

Wagner College Forum for
Undergraduate Research



Fall 2008
Volume VII, Number 1

Wagner College Press
Staten Island, New York City

EDITOR'S INTRODUCTION

The Wagner Forum for Undergraduate Research, now in its seventh year, 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 of these two sections are limited to papers and abstracts dealing with scientific investigations (experimental and theoretical). The third section is reserved for speculative papers based on the scholarly review and critical examination of previous works.

As has become a tradition, the abstracts of papers and posters presented at the Eastern Colleges Science Conference have been reprinted and placed in a special section. The ECSC is the largest undergraduate research conference in the United States and Wagner College has factored in prominently over the past several years. We hosted this annual event in 2000 and again have been asked to host it on April 25th, 2009. In addition, some of our faculty members serve on the Board of Directors, including Professor Donald Stearns who is the current president. Most importantly, though, is the outstanding work that our students contribute year after year.

A quick glance at the table of contents reveals that students of all disciplines are passionate about their work and eager to contribute to their chosen fields. Lauren Brillante and Anthony Pircio explore the importance of play and social interaction amongst young children. Rebecca Giannattasio stresses the need to motivate young minds and counteract the deficit that the United States is beginning to have in technical fields. Also, be sure not to miss the papers dealing with art and literature in turn-of-the-century Paris.

Congratulations to all who have created an environment conducive to the pursuit of knowledge and the exploration of new ideas.

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

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¹ Papers and posters presented at the 62nd Eastern Colleges Science Conference held in Niagara, NY on April 12, 2008.

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**Section I: Eastern Colleges
Science Conference**

Insults as Predictor of Popularity in a Social Organization

James Hodnett (Psychology) and Dr. Amy Eshleman (Psychology)

In a study of norms within a significant social group, playful insults were identified as a possible marker of popularity. In a conceptual replication of Crandall's (1988) study on binge eating in sororities, we examined whether the most popular members of a fraternity would set specific norms for playful insults within the group. Popularity predicted the act of insulting others, but not being the target of an insult. Implications for leadership within the fraternity will be discussed.

Antimicrobial Properties of Chios Mastic In Vitro¹

Michael Bois (Microbiology), Edmond Kurtovic (Microbiology) and
Dr. Kathleen Bobbitt (Microbiology)

Chios mastic is a natural plant resin, which was purified using two slightly different methods. All extracted products were used in this study. Various organisms including *Streptococcus pneumoniae*, *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Streptococcus equi*, *Streptococcus pyogenes*, *Streptococcus bovis*, *Actinomyces odontolyticus*, *Propionibacterium acnes*, *Enterococcus durans*, and *Enterococcus faecalis* were challenged against mastic's antimicrobial properties. Minimal inhibitory concentrations (MIC) were obtained by the broth dilution method. Mastic's antimicrobial properties were evaluated. This study represents the first attempt to test the antimicrobial properties of mastic against these clinically important gram positive bacteria.

Introducing Materials Science to Middle School Students and Educators

Kristen Solheim (Chemistry), Dr. Wendy Driscoll (Chemistry) and
Elizabeth Kurzawa (Liberty Science Center)

Three years ago a collaboration was formed between Wagner College, Picatinny Center, and Liberty Science Center. The project was funded by Picatinny Center, with the intention of introducing the abstract field of materials science to middle school students and educators in the New York/New Jersey areas. Interns from Wagner College developed numerous forty-five minute lessons on a wide-range of topics in the materials science field including sports materials, food packaging materials, composites, and

¹ Recipient of Excellence Award for Best Manuscript in the Biological Sciences

concrete. The lessons were based on Materials World Modules Kits developed at Northwestern University through an NSF-funded grant. The lessons were prototyped by the Wagner Students with middle school students in schools in New Jersey and New York. In year one of the project, six Wagner College interns developed lessons on ceramics, smart sensors, and sports materials. The following year, eight interns implemented lessons on concrete, food packaging materials, biodegradable materials, and biosensors. In the summer of 2007, a new task was set to develop a residency program based on materials science and revolving around Liberty Science Center's new Skyscraper! exhibition. The residency, "Building Materials," was developed using lessons from the ceramics, concrete, and composites modules. Throughout year three, eight interns revised and delivered previous lessons on food packaging and biodegradable materials, biosensors, and smart sensors and developed and led new lessons on polymers and composites. All of the individual lessons and residency lessons were mapped to national educational standards as well as local New York and New Jersey educational standards.

Pathogenesis of Various Induced Bacterial Infections of the Cardio-Thoracic Region of Adult Zebrafish²

Lauren Maltese (Microbiology), Christopher Corbo (Microbiology) and Dr. Kathleen Bobbitt (Microbiology)

Due to its fully developed immune system, the zebrafish has become an important model for immunological studies. In this study, a method of examining the pathogenesis of various induced bacterial infections of the cardio-thoracic region of adult zebrafish was established using *Pseudomonas aeruginosa*, *Streptococcus pyogenes*, and *Streptococcus viridans*. An infection with these microbes, in an attempt to mimic bacterial myocarditis or pericarditis, was established intrathoracic injection of the cardio-thoracic region of the adult zebrafish. Tissue samples were collected, fixed, and processed using paraffin infiltration. Slides of semi-thin sections (7-10m) were stained using Hematoxylin and Eosin and a modified Brown and Hopps' method. The study showed bacteria present around the periphery of the zebrafish heart when infected with *Streptococcus viridans* at one and four hours post infection. No bacteria were found in or around the tissue of the *Pseudomonas aeruginosa* and *Streptococcus pyogenes* infected zebrafish. The tissue was also examined for signs of inflammation and compared to a mock-infected control.

² Recipient of Excellence Award for Poster Presentation in Microbiology

The Need for Creativity in the Physics Lab

Rebecca Giannattasio (Physics)³

The United States is facing a great deficit of technical minds. Many would-be scientists are never discovered because of a negative experience with science in high school. The secondary level physics laboratory experiments as well as those at the introductory collegiate level are highly undervalued and a greater emphasis on creativity might be the solution. Physics should be taught in such a way that is engaging and effective; science classrooms should uphold the same academic integrity as other disciplines. Students should be expected to write research papers and laboratory reports, design and execute experimental procedures, analyze error analysis, and clearly present classroom material before their peers. All of these skills are true of scientists and other technical professionals. A special attempt to design low cost experiments that can be tailored to either educational level is essential to encourage young scientists and engineers. The teaching of these skills in high school and at the beginning of college will cultivate a new generation of technical minds.

Hydrothermal Growth of Zinc Oxide Utilizing Aqueous Speciation Calculations

Lindsay Lucas (Chemistry) and Dr. Maria Gelabert (Chemistry)

In this study, zinc oxide (ZnO) crystals were grown hydrothermally using zinc chloride (ZnCl₂), zinc sulfate (ZnSO₄) or zinc acetate [Zn(CH₃COO)₂] and multidentate ligands: diethylenetriaminepentaacetate (DTPA) or ethylenediaminetetraacetate (EDTA). Employing aqueous speciation calculations (OLI Systems, Inc.), with a zinc concentration of 0.05 M, the reactants for each zinc-ligand combination, and additional KOH and water, were added to produce a desired pH level ranging from 6 to 14. The maximum ionic strength for each complex was calculated using OLI software and each trial was calibrated to meet this ionic strength. Teflon-lined, stainless steel autoclaves were used for synthesis at 200°C, generating pressures of 15 atm. Optical microscopy on the products demonstrated crystals with needle, cluster, and plate habits depending on pH levels and the zinc-ligand system. Connections between synthesized crystals and speciation calculations will be described.

³ Research conducted under the supervision of Dr. Otto Rath (Physics)

Teratogenic Effects of Lithium Chloride Exposure on Eye Development during Embryogenesis in Zebrafish (*Danio Rerio*)⁴

Christina Lamb (Biology), Dr. Ammini Moorthy (Biology) and Dr. Zoltan Fulop (Biology)

This experiment focuses on the teratogenic effects of lithium chloride in zebrafish (*Danio rerio*) eye development from a morphological perspective. In order to explore the effects of lithium chloride (LiCl) exposure on the molecular morphology of developing zebrafish embryos, a blind study was performed with exposure to 0.15M LiCl, 0.3M LiCl, 0.45M LiCl, and a control. Embryos exposed to 0.15M LiCl showed no abnormal defect in eye development. All embryos exposed to 0.3M LiCl failed to develop eyes. 100% mortality was seen in embryos exposed to 0.45M LiCl. Using scanning electron microscopy and semi-thin histology sections, exposure defects were viewed at the cellular level. Scanning electron microscopy revealed no external morphological differences between the 0.15M LiCl exposure group and the control. Histological sections revealed normal eye development in embryos exposed to 0.15M LiCl. Failure of optic cup formation and associated bipolar neurons and ganglion cell development were seen in the 0.3M exposure group.

Relational Aggression Intervention

Lauren Bernardo (Psychology), Christina Herrera (Psychology), Leah LaPrate (Psychology), Dana Trotter (Psychology) and Dr. Amy Eshleman (Psychology)

Relational aggression often goes undetected in a school setting due to its often covert nature. Therefore, this study examines the ability of fourth grade students to identify acts of aggression, including direct verbal aggression and indirect or relational aggression. In order to alleviate relational aggression in the classroom, the SARA (Students Against Relational Aggression) program was developed. SARA is a 12-week relational aggression intervention program in which participants learn to identify, recognize, and combat the varying forms of relational aggression. The program covers such topics as body language, gossip, and the role of the bystander. Over the 12 weeks, the intervention utilizes role playing, videotherapy, and art to demonstrate the harm of bullying, empowering participants to take an active role in eliminating aggression. After participating in the SARA program, sixteen fourth grade participants completed scenario questionnaires. Each participant was randomly assigned into one of two conditions: reading a scenario about an incident of direct aggression or one of indirect aggression. The results indicate that participants identified

⁴ Recipient of Excellence Award for Poster Presentation in Molecular Biology/Genetics

both scenarios as aggression. Across conditions, most participants indicated that they would take an active role as a bystander when someone else was the victim of either direct or indirect aggression—most students indicated that they would comfort the victim and that they would defend the victim. These results demonstrate that despite the covert nature of relational aggression, fourth graders can come to recognize and respond prosocially to relational aggression.

