' perceptions of veterans' deployment experiences. *Journal Of Family Psychology, 25*(6), 953-962. doi:10.1037/a0025871

Sautter, F. J., Armelie, A. P., Glynn, S. M., & Wielt, D. B. (2011). The development of a couple-based treatment for PTSD in returning veterans. *Professional Psychology: Research And Practice, 42,* 63-69. doi:10.1037/a0022323

Sherman, M. D., Sautter, F., Jackson, M., Lyons, J. A., & Han, X. (2006). Domestic violence in veterans with posttraumatic stress disorder who seek couples therapy. *Journal Of Marital And Family Therapy, 32*, 479-490. doi:10.1111/j.1752-0606.2006.tb01622.x

Taft, C. T., Weatherill, R. P., Woodward, H. E., Pinto, L. A., Watkins, L. E., Miller, M. W., & Dekel, R. (2009). Intimate partner and general aggression perpetration among combat veterans presenting to a posttraumatic stress disorder clinic. *American Journal Of Orthopsychiatry, 79*, 461-468. doi:10.1037/a0016657

Teten, A. L., Schumacher, J. A., Taft, C. T., Stanley, M. A., Kent, T. A., Bailey, S. D. & White, D. L. (2010). Intimate partner aggression perpetrated and sustained by male Afghanistan, Iraq, and Vietnam veterans with and without posttraumatic stress disorder. *Journal Of Interpersonal Violence, 25,* 1612-1630. doi:10.1177/0886260509354583

Wilcox, S. (2010). Social relationships and PTSD symptomatology in combat veterans. *Psychological Trauma: Theory, Research, Practice, And Policy, 2,* 175-182. doi:10.1037/a0019062

A Total Work of Art: In Search of the Gesamtkunstwerk

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In the words of German composer Richard Wagner, the ultimate work of art draws from "an interest common to divers men at divers times and under divers circumstances, and ever shaping itself afresh according to these diversities" (Wagner 194). The question, then, is how to create a pure and independent work of art that will translate across time and circumstance. In the mid-to-late nineteenth century, certain artists thought that they could solve this dilemma through the concept of the *Gesamtkunstwerk*. This term, which translates from the German as "total work of art," refers to a work which creates a complete experience by incorporating multiple artistic media. Countless artists attempted to create a Gesamtkunstwerk, but the most complete and worthy examples lie in the dramas of Richard Wagner, the symphonic poetry of Claude Debussy, and the paintings of Gustav Klimt.

The fin-de-siècle period was not, however, the first to pursue the idea of fusing artistic media. It is known that the earliest Greek dramas, including those of Sophocles and Euripides, included song and dance as well as poetry; these gave rise to the concept of the Greek chorus. During the Renaissance and the Baroque era, composers such as Claudio Monteverdi employed the concept of "text painting," in which a poem is set to music that literally exemplifies its meaning; for example, the word "mountain" might be sung on a high note, while the word "valley" would be assigned a lower pitch. This technique fell out of fashion during the Romantic period, which reviled its blunt and literal nature, but composers setting words to music still attempted to allow the text to inform the music; the German Romantics' *lieder* cycles, for example, used tonality and tempo to reflect the atmosphere of the lyrics without directly portraying them.

The fin-de-siècle conception of the Gesamtkunstwerk began, though, a generation before, in the writings of German philosopher Arthur Schopenhauer. Schopenhauer argues that music is the most universal art, since it can be understood instantly. All other forms of art, such as the visual arts and poetry, must be decoded and processed before we can truly understand them. These other art forms are incomplete,

[1] Written under the direction of Drs. Laura Morowitz and Katica Urbanc for the team-taught honors ILC entitled *Cities and Perversities: Art and Literature in Turn-of-the-Century Paris, Berlin, and Vienna*.

says Schopenhauer, because an idea derived from the knowledge of the relationship between signified and signifier is not the same thing as the essence of the idea itself (Wagner 181). Simply put, when we read poetry, we must first parse the words and then infer their meanings; when we look at a painting, we must recognize the actual images we are looking at before we can understand the message of the work as a whole. Many fin-de-siècle artists were well-versed in Schopenhauer, and they took his ideas a step farther, postulating that because the individual art forms cannot be fully understood without inference, they could create a self-informing work of art by employing several art forms which fed into one another.