The Effects of Different Nutrients on the Transepithelial Voltage of the Isolated and Perfused Anterior Midgut of Larva *Aedes Aegypti*⁵

Sejmir Izeirovski (Biology) and Dr. Horst Onken (Biology)

The effects of luminal nutrients on the lumen negative transepithelial voltage (V_{te}) of anterior midguts of larval mosquitoes (*Aedes aegypti*) were studied with isolated midgut preparations bathed in aerated mosquito saline and perfused with 100 mM NaCl. In all cases the quality of the preparation and mounting was tested by observing the typical increase of the lumen negative V_{te} to more negative values with hemolymph-side serotonin. Luminal addition of nutrients (arginine, glutamine, histidine, proline, malic acid or succinic acid, each at a concentration of 10mM) in the presence of serotonin resulted in further increases of the lumen negative V_{te} , suggesting active absorption of the amino acids and metabolites. Washout of hemolymph-side serotonin reduced V_{te} , indicating that nutrient absorption is stimulated by this hormone.

The Role of Micro RNA's in the Regulation of Both Normal and Malignant Hematopoiesis⁶

Andrew Pistilli (Biology), Chris Roxbury (Johns Hopkins University) and Dr. Elias Zambidis (Johns Hopkins University)

MicroRNA's constitute a novel class of small, non-coding RNAs that regulate gene expression at the post-transcriptional level. The microRNA-RISC complex binds to the 3' UTR of target messages based on sequence complementarity and silences gene expression by either degrading the message or by interfering with its translation. In this study, the regulatory role of mir-155 microRNA in blood cell formation was examined. A novel

⁵ Recipient of Excellence Award for Poster Presentation in Physiology

⁶ Recipient of Excellence Award for Poster Presentation in Health Sciences

construct for the overexpression of mir-155 using a loxP-Cre conditional expression system was created using standard recombinant DNA technology. The mir-155 loxP-Cre construct is flanked by an upstream β -Geo cassette and a downstream eGFP reporter transgene. Fluorescence-activated cell sorting (FACS) and fluorescent microscopy demonstrated that mir-155 and eGFP expression was conditional and depended on co-transfection of pGK/Cre plasmid. In addition, the possible involvement of five additional microRNA's in leukemia cells was examined using TaqMan RT-PCR. The results indicate that mir-10a, -10b, -181, -196a, and -196b are significantly over-expressed in RS4:11 MLL-fusion leukemia cell lines, which suggests that microRNA dysregulation may be involved in the molecular pathogenesis of blood cancers.

Introducing Materials Science to Middle School Students and Educators: Residency Program on Composites⁷

Kathryn Chepiga (Chemistry), Emily Mihalick (Psychology), Kristen Solheim (Chemistry), Dr. Wendy Driscoll (Chemistry) and Elizabeth Kurzawa (Liberty Science Center)

The objective in this project is to introduce materials science to middle school students through inquiry-based lessons based on Materials World Modules (MWM). MWM were previously developed at Northwestern University and were made possible through an NSF funded grant. A team of three Wagner College undergraduate students has worked together since the summer of 2007 to develop a three-day residency program titled "Building Materials" which was linked to Liberty Science Center's new exhibition Skyscraper! The program was designed to teach middle school students about ceramics, concrete, and composite materials. Some of the lessons included in this residency involve working with Zinc Oxide powder to understand the concept of porosity, testing and comparing concrete to cement, exploring the strength and stiffness of different types of foam boards, and, finally, obtaining three different materials to collectively construct a composite building material. The team completed the 80-page residency program and once prototyped, the program will be used by educators at Liberty Science Center. A 45-minute lesson on composites for middle school classrooms was then developed based on the residency program. Through the 45-minute lesson, students explore the different properties of composites and test composite foam boards for their strength and stiffness. This lesson will be delivered in four middle schools in New York and New Jersey this spring. At the conclusion of each semester an evaluator compiles the feedback from both the middle school students and interns to gather feedback about the impact of the lessons.

⁷ Recipient of Excellence Award for Poster Presentation in Education

Introducing Materials Science to Middle School Students and Educators: Biosensors and Polymers

Jennifer Lewis (Chemistry), Cassie Bray (Biopsychology),
Dr. Wendy Driscoll (Chemistry), Elizabeth Kurzawa (Liberty Science Center)

The objective in this project is to introduce materials science to middle school students using Materials World Modules (MWM) obtained from Picatinny Center. MWM were developed at Northwestern University and were made possible through an NSF funded grant. Teams of two students worked together to develop 45 minute inquiry-based lesson plans for delivery in four middle school classrooms over the course of each semester. In the fall of 2007, one team of interns explored biological molecules and bioluminescence through the use of a firefly experiment. A dead whole firefly and a crushed up firefly were used to demonstrate how adding the necessary substances used in a chemical reaction such as the reaction where a biosensor, ATP, and oxygen react to yield a result of bioluminescence. In the spring of 2008, the team is currently developing and implementing a new lesson plan relating the properties and implications of polymers. Polymer pellets are used in an experiment analyzing absorption and viscosity. At the conclusion of each semester an evaluator compiles the feedback from both the middle school students and interns in order to determine the success rate of each experiment.

Introducing Materials Science to Middle School Students and Educators

Christopher Cappelli (Chemistry), Dr. Wendy Driscoll (Chemistry),
Elizabeth Kurzawa (Liberty Science Center), Lindsay Lucas (Chemistry)

The following lessons have been developed in an effort to teach middle school students concepts related to materials science throughout the New York City/New Jersey metropolitan areas. The lessons were mapped to the NY, NJ, and national science standards and were based on Materials World Modules developed by Northwestern University through an NSF-funded project. During the fall semester of 2007, one team of interns developed and implemented a 45 minute inquiry-based lesson to introduce biodegradable materials and packaging materials. Through the lesson, students were able to understand the uses of packaging materials and their different properties, determine how structure affects material durability, and the importance of biodegradable materials in society and our environment. For the spring semester of 2008, the same team of interns has developed and is currently implementing a second lesson on smart sensors: devices that use external

stimuli such as motion, sound, or temperature, and create a usable response. This technology has been used in items such as the clapper, car alarms, and motion detectors. This interactive 45 minute lesson will allow students to identify piezo-electric forces and various smart sensors, as well as the concepts of a natural stimulus being transformed into a mechanical response. Students will now understand how smart-sensors are used in our society, and the importance of them in our everyday lives. At the end of each classroom visit, the students completed a survey to determine the success rates of each experiment, and the results have been analyzed.

Section II:
The Natural Sciences

Teratogenic Effects on Eye Development Resulting from Lithium Chloride Exposure in Early Embryogenesis of Zebrafish (*Danio rerio*)¹

Christina Lamb (Biology)², Dr. Ammini Moorthy (Biological Sciences), Christopher Corbo (Biological Sciences), Dr. Zoltan Fulop (Biological Sciences)

This experiment analyzed the teratogenic effects of lithium chloride on zebrafish (*Danio rerio*) eye development from a morphological perspective. In order to explore the effects of lithium chloride on the molecular morphology of developing zebrafish embryos, a blind study was performed with exposure to 0.15 M LiCl, 0.30 M LiCl, 0.45 M LiCl, and a control. Using light microscopy, semi-thin histological sections, and scanning electron microscopy, exposure defects were viewed at both the gross and cellular level. Embryos exposed to 0.15 M LiCl showed abnormal defects in eye development including the loss of one eye and irregular eye shape. Scanning electron microscopy revealed slight morphological differences between the 0.15 M LiCl exposure group and the control including misshapen eyes. All embryos exposed to 0.30 M LiCl failed to develop eyes. Scanning electron micrographs of the 0.30 M LiCl exposure group displayed development of the skull but a complete lack of eye formation. 100 percent mortality was seen in embryos exposed to 0.45 M LiCl.

I. Introduction

Lithium has become of great interest as a teratogen in laboratory research, not only because of its influence on development but also because it is one of the most common and successful drugs used in the treatment of bipolar disorder (Klein & Melton 1996). Bipolar disorder is a disease characterized by rapid changes in mood, energy level and normal functioning (NIMH 2007). Approximately 5.7 million American adults age 18 and older in any given year have bipolar disorder (Kessler *et al.* 2005). This illness is long term but treatable with specific medications that stabilize the mood. Through clinical trails, El-Mallakh and Karipot (2006) concluded that lithium should be considered a key drug to treat acute depression caused by bipolar disorder. Although its

¹ This work was presented at the 2008 Eastern Colleges Science Conference (ECSC) and the 2007 Metropolitan Association of College and University Biologists (MACUB) Annual Conference. Christina Lamb received an Excellence Award for her poster presentation at the Eastern Colleges Science Conference.

² Research performed under the direction of Dr. Ammini Moorthy (Biological Sciences) and Dr. Zoltan Fulop (Biological Sciences) in partial fulfillment of the Senior Program requirements.

use as a treatment option has been supported, the use of lithium must be monitored in pregnant women who suffer from bipolar disorder, because it has shown teratogenic effects in early pregnancy (Viguera *et al.* 2000). Currently, the mechanism for lithium's effect remains unclear, but continued research is elucidating some of the molecular pathways involved (Klein & Melton 1996).

The zebrafish has become an important vertebrate model in developmental analysis. Because of the transparency of the embryos and simplicity of chemical exposure in the water environment, zebrafish should be considered a main model in developmental toxicology. In addition, zebrafish possess conserved gene expression with other model organisms such as *Drosophila* (Nusslein-Volhard 1995). The mutant *masterblind* shows the development of posterior structures in place of the eye which is similar to homeotic transformation (Nusslein-Volhard 1995). Because of observations such as these, the zebrafish is a powerful model of gene expression and is a more reliable model in vertebrate developmental studies than *Drosophila*. These characteristics allow zebrafish research to be applied to development in more complex organisms.

Lithium chloride is a known teratogen that has been shown to cause severe defects on morphological development in early embryogenesis of numerous organisms (Klein & Melton 1996). Klein and Melton's (1996) work with *Xenopus* embryos has shown that lithium inhibits the cell fate determination regulator glycogen synthase kinase-3B (GSK-3B). Further evidence for this hypothesis is that the loss of GSK-3B in *Xenopus* and *Dictyostelium* produces the same phenotypic response as lithium treatment (Klein & Melton 1996). These results suggest a possible mechanism for lithium activity within developing embryos. In studies with zebrafish (*Danio rerio*) embryos, exposure to lithium chloride caused defects in anterior-posterior development (J. White, unpubl. data, 2004). Abnormal eye and tail development were noted with escalating severity with increased lithium chloride concentrations (White, unpubl. data, 2004). Because of these observations, it is critical to further document the developmental defects caused by lithium chloride.

Lithium chloride has been shown to affect zebrafish development during two specific stages, and these two transitions corresponded to separate defect patterning found in the embryos (Stachel *et al.* 1993). The first transition of lithium chloride is the initial entry of the chemical at the 16-cell stage (Stachel *et al.* 1993). Embryos exposed in the early stages of development (before midblastula stage) develop bustled and radialized defects (Stachel *et al.* 1993). The bustled embryos appear twisted above the yolk and notochord cells become stacked while radialized embryos have distinct notochord regions separated by yolk (Stachel *et al.* 1993). The second transition occurs after the midblastula stage (Stachel *et al.* 1993). Embryos exposed after the midblastula stage and prior to early

gastrulation display eye and head defects (Stachel *et al.* 1993). This is attributed to reduced expression of the *gooseoid* gene in the lateral wings which is the site for abnormal cell differentiation (Stachel *et al.* 1993).

It is critical to conduct experiments with lithium to study its effects on early development. Previous research has revealed defects in anterior posterior development, but no histological analysis has been performed for lithium chloride exposure in zebrafish. This study is the first purely morphological analysis of the teratogenic effects of lithium chloride. The effects of 0.15 M, 0.30 M, and 0.45 M lithium chloride (LiCl) solutions on eye development in zebrafish (*Danio rerio*) embryos were studied. To analyze the data fully, histological sections of the eyes and electron microscopy were utilized to locate the specific sites of the morphological defects. A photographic catalog of zebrafish development with control specimens and specimens exposed to lithium chloride was produced.

II. Materials and Methods

Care of Adult Zebrafish

Adult zebrafish were housed in the Megerle Science Building on the Wagner College campus (Staten Island, New York, USA). Fish were maintained in four tanks with water kept at 28°C. Filters were changed approximately every two months, and tanks were inspected daily for water temperature, salinity, and water level. Tanks were located in a windowless room so light levels could be controlled. Fish were fed TetraMin® flake food once a day and three times a day the day before breeding. Breeding fish were also fed brine shrimp (*Artemia franciscana*) along with the flake food. Light patterns simulated the sunrise and sunset (photoperiod of 12 h daylight:12 h night), and eggs were laid at approximately 10:00 am EST on breeding days. Fish were trained to eat food in breeding boxes so that they would be comfortable in the breeding environment. For additional information concerning care and breeding of adult zebrafish please refer to (Westerfield 2000).

Collection and Care of Zebrafish Embryos

The night before breeding, a plastic grate was placed over breeding boxes and green plastic plants were placed in the boxes to give fish a covered area to lay eggs (Figure 1). Before breeding, all objects in the tank were removed, plants were placed in breeding boxes, and the fish were fed brine shrimp in addition to flake food. Zebrafish embryos were transferred from breeding boxes in the adult fish aquariums to beakers. Beakers were filled with 100 ml of egg water (1.5 ml stock salt/ 1000 ml de-ionized water [stock salt- 40 g

Instant Ocean®/1000 ml de-ionized water]) and twelve embryos were placed in each beaker. Zebrafish aged 1-4 weeks ate 2 ml of *Paramecium* twice a day. At four weeks, they began to eat brine shrimp. A mixture of three drops brine shrimp and 1-2 ml *Paramecium* were fed until the fish ate flake food when sprinkled into the beaker. When they willingly ate flake food, they were slowly weaned from *Paramecium* and had a diet of flakes and brine shrimp. The egg water in the beakers was cleaned every day by transferring the fish with a plastic pipette into fresh beakers. All beakers were kept in a water bath at approximately 28°C to ensure proper growth and hatching times.

Paramecium Culture Instructions

Four culture bowls were filled with 175 ml of de-ionized water. *Paramecium* culture (1 ml) was added to the culture bowl. Half of a tablet of NOW® Brewer's Yeast and 6 boiled, frozen wheat seeds were added to each bowl. Bowls were kept covered when not using.

Brine Shrimp Culture Instructions

Instant Ocean® (26 g) was dissolved in 1500 ml distilled water and poured into a cylinder with an aerator at the base. Frozen brine shrimp eggs (1 g) were added and the aerator was placed in the middle of the cylinder to allow for constant circulation. After 2-3 days, a pinch of wheat germ was crushed with a mortar and pestle and added to the brine shrimp solution.

Lithium Chloride Exposure

Zebrafish embryos at the sphere dome stage of development (Nüsslein-Volhard 1995) (Figure 2) were obtained and washed twice in an egg water bath for 10 min. As part of a blind experiment, lithium chloride concentrations (0.45 M, 0.30 M, 0.15 M, and a control (0.0 M LiCl)) were prepared ahead of time in 500 ml flasks labeled A, B, C, and D. Research by Jessica White was used as a basis for concentration amounts (J. White, unpubl. data, 2004). Prepared lithium chloride solutions were placed in labeled beakers, with only egg water for the control. Embryos were transferred to the beakers with transfer pipettes and exposed for 10 min. A maximum of 12 embryos was placed in each beaker. The control group consisted of 44 fry, the 0.15 M LiCl group consisted of 53 fry, the 0.30 M LiCl group consisted of 15 fry, and the 0.45 M LiCl group consisted of 30 fry. After 10 min, embryos were removed and washed twice in egg water for 10 min each. Embryos were placed in beakers containing egg water and the fish were allowed to develop in the beakers, monitored daily, and photographed to view morphological defects

in eye development. Beakers were maintained in a 28°C water bath and fry were fed 1 ml *Paramecium* once a day after hatching. The experiment lasted ten days.

Histological Sectioning

On the 10th day, fry were fixed with Karnovsky solution and allowed to sit at 4°C overnight. Fry were placed in porcelain wells, and washed twice with filtered phosphate buffer for 10 min each. Fry were then post fixed in 1% osmium tetroxide for 30 min under a fume hood. Fry were washed with phosphate buffer to remove osmium for 5 min and dehydrated through increasing concentrations of ethanol (50%, 70%, 80%, 95%, 100%, 100%) for 10 min each. Remaining fry were prepared for electron microscopy after completing the dehydration sequences. Specimens reserved for histological sectioning were treated with propylene oxide twice for 15 min each time. Spurr medium was prepared using standard component volumes (Spurr 2007). A 2:1 ratio of propylene:Spurr was created and each fish was allowed to sit in the mixture for 15 min. A 1:1 ratio of propylene:Spurr was created and each fish was transferred and allowed to sit in this mixture for 30 min. A 1:2 ratio of propylene:Spurr was created and fish were transferred and allowed to sit in this mixture for 15 min. Plastic embedding tubes were filled halfway with Spurr media and fish were transferred to individual tubes and oriented. The tubes were then filled to the top with Spurr media and hardened for 24 h at 50°C. After embedding, fish were cut from tubes using a razor blade and trimmed under a dissecting microscope. Glass knives were made using LKB KnifeMaker Type 7801B. Semi-thin sections were obtained using a Reichert OM-1 ultramicrotome and were collected with a paint brush in boats made from Scotch # 850 Silver Tape filled with de-ionized water. Sections were expanded by heating on a hot plate and heat fixed to a glass slide. Slides were stained with toluidine blue by covering each slide with the stain and waving it over a hot plate for approximately 4 s and running cold water over the slide. Samples were analyzed using an Olympus BX40 microscope with a Sony ExWave HAD digital camera.

Scanning Electron Microscopy

After the dehydration sequence, the fry used for electron microscopy were fully dried through evaporation with Hexamethyldisilazane (HMDS). Specimens were mounted on aluminum chucks, coated in gold using the Hummer VI Sputtering System and viewed using a Topcon ABT-32 scanning electron microscope.

Statistical Analysis

Statistical analysis was performed by comparing the number of dead fish and surviving fish on the final day of the experiment (day 10) between each of the three experimental groups and the control using the Fisher's Exact Probability Test (Samuels and Witmer 1999). Because multiple sample data were not available and each experimental group was individually compared to the control, the alpha level was adjusted using Bonferroni's Method (Samuels and Witmer 1999). This adjustment is a conservative measurement to limit the risk of a Type I error. The Bonferroni's Method application used an adjusted alpha level of $0.05/3 = 0.017$ for comparison between each of the three experimental groups and the control.

III. Results

Lithium Chloride Exposure

Control fish developed normally and possessed no deformation in eye development (Figure 3). Fish were active in beakers and avoided the transfer pipette during cleaning. This behavior was considered a sign of normal behavior when comparing specimens.

Zebrafish exposed to 0.15 M LiCl showed a variation of eye defects including small and irregularly shaped eyes (Figure 4F). Some evidence of disrupted symmetry of the yolk sac was noticed (Figure 4C). Histological sections revealed development of only one eye on rare occasions (Figures 11 & 12). Despite the occurrence of developmental defects, fry exhibited normal behavior such as actively avoiding the transfer pipette, energetically eating during feeding times, and constantly swimming in beakers. Zebrafish exposed to 0.30 M LiCl failed to develop eyes in 100 percent of the 58 cases (Figure 5). Not only did fish fail to develop eyes, but their behavior was completely disturbed. Fish remained sedentary and exhibited almost no swimming or dodging movement when transferred in a pipette. Many embryos did not survive past day 2 (Figure 20), and throughout the 10-day time course, a large portion of fish did not hatch at all. Fish that did hatch were lethargic; no visible catching of food was observed. Although feeding behavior was not seen, several fish survived until day 10. Electron microscopy determined the cellular position of morphological defects (Figures 16 & 19).

Zebrafish exposed to 0.45 M LiCl did not survive past day 1. All treated embryos clouded over within 24 h and could not be analyzed. No images exist for this exposure group, because once the embryos cloud over, they are no longer transparent and an image cannot be captured.

Histological Sectioning

Histological sections revealed the cellular organization of eye cells. As predicted, control fish displayed normal cellular organization (Figures 6, 7, & 8). Fry exposed to 0.15 M LiCl appeared to have a variation of eye defects including development of only one eye (Figures 11 & 12). Despite this, eyes that did develop showed normal patterning and layering of eye cells (Figures 9 & 10). Fry exposed to 0.30 M lacked normal eye tissue (Figure 13).