Schopenhauer's other major artistic standpoint is that art should overcome the individual will. The ultimate goal of art is to make the observer temporarily forget himself and join with the other artists and observers in a moment of absolute perception. In his essay "The Artwork of the Future" (1849), Richard Wagner notes that at this moment of perception, "no illusion is possible here, as in the daylight show, to make us deem the essence of the world outside is not wholly identical with our own" (Wagner 183). To do this, art needs to stir something both deeper than individual identity and common to each observer. Schopenhauer and Wagner each argue that art should not have an explicit moral, social or political agenda, as positions on these issues change from generation to generation and may not be universally relatable. The artist's work, then, is "indicated by the clearest human consciousness, the new-devised to answer the beholdings of an everpresent life, the brought in drama to a show the most intelligible: the mythos" (Wagner 193). Since art needs to awaken something deeper than the self to truly move us, the most effective subject matter is myth, which draws upon a common ancestral memory from which we are all descended. Armed with its mythical plot and characters, the Gesamtkunstwerk can break down the barriers not only between the various art forms, but also between performer and audience, to create a truly unified artistic experience.

The unity of the arts exemplified by the Gesamtkunstwerk was felt to be necessary because, in the early nineteenth century, artists began to feel that art was becoming trivial and devoid of meaning. In the visual arts, too much attention was being paid to style and not enough to substance and feeling; attending the theatre was becoming more of an excuse to see and be seen than to experience art; and in music, the ornamentation associated with the bel canto style was taking priority over pure musicality. The early Classical dramas incorporated all forms of art, took on universally relevant subject matter, and required the participation of the entire community – but, as time went on, the arts began to separate and specialize, and the unity and purity of art got

lost amid progress and innovation (DiGaetani 71). In this new age, the basic artistic idea of a piece was being "not so much stated or expounded and then developed as brought forth by the…process in which it has a function to fulfill, and the…'idea' is the…process itself, not the theme" (Dahlhaus 41). In the pursuit of the Gesamtkunstwerk, artists sought to lessen the focus on the technical aspects of art, and draw attention back to the work's actual meaning and pure aesthetic merit. Art, they argued, did not need to be justified by any worldly standards. Ideally, the true work of art would subscribe not to hard logic but to a created "logic of feeling" (Wagner 187).

In Wagner's plans for the future of the arts, he posits that the "music drama" is the greatest and most all-encompassing medium. The Wagnerian music drama is something of an inversion of traditional opera, and the blueprint of the Gesamtkunstwerk. It incorporates all art forms: dance, gesture, facial expressions and lavish scenery provide the visual component; the poetry of the libretto takes care of the written aspect; and the music of the singers and orchestra cover the aural category. In "The Artwork of the Future," Wagner stresses the equal importance of all of these aspects: "Where the hearing is to be roused to greater sensuous interest," he argues, "the messenger involuntarily has to address the eye as well: eye and ear must mutually assure each other of a higher-pitched message before they can transmit it convincingly to the feeling" (Wagner 218). He emphasizes that lyric poetry, gesture, orchestral music, and vocal music are all of equal importance. Vocal and orchestral music are equal because, while vocal music expresses the characters' voiced feelings, the orchestra expresses a deeper level of feeling, the "unspoken," which cannot be put into words. Similarly, while characters can speak their intentions through poetry, gesture and expression reveal things that words cannot. The spoken and unspoken are two halves of a whole. Further, Wagner argues, poetry and music are perfectly equal in drama: "poet and musician herein are like two travelers who have started from one departure point, from thence to journey straight ahead in the opposite direction. Arrived at the opposite point of the earth, they meet again; each has wandered round one half of the planet" (Wagner 215). Poetry is the pure expression of thought, music is the pure expression of feeling, and the two of them meet in drama, the most complete form of art.

The staginess of bel canto operas, however, was repulsive to Wagner. He deplored their artifice and the emphasis on plot over characters. In Wagner's music dramas, we see the iteration of a theme common to fin-de-siècle works of art: a preoccupation not with the external relations between characters, but instead with internal conflicts and matters of the soul; namely, the inner drama before the outer (DiGaetani 72). Wagner's characters are remarkable not for what happens *to* them, but for what

happens *within* them. These internal conflicts are broader than external circumstance, and therefore translate more easily over time and distance. Wagner used this universality of experience, coupled with the deep ancestral power of myth and the harmony enforced by the unity of the arts, to create his conception of the Gesamtkunstwerk. Each aspect of his vision feeds into the whole, but also *is* the whole, creating a perfectly complete and self-informed work of art.