Scanning Electron Microscopy

Scanning electron micrographs of exterior morphology were taken to compare control specimens (Figures 14 & 17), specimens exposed to 0.15 M LiCl (Figures 15 & 18), and specimens exposed to 0.30 M LiCl (Figures 16 & 19). Analysis of external morphology revealed a slight difference in eye shape between control and 0.15 M LiCl-exposed fry (Figures 17 & 18). Vascular tissue was maintained in both systems, but detailed photographs of eyes showed a slightly malformed eye in the 0.15 M LiCl exposed fry due to chemical exposure (Figure 18). This effect is relatively minor considering the dramatic effect of the 0.30 M LiCl exposure. The 0.30 M LiCl exposure group displayed a complete lack of eye development. The skull appeared to develop normally, but no eye tissue or cellular organization was seen in the system (Figure 16). There is a hole where the eye was expected to develop (Figure 16). A highly magnified view of this depression shows the eye socket but with the absence of any noticeable tissue (Figure 16B).

Statistical Analysis

The number of dead and surviving fish from the final day of the experiment (day 10) were tested for significance against the observed control data using the Fisher's Exact Probability Test with Bonferroni's Method adjustment (Samuels & Witmer 1999). The P value for the control versus 0.15 M LiCl was 0.533681 and the result was not significant at an adjusted alpha level of 0.017. The P value for the control concentration group versus 0.30 M LiCl was 4.646×10^{-6} and was highly significant at an adjusted alpha level of 0.017. The P value for control versus 0.45 M LiCl was 9.886×10^{-17} and was highly significant at an adjusted alpha level of 0.017. A graph of zebrafish mortality shows the number of deaths in each concentration group over the 10-day time course.

IV. Discussion

Control fish developed normally and were used as a standard for comparison to analyze lithium chloride effects. All fish exposed to 0.45 M LiCl died within 24 h. The

embryos became white and cloudy and could not be analyzed under the microscope. All fish exposed to 0.30 M LiCl failed to develop eyes (Figure 5). Previous work by Jessica White (unpubl. data 2004) showed cases of failed eye development but never reported such a severe result. Because of this, the 0.30 M exposure group was replicated two additional times, and each of these subsequent tests revealed the same result of 100 percent failed eye development (total of 58 fish in the three populations). This dramatic effect was coupled with defects in anterior-posterior development (Figures 5E & 5F). Fish survived for the 10-day period but limited swimming and no eating behaviors were observed. The survival of the fish showed that the fry must have been able to eat without vision because control fish raised previously would die within two days post-hatching if not fed. Fish remained on the bottom of the beaker and many did not hatch from eggs. Because of these results, embryos exposed to 0.15 M LiCl were expected to show a moderate teratogenic effect lying somewhere in intensity between the control fish and the 0.30 M LiCl exposure group. This prediction was seen but on a less extreme level than expected. Some abnormal eye shape was seen, and certain specimens developed only one eye (Figures 11 & 12). What was more interesting in light of the minor but apparent defects caused by lithium chloride was that embryos exposed to 0.15 M LiCl did not reveal any behavioral abnormalities such as lack of eating and movement. Surprisingly, the embryos in the low dose acute exposure (0.15 M LiCl) were often more energetic and tended to avoid the pipette at a higher rate than control fish. This could be viewed as evidence for hormesis, but no analytical calculations were recorded to test that hypothesis. Hormesis occurs when exposure to a teratogen or historically harmful substance (e.g. ethanol) in very low doses actually has a beneficial effect on an organism (Calabrese 2002). Future studies should perform a range of low-dose exposures (e.g., 0.05 M, 0.08 M, 0.1 M, 0.12 M, and 0.15 M LiCl) and perform an analytical study of behavior compared to a control population to test for the possibility of hormesis.

Semi-thin histological sections of the control specimens revealed normal cellular organization and development as described by Raymond *et. al.* (2006) (Figures 6-8). The zebrafish eye showed several distinct cellular patterns that characterize development. Figure 7 showed the round lens in the center of the developing eye. The next layer was the ganglion cell layer followed by the bipolar neurons, the developing rods and cones, and finally the pigmented epithelium. When viewing specimens from the 0.15 M LiCl exposure group, the cell patterning remained intact with the presence of the pigmented epithelium and cell layers leading to the lens (Figures 9D & 10). It is interesting to note that this detailed view showed no striking difference in cellular organization within the eye compared with the control group even though defects in eye shape and size were seen. Even though normal cell patterning was viewed, there were examples of

development of only one eye in the 0.15 M LiCl exposure group (Figures 11 & 12). These images present horizontal sections through the gills and the brain. Because membranes are intact throughout the entire fish in these histological sections, there is no reason to suspect that the missing eye was an artifact of preparation. A small segment of tissue was present where the eye should have been on the left side (Figure 12 arrows). It seems likely that the tissue may correlate with the initiation of eye development but with subsequent failure of optic cup formation. Arezana *et. al.* (2006) noticed similar defects seen in the lithium chloride exposure in developmental studies with ethanol. Data showed optic tectum impairment in zebrafish that only developed one eye (Arezana *et. al.* 2006). Because of these results, it is possible that exposure to lithium also impairs the formation of the optic tectum. Future studies should focus on the optic tectum formation throughout a developmental time course to see if impairment of the optic tectum is also seen in lithium chloride exposure. Specimens exposed to 0.30 M LiCl failed to develop eyes in all histological analyses (Figure 15). Figure 15 does not show evidence of any eye formation; however, rudimentary eye tissue could have been undetected due to the fact that the section was not deep enough into the tissue. Because the sagittal orientation for sectioning is not the most revealing position in this case, further analysis should orient fry for horizontal sectioning. Scanning electron microscopy explains this lack of eye tissue much further by showing the complete absence of the eye (Figures 16 & 19).

A slight difference in external eye morphology was found between control fish and fish exposed to 0.15 M LiCl under the scanning electron microscope (Figures 5 and 6). The 0.15 M LiCl eyes were misshapen and did not possess the perfect roundness of the control eyes (Figure 18). Eyes from the 0.15 M LiCl exposure appeared slightly more sunken (Figure 18). However, it is difficult to attribute this result entirely to the lithium chloride exposure, because the dehydration steps in the preparation can lead to an indented appearance postmortem. This indentation was occasionally seen in control fish, so one should be cautious when attributing the change to a teratogenic effect. Scanning electron images of the 0.30 M LiCl exposure group revealed a complete lack of eye tissue (Figure 19). Interestingly, the skull developed into the eye socket, but no optic cup was formed under these conditions. These results explain the apparent lack of eye tissue in histological sections of the 0.30 M LiCl group (Figures 16 & 19). Klein and Melton (1996) attribute the teratogenic effects of lithium chloride to the inhibition of the cell fate determinator, GSK-3 β . Their data showed that GSK-3 β is a kinase that may play a role in neurological signal transduction, and they believe treatment with lithium inhibits the expression pathway (Klein & Melton 1996). Viewing the effects of lithium chloride exposure, the lithium pathway must involve the disruption of cell fate determination during embryogenesis. Continued research should be conducted to monitor changes in

protein expression and gene expression of developmental genes that are involved in zebrafish eye development.

Zebrafish mortality was analyzed for each of the three test groups and the control. The graph (Figure 20) shows the trends of zebrafish deaths over the 10-day time course. The 0.45 M LiCl exposure group showed 100 percent mortality within one day. The graph revealed that among all of the concentration groups, the majority of fish deaths occurred before the second and third days. This is due to the fact that the embryos are the most sensitive to lethal developmental defects in the earlier stages of development. The Fisher Exact Probability Test with Bonferroni's Method adjustment (Samuels & Witmer 1999) revealed a significant difference between the number of deaths in the 0.45 M LiCl experimental group versus the control and in the 0.30 M LiCl experimental group versus the control. Because the only variable between the groups was the concentration of lithium chloride, the deaths are attributed to the chemical effect. The 0.15 M LiCl deaths did not significantly differ from the control ($P = 0.533681$). Despite defects in eye shape, size, and development, the dose did not cause a significant change in mortality.

V. Conclusion

Control fry developed normally while embryos exposed to 0.15 M LiCl revealed a range of eye defects, including small eyes as well as development of only one eye. Embryos exposed to 0.30 M LiCl failed to develop eyes in all treated populations and had disruption of anterior-posterior development and behavior. Electron microscopy revealed a complete lack of eye tissue in the head region. Embryos exposed to 0.45 M LiCl died within 24 h of exposure and could not be analyzed postmortem. Future studies should focus on the possibility of hormesis through an analytical study of behavior. Another interesting study would be a low-dose, chronic exposure to lithium chloride during embryonic development followed by a long-term study of adult behavior. These experiments would give more insight into the effects of lithium chloride on zebrafish embryogenesis.

VI. References

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Figure 1: Tank setup for embryo collection.

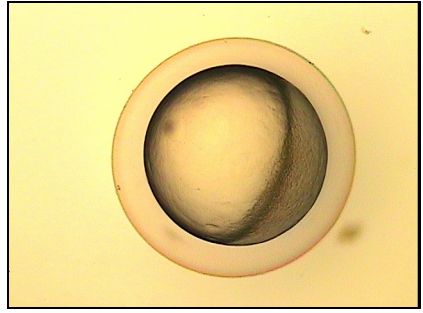


Figure 2: Sphere Dome Stage.