Wagner's ambitions were not realized, however, until later in the nineteenth century. In 1876, the first Bayreuth Festival was given at Wagner's custom-built Bayreuth Festspielhaus. The Festival was the culmination of Wagner's aesthetic vision and designed to further enhance the experience of viewing one of his music dramas. The mountain village of Bayreuth was chosen as the location because its isolated nature would remove any hint of influence from the outside world, and allow the spectators to feel truly at one with the work. The journey to Bayreuth in order to see the festival was long and arduous, and meant to mimic a sort of religious pilgrimage. The Festspielhaus was commissioned and built to serve Wagner's purposes, with many revolutionary enhancements designed to increase the level of audience immersion. Wagner commissioned the first-ever covered orchestra pit – before his time, the orchestra had sat directly in front of the audience and obstructed their view of the stage – and was among the first to stipulate that the house lights should be turned off entirely during a performance, eliminating any possibility of conversation or posturing among the audience. The ultimate goal was to eliminate the boundary between performer and spectator, making the audience equally as important as the stage. Early visitors to the Festspielhaus spoke of a feeling of "suction" when they were seated in the theatre – Wagner's aesthetics were, just as he hoped, drawing them in (Bowman 435). Since every aspect of the building was designed with a single artistic purpose in mind, it might even be said that the Festspielhaus itself was an extension of the Gesamtkunstwerk.

Wagner's work caught on like wildfire in the French Symbolist circles. In 1861, after attending a performance of *Tannhäuser*, French poet Charles Baudelaire wrote a letter to Wagner in which he described his experience as follows: "At first it seemed to me that I knew this music already, and later, in thinking it over, I understood what had caused this illusion. It seemed to me that the music was *my own*, and I recognized it as any man recognizes those things he is destined to love" (Hadlock 27). Baudelaire's moment of revelation is precisely the outcome desired by Wagner: Baudelaire, a spectator with a minimal knowledge of music, is able to see one of Wagner's dramas and immediately feel as though he already knows it and it belongs to him. Baudelaire's

individual will has been overcome and he has been drawn fully into the sway of Wagner's art.

It was not only Wagner's music that enchanted Baudelaire – his poetry, too, was well-received by the Symbolists. Wagner wrote all of his own librettos, and he employed several literary devices which worked very well with Symbolist themes. His concept of *stabreim* asserts that alliteration can be used to relate words through sound and concept; for example, the phrase "the red rose" sounds stronger to us than "the red flower" because *red* and *rose* begin with the same sound, and are thus related in our minds before we even begin to parse their meaning (Wagner 211). The Symbolists were also enamored by Wagner's use of *leitmotif*. A leitmotif is a musical phrase which suggests some character, object or idea, and recurs whenever its subject is called to mind in the work – for example, in Wagner's *Siegfried* (premiered 1876), the title character is represented by a particular leitmotif which is repeated countless times throughout the opera. The leitmotif suggests Siegfried's character, and when we hear it, we think of him, even if the actor himself is not onstage. This use of one thing to represent another plays perfectly into Symbolist aesthetics. Each of Wagner's works is a finely-constructed puzzle, and the Symbolists delighted in attempting to decode them.

Not every Symbolist was a Wagnerian, however. Claude Debussy, as a young man, adored Wagner's work and even attended Bayreuth, but as he aged and matured as a composer, he began to see the leitmotif system as too blunt and indelicate, and the days-long *Der Ring des Nibelungen* (1876) as more tiresome than profound. He respected the immersive power of Wagner's work, but found it pretentious. In a later essay he notes, with characteristic snark, that "it is hard to imagine the state to which the strongest brain is reduced by listening for four nights to the *Ring*…It is worse than obsession. It is possession. You no longer belong to yourself. You are but a leitmotif moving in an atmosphere of tetralogy" (Vallas 117). Debussy commended the beauty of Wagner's music, but the "suction" the Bayreuth attendees spoke of seemed to him too tense and restrictive. While Wagner's work is intended to consume his audience, Debussy's music is loose and free. His respect for rhythm and tonality is tenuous at best, and he argues for the concept of "open air art" – art as sinuous and unrestricted as the natural world. He holds that art, being man's most natural inclination, should follow nature's example. Since the first art was created by savages, artists must think like savages in order to create true art. The true artist dispenses with formality and simply "feels what he sees," and synthesis of the arts occurs naturally as the senses bleed into one another (Vallas 8). In his *Prélude à l'après-midi d'un faune* (1894), a musical setting of a poem by Stéphane Mallarmé, Debussy, too, strives for a Gesamtkunstwerk, but of a slightly different nature.

The poem's subject is mythical, like those of Wagner's operas. Debussy agrees with Wagner that the culture of the past is the most reliable subject for a universal artwork, because it contains "the unextinguishable flame to which our present must always owe a part of its splendor" (Vallas 21). His definition of "universal," however, differs from Wagner's. A French Nationalist, Debussy argues that social and cultural boundaries are very real, and that art from one culture cannot translate to another. When he speaks of universal art, he means that which is universal to everyone within one nation, not worldwide (Vallas 31).

The construction of *Faune* is also intrinsically different from Wagner's music dramas. Debussy's piece is a tone poem, without words. In Debussy's view, words and music are two entirely separate animals, and should not be performed simultaneously. In *Faune*, Debussy seeks instead to simply *suggest* the poem's words through his music. Instead of resorting to the blunt and literal symbolism of Wagner's leitmotif system, Debussy strives to "contain every nuance" of the poem by presenting a "general impression" thereof instead of a literal translation (Code 508). In Debussy's view, the arts do not need to directly indicate one another in order to correspond. His "open air art" is free of the constraints of form, composition and logic, and his Gesamtkunstwerk is simply the natural result of the mingling of art forms.

Composers and dramatists were not the only ones striving for a Gesamtkunstwerk. At the same time that Debussy was writing his music, Gustav Klimt was beginning his career as a visual artist in Vienna. Klimt was well-versed in Schopenhauer and Nietzsche, and even his early work shows signs of an understanding of the Gesamtkunstwerk. In his early Academic works such as *Auditorium of the Old Burgtheater* (1882), Klimt depicts scenes of the theatre, but he always makes a point of portraying the audience in equal, if not more, detail than the stage. This suggests an understanding of the idea that performer and spectator are joined through the creation of art, and that both are of equal importance (Koja 13). In *Music* (1895), Klimt goes a step further, attempting to create a visual representation of the idea of music – a sort of reverse of Wagner's dramas, which aim to express physical concepts through music. For Klimt, *Music* was an ode to art as the organic solution to the artificiality of Viennese society; his work represented "the cathartic and healing power of art, which he saw as the only force capable of vanquishing the destructive powers that man had unleashed" (Sarmany-Parsons 22). His *Nuda Veritas* (1899) depicts Art as a clarifying force, the only absolute truth, holding up a mirror to civilization. Klimt saw art as mankind's highest achievement, and thus it only made sense that he, too, should pursue the Gesamtkunstwerk.

In fin-de-siècle Vienna, artists from all disciplines were beginning to feel constricted and oppressed by their society's archaic structure. They gravitated together and worked in concert out of necessity. They sought to defeat society's mundane power through artistic catharsis; as Klimt said in his address at the Emperor Franz Josef's 60th anniversary celebration, "The progress of culture is based only on continual and progressive impregnation of life as a whole with artistic goals" (Sarmany-Parsons 66). To the Viennese Secessionists, life itself had to be a work of art – and no one exemplified that ideal more than Ludwig van Beethoven.

In 1902, the 14th Vienna Secession Exhibition opened. The entire exhibition was dedicated to works based upon Beethoven's Ninth Symphony, and Klimt painted a frieze illustrating what he imagined might be the story told by the music. To the artists of the Secession, Beethoven was the ultimate representation of artistic passion, and the triumph of love and purity over evil. Their adoration of Beethoven elevated his art to a kind of religion, and participating in the exhibition was the equivalent of going to church – not unlike the Bayreuth pilgrimage (Koja 150). Klimt's frieze employs pagan and Christian religious imagery, which serves the triple purpose of reinforcing the churchlike nature of the exhibition, falling in line with Schopenhauer's idea of myth as the most universal subject matter, and, through the repetition of the same symbols, calling to mind Wagner's system of leitmotifs. The aim of the exhibition was to portray "the artist as the redeemer of man in his struggle for happiness" (Koja 13), and Klimt, in creating a visual mate to Beethoven's music, sought to create a Gesamtkunstwerk which would encompass not only the art within the exhibition, but the very atmosphere and life around it.