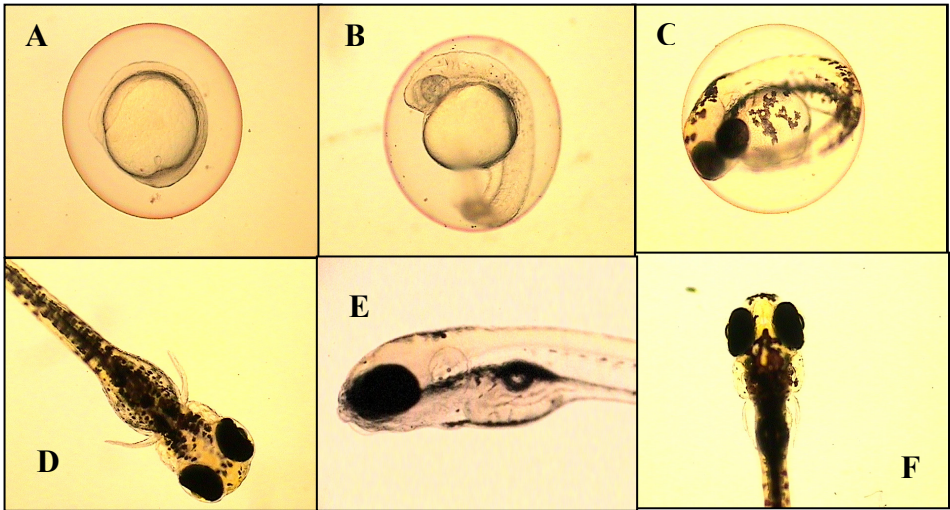


Figure 3: Control fish development. A) Somite Stage B) Early development C) before exit from egg D) 4 days E) 5 days F) 9 days. Notice normal eye development.

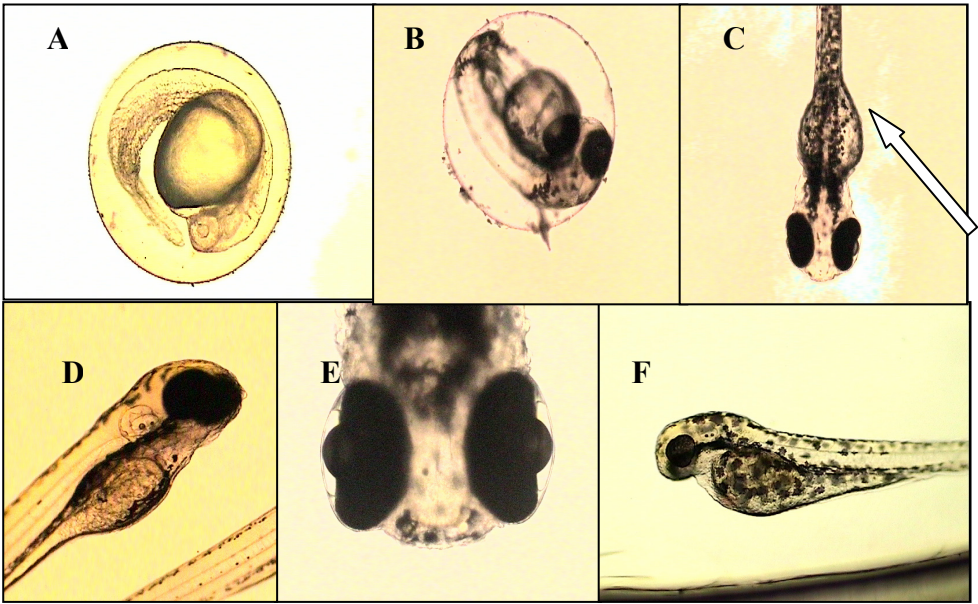


Figure 4: 0.15 M LiCl exposure A) Early development B) before exit from egg C) 4 days D) 5 days E) 8 days F) 10 days.

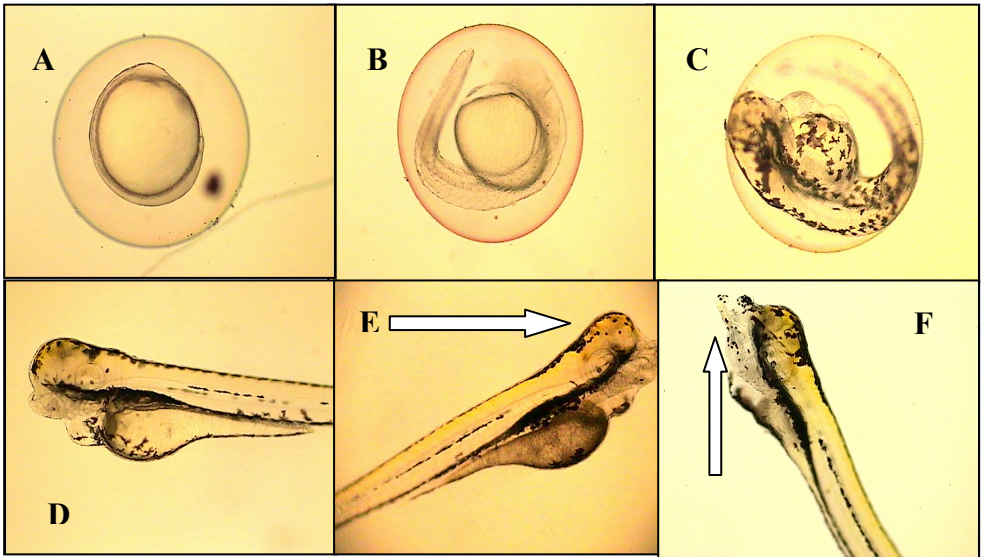


Figure 5: 0.30 M LiCl exposure A) Somite Stage B) Early development C) before exit from egg D) 4 days E) 5 days F) 10 days.

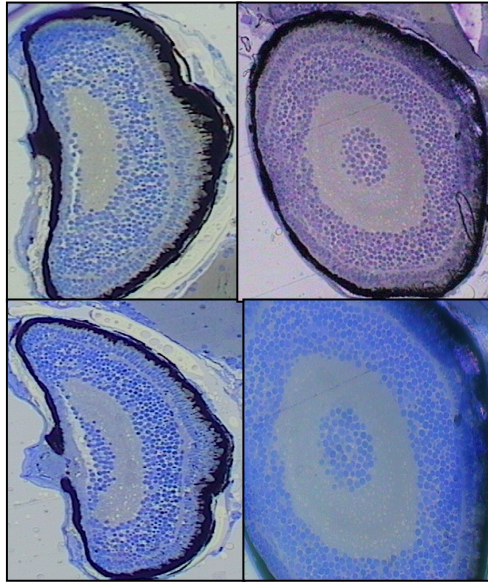


Figure 6: Control specimens: Semi-thin histological sections of the eye, 10x.

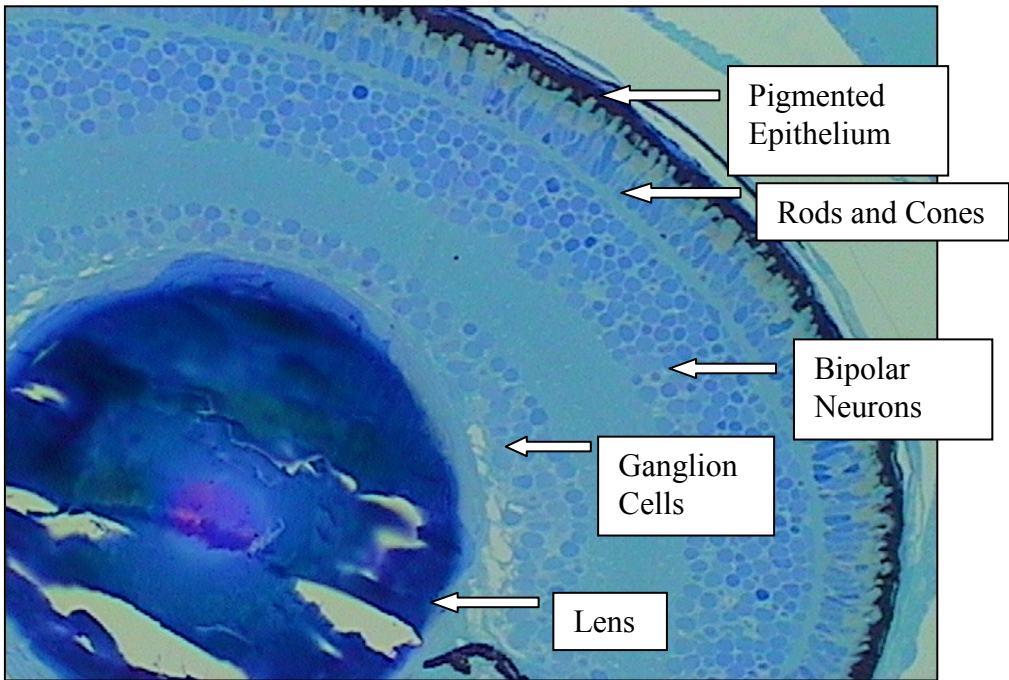


Figure 7: Control Eye, 40x.

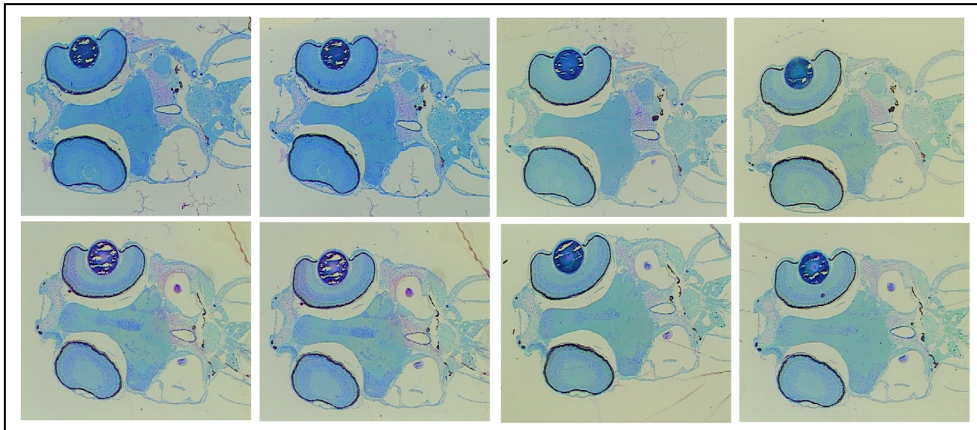


Figure 8: Atlas of Control eye, 14 day old fish, 10x.