The Gesamtkunstwerk is an elusive concept which has taken countless forms over its evolution. In their attempts to realize it, artists such as Wagner, Debussy, and Klimt have pursued different art forms and followed different creeds. The intent is always the same, however: to create an elevating experience through the absorbing power of art, for, as Wagner puts it, "he who cherishes this longing within the inmost chamber of his powers, he lives already in a better life – but only one can do this thing: the artist" (Wagner 235).

Works Cited

Bowman, Ned A. "Investing a Theatrical Ideal: Wagner's Bayreuth "Festspielhaus". *Educational Theatre Journal*. 18 (1966): 429-38.

Code, David J. "Hearing Debussy Reading Mallarmé: Music après Wagner in the Prélude à l'après-midi d'un faune." *Journal of the American Musicological Society*. 54 (2001): 493-554.

Dahlhaus, Carl. *Between Romanticism and Modernism: Four Studies in the Music of the Later Nineteenth Century*. Berkeley: University of California Press, 1980.

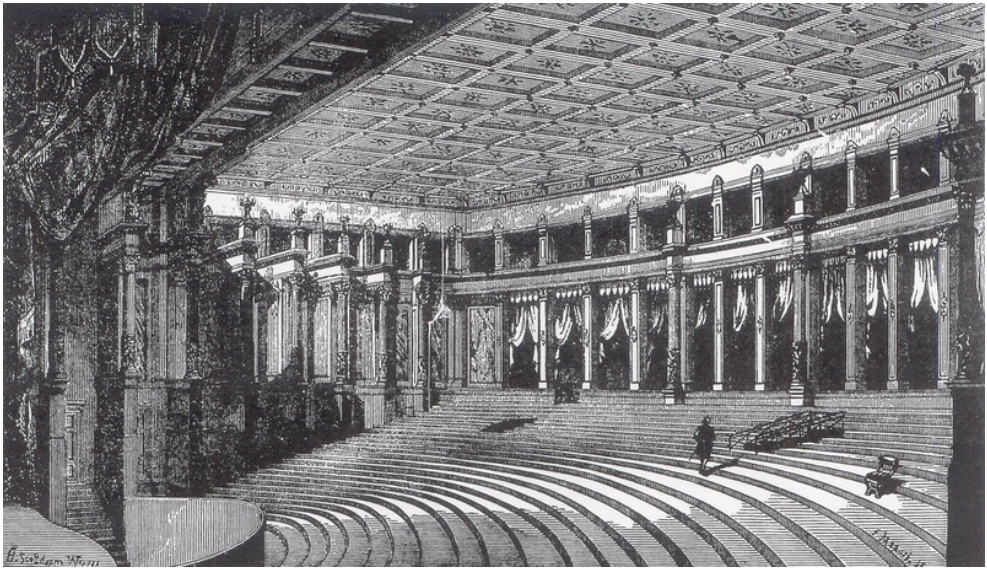
DiGaetani, John Louis, ed. *Penetrating Wagner's Ring*. New York: Da Capo Press, 1978.
Hadlock, Philip. "Baudelaire and the Unstaging of "Tannhäuser"." *South Atlantic Review*. 68 (2003): 26-46.

Koja, Stephen, ed. *Gustav Klimt: Landscapes*. New York: Prestel Publishing, 2007

Sarmany-Parsons, Ilona. *Klimt*. New York: Three Rivers Press, 1995.

Vallas, Léon. *The Theories of Claude Debussy, Musicien Français*. London: Oxford University Press, 1929.

Wagner, Richard. Goldman, Albert, and Sprinchorn Evert, comp. *Wagner on Music and Drama*. Unabridged ed. New York: Da Capo Press, 1964.



1875 engraving of the Bayreuth Festival Theatre, by Eduard Schuré

Gustav Klimt, *Music* (1895)

Section of Gustav Klimt's 1902 *Beethoven Frieze*