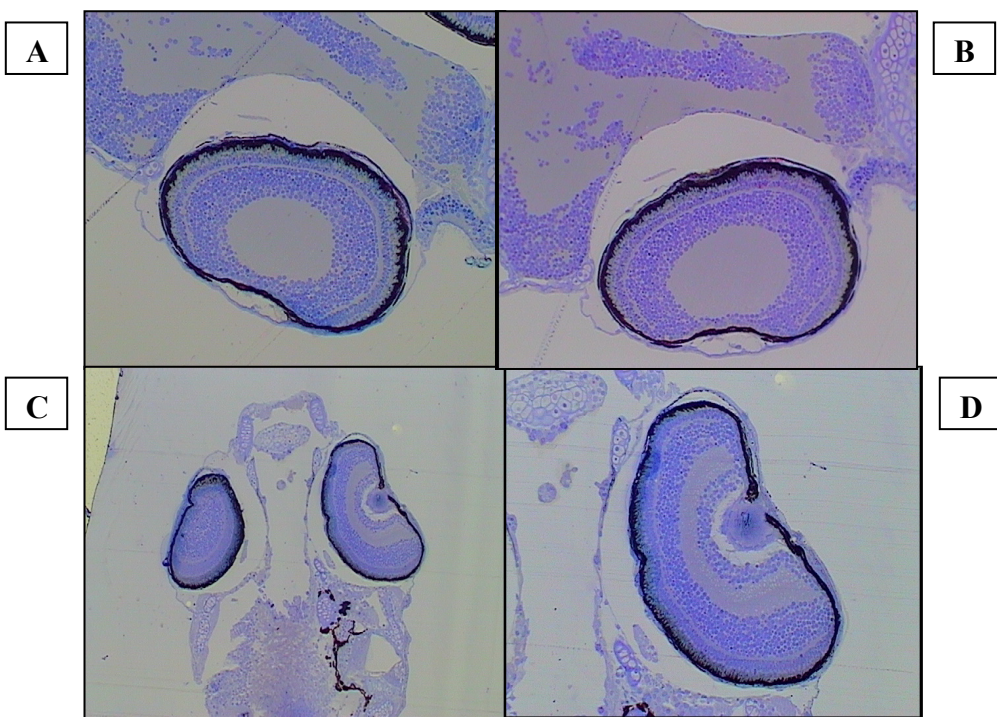


Figure 9: 0.15 M LiCl: Semi-thin histological sections of the eye, 10x.

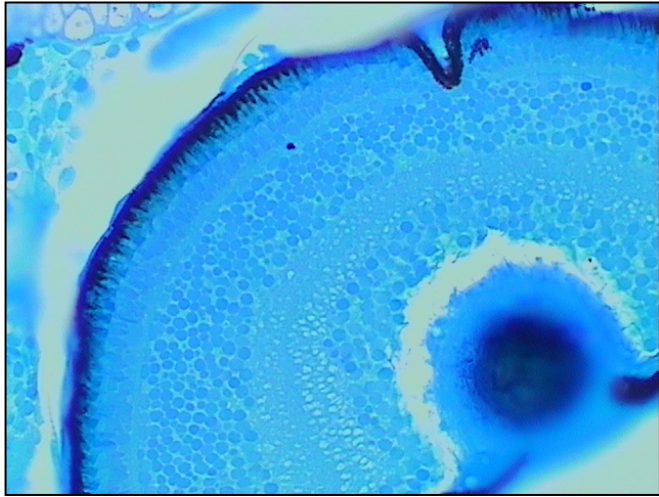


Figure 10: 0.15 M LiCl eye, 20x. Notice normal patterning as compared to Figure 7.

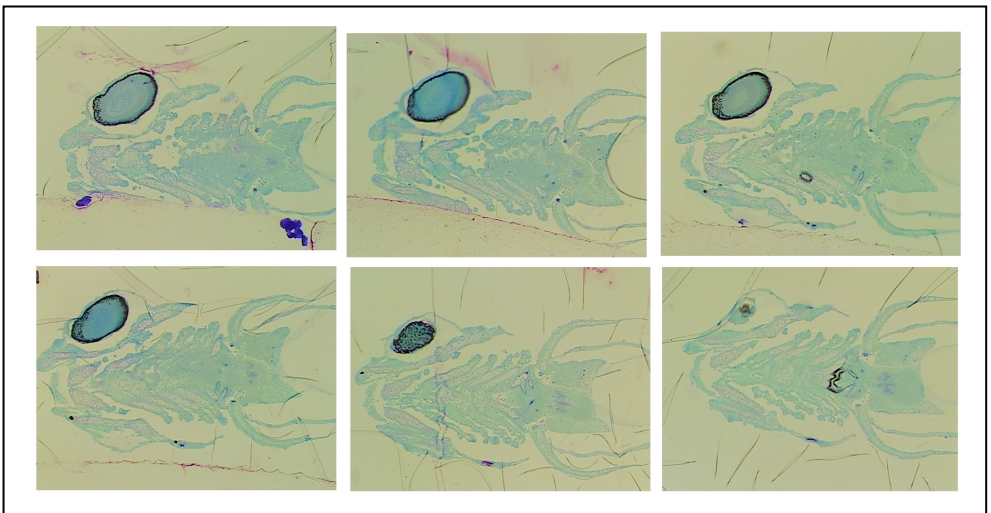


Figure 11: Atlas of 0.15 M LiCl exposure fish, 14 day old fish, Horizontal sections through gills, 10x, notice the absence of one eye.

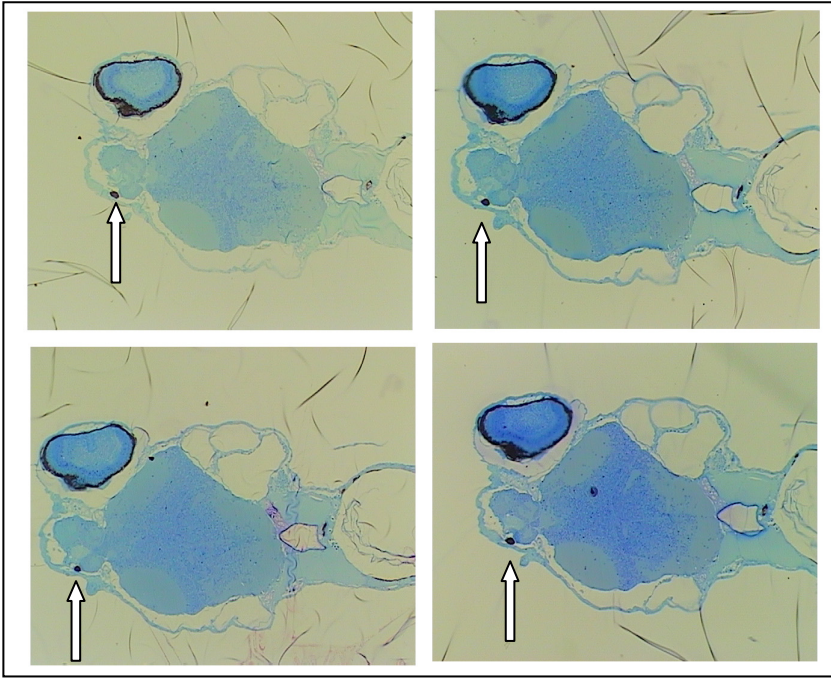


Figure 12: Atlas of 0.15 M LiCl exposure fish from Figure 12, Horizontal sections through brain. Arrow: Potential incomplete formation of the left eye.

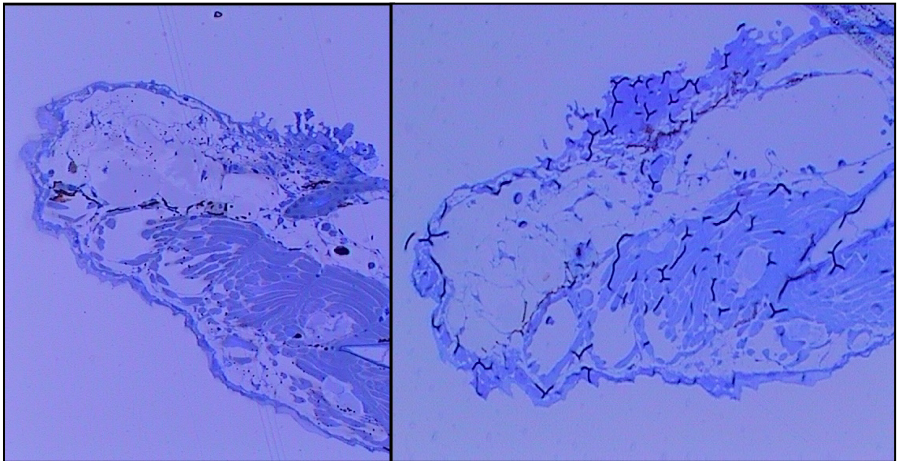


Figure 13: 0.30 M LiCl: Semi-thin histological sections of the eye, 10x.

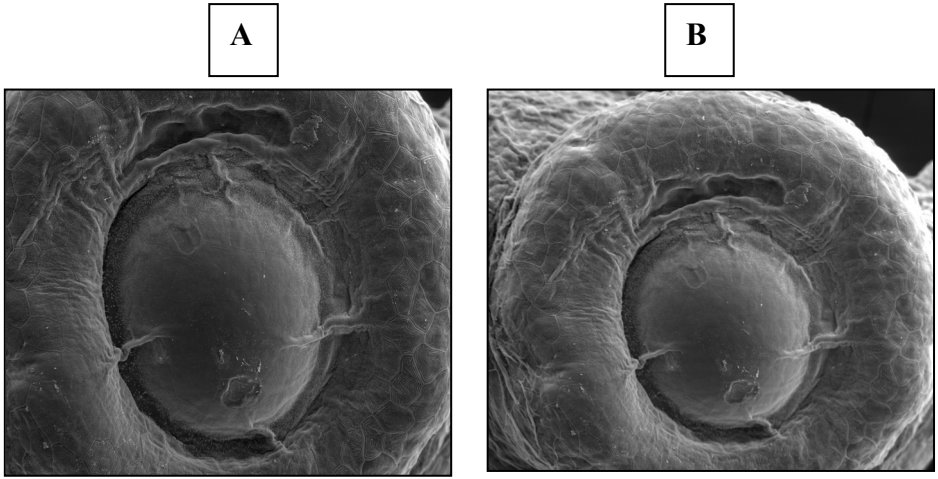


Figure 14: Scanning electron photographs of control eyes. A) 580x B) 400x.

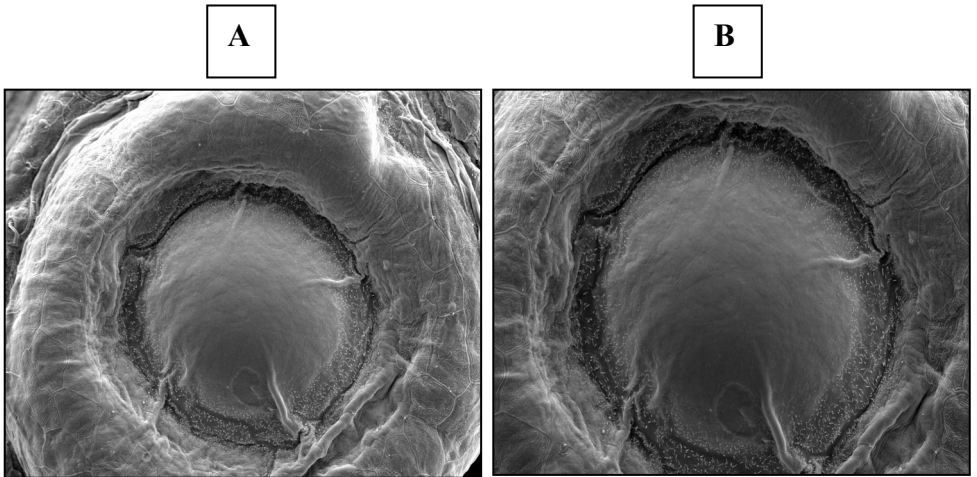
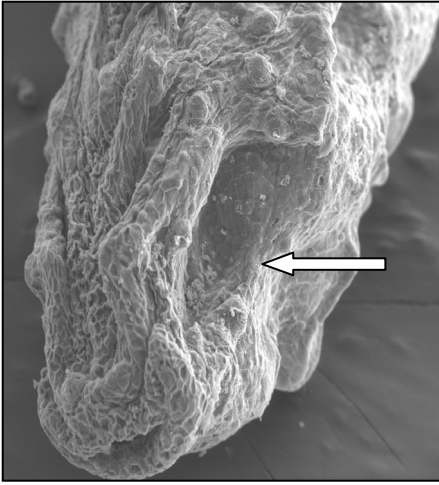


Figure 15: Scanning electron photographs of eyes exposed to 0.15M LiCl. A) 400x B) 750x.

A



B

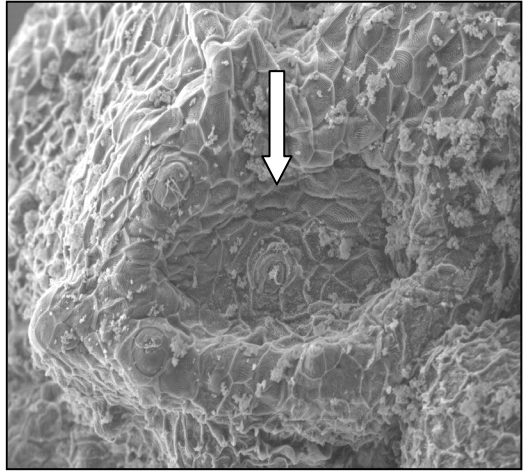


Figure 16: Scanning electron photographs of eyes exposed to 0.15M LiCl. A) 290x B) 490x.



Figure 17: Control Specimen, 200x.

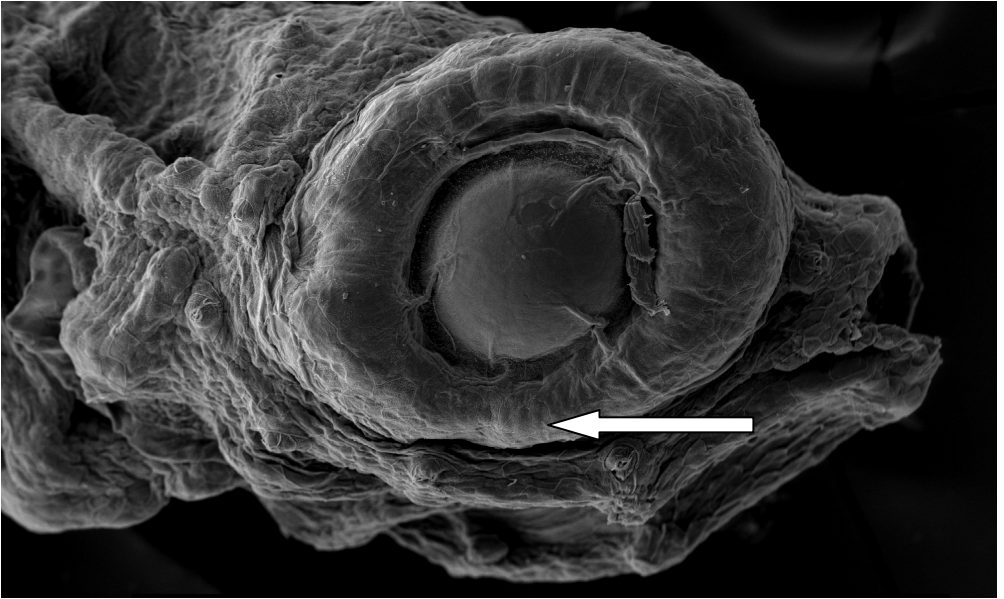


Figure 18: 0.15 M LiCl exposure group, 280x. Arrow shows malformation of eye.

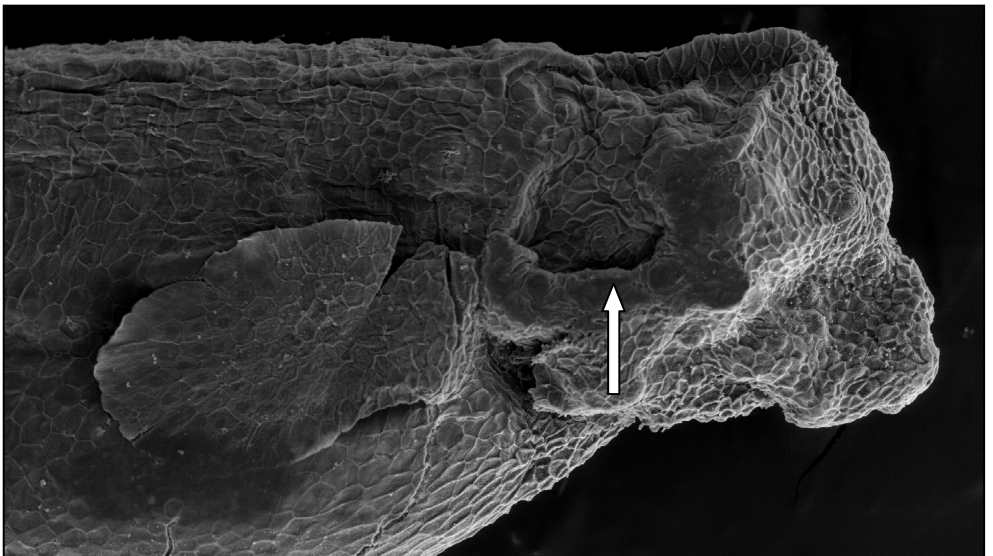


Figure 19: 0.30 M LiCl exposure group, 175x.

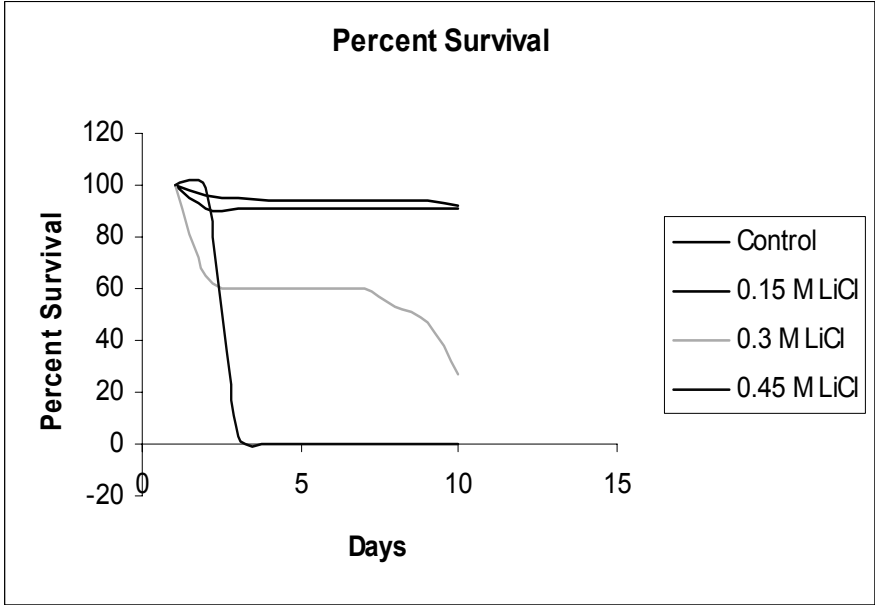


Figure 20: Percent survival in each concentration group.

**Section III:
The Social Sciences**

The Understanding and Dynamics of Play and Imitation: Observation and Interpretation of Two-Year-Olds

Anthony Pircio (Psychology)¹

Play and imitation are two elements of childhood in which will forever be embedded in our memories. As adults, these elements are still quite prominent in our lives. We often imitate people and things almost everyday; however, the root of imitation exists only in our childhood. The cause and reason for imitating is still being researched and psychologists are putting conclusions together every day. Through understanding the concept of imitation we can conclude that it is a part of learning and helps children to develop entirely. This thesis reviews recent literature and observations in an attempt to clarify the root cause and understanding of play and imitation in a general scope.

I. Literature Review

The human race is an entity unlike anything we can imagine. Our capabilities and imaginations are extremely influential yet sometimes become a threat to our own existence. The human race is comprised of individuals whom vary almost entirely from one another on the basis of DNA, genetics, behavior, personality, body composition, height, weight...etc, to name a few. However, beyond the numerous variations that exist, it is safe to say that the human race has at least one thing in common: at one point in our lives we were all once children. For some, our childhood was a vivid memory and for others it was a mere blur. Whatever the case may be we have all experienced the long, tedious (or for some, exciting) years of childhood.

The majority of people, including myself, remember only certain aspects of our childhood. These aspects are usually milestones and/or times worth storing in our memories, whether it may be taking our first step, using the “potty” for the first time, or perhaps going to our first amusement park. Since we have a tendency as children to remember only the aspects of our lives in which stand out, we often forget the normal everyday activities that we partook in. More specifically, the general mechanics of childhood, which include: behavior among other children, play tactics, reactions to certain situations, behavior during solitude...etc. These general mechanics often explain why children act in certain ways, the reasoning they use to justify the act, as well as, their

¹ Research performed under the direction of Dr. Miles Groth (Psychology) in partial fulfillment of the Senior Program requirements.

thought processes throughout the reasoning. Many times we cannot measure these mechanics as children, which is why we study childhood and the way in which children perform certain tasks.

Play and imitation during the childhood years are two tasks which are thoroughly studied by psychologists. It makes sense that these tasks are studied thoroughly, because of the fact that the majority of our childhood experiences engulf play and imitation. When discussing any topic in psychology or any discipline, a definition of the subject matter is always appreciated. In an article titled *Effects of Play on Associative Fluency in Preschool-Aged Children* by Dansky and Silverman (1973) the authors turn to no other than Piaget, who supplies us with the definition of play as, "...any behavior, which is characterized by a predominance of assimilation over accommodation," (p. 38). In addition to this definition of play, Piaget follows it up with a definition of imitation in which he describes as the contrary to play, or a predominance of accommodation over assimilation. To better understand exactly what Piaget means by play and imitation, we must first dissect the words assimilation and accommodation. From what I understand, assimilation describes the process of receiving new facts or of responding to new situations in conformity with what is already available to consciousness. Similarly, accommodation can be described as the adjustment/adaptation to differences/circumstances. With that said, Piaget's definition of play can now be interpreted as any behavior in which there is an excess of observing differences rather than adjusting/adapting to them. At the same time, Piaget's definition of accommodation can now be interpreted as any behavior in which there is an excess of adjusting/adapting to differences rather than simply observing them.

It is obvious that children of all ages engage in playful activities throughout their childhood. Playful activities can be defined as playing tag with another child, playing "make-believe" in solitude or with another child, and various other games children play when they are young. One may bring up the question concerning the child's awareness and understanding of what they are doing when they engage in these playful activities, and whether or not they are the least bit aware of what they are doing. In an article titled *Young Children Know That Trying Is Not Pretending: A Test of the "Behaving-As-If" Construal of Children's Early Concept of Pretense* by Rakoczy, Tomasello, and Striano, two theories on the idea of awareness in children are introduced. The first is a theory by two psychologists, Leslie and Fodor, which states that, "...children as young as 2 years of age apply the same concept of pretense as do adults" (p. 388). It should be noted that when the authors use the word "pretense" it could be translated to mean "make-believe". The authors then use an example to help better clarify the explanation, "In pretending that

a telephone is a banana, for example, and in observing someone else pretend in this way, children do not represent the counterfactual situation ‘this is a banana’ as literally true. Rather, to avoid this, the child makes use of a specialized innate cognitive architecture involving an adult concept of pretense, meta-representing his or her own and others’ pretense in the form ‘person pretends (this is a banana)’” (p. 388). This first theory simply attributes children to a more mature thought process. The second theory, however, is not as encouraging for children. The authors make a note that the second theory can be referred to as the “behaving-as-if” construal of children’s early pretense performance and understanding. The main idea behind the second theory is one in which says that, “...children do not yet have the mature adult concept of pretending as acting intentionally and knowingly according to a counterfactual proposition that one believes to be false” (p. 388). The authors continue by saying that, “The behaving-as-if theory thus predicts that young children should make overextension mistakes, applying their concept of pretending both to behaving-as-if unknowingly and to behaving-as-if unintentionally” (p. 388). The figure below shows for the 2- and 3-year-olds, respectively, the numbers of pretense and trying responses as a function of model type.

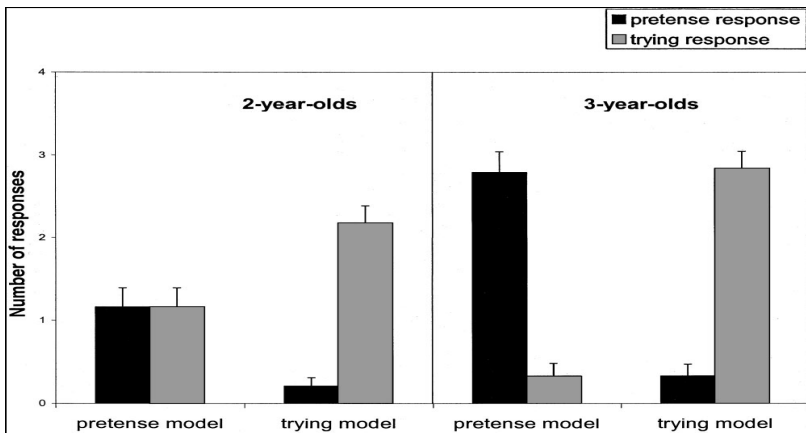


Figure 1: Mean numbers of Children’s Pretense and Trying Responses as a Function of Age and Model Type (Rakoczy, Tomasello, Striano p. 391)

When observing children either in public or behind closed doors, it is often common to see them imitating whatever they are looking at and/or playing with or whomever they are playing with. I feel as though engaging in the act of imitation is a crucial part in the development of young children. If one were to analyze how adults learn to perform certain tasks or learn how certain operations work, one may realize that

adults, like children, also engage in the act of imitation. Imitation by young children is said to occur as early as minutes after birth. Whether or not the children know exactly what and why they are imitating is to be researched later a bit more in detail. In an article by Colwyn Trevarthen titled *First Things First: Infants Make Good use of the Sympathetic Rhythm of Imitation, without Reason or Language*, the author makes an interesting observation that newborn babies imitate facial expressions, hand gestures, head shifts, looking and/or closing the eyes, and even simple sounds. These actions are almost always observed, however, the idea of imitation is never really within the limits of the reasoning. The author continues by explaining that, “In experimental demonstrations, imitating, defined as reproduction of the same form of act as the act presented, is a rather puzzling activity, elicited by a ritual of exaggerated ‘modeling’ behavior of an adult interrupted by waiting for a reaction from the infant” (p. 94). Simply stated, imitation is the reproduction of an act that was previously observed by the imitator. With prior knowledge of Piaget’s terminology, we can make the conclusion that there is a predominance of accommodation over assimilation.

Most people would agree that a young child playing “make-believe” is a form of imitation. Someone may be wondering how the child learned this form of play. Two answers that will properly address the question are readily at hand. The first is the idea that the child learned the behavior by himself. The child simply thought of playing “make-believe” in solitude. The second is the idea that the child learned the behavior through imitation or by watching another person engage in the act of “make-believe”. A recent study by Striano, Tomasello, and Rochat, found that before the age of two, young children displaying acts of “make-believe” with objects was a direct result of imitations and/or verbal instructions of adults.

Furthermore, in an article titled *On Tools and Toys: How Children Learn to Act on and Pretend with ‘Virgin Objects’* by Rakoczy, Tomasello and Striano, the authors make mention that if two-year-old children were not exposed to other people playing “make-believe”, the children would not have invented the solitary activity to play by themselves. In the same article, a study was performed to test the claims that pretense or “make-believe” actions on toys and instrumental actions on tools can be obtained by imitative learning. The experimenters presented ‘virgin objects’ (unfamiliar objects with no prior function) to a group of children and showed them that the objects can be used for different types of actions. In the “model phase” part of the experiment, the experimenters presented the ‘virgin objects’ to the group of children in which they demonstrated instrumental actions as well as different ways to play “make-believe” with the objects. The experimenters then initiated a “test phase” where they allowed the children to act on each object themselves up

to three times (Trials 1-3). The authors noted that the organization of the experiment allowed the researchers to take the children’s actions on the objects during the “test phase” as a simple measure of imitative learning and “make-believe” creation. Two interesting hypotheses were made for the experiment at hand. The first is the idea that both “make-believe” and instrumental actions can be learned through imitation. The second is the idea that since “make-believe” intentions are more complex, for children, they should be more difficult to understand and imitate than instrumental actions. These claims were consistent with and supported the major findings in the study.

Another article in which the main goal is to analyze the basics of which type of children engage in the act of pretending, as well as, general motives for which children perform this activity, is titled *A Transformational Analysis of Pretending* written by Fein (1975). The author makes an observation that at about 12 months of age, children may engage in simple forms of pretending. These may include drinking from an empty cup, or perhaps sleeping, when they really are not. At this young age, when children engage in the act of pretending, they usually use common household objects, and the act of pretending seems to be quite notable because the child desires food or sleep when it clearly is not necessary. A bit later in life, at around 18 months or so, the act of pretending takes on two new characteristics. The first characteristic is a shift of focus from the self to others (p. 291). An example of this shift can be seen when a child pretends to feed his mother, a doll, or perhaps a toy animal. The second characteristic is the idea that between 20 and 26 months the act of pretending becomes more independent of the features of immediate stimulation (p. 291). An example of this can be seen when a child treats an inanimate object as if it were animate. Below is a figure illustrating the scheme for a child pretending to feed a toy horse with an empty cup. It should be

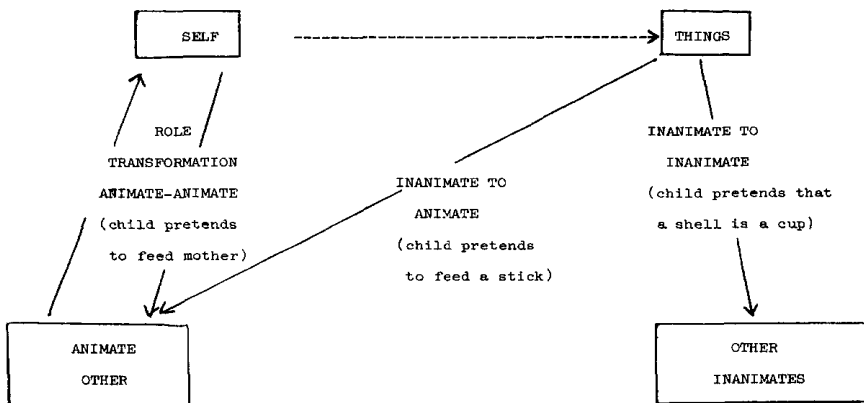


Figure 2: Transformation categories in role-related pretends (Fein p. 292)

understood that in figure 2 there are three categories of transformations. The first transformation is one in which there is a shift from the self to others. The second transformation involves the transition of an inanimate object into an animate one. The third transformation is a bit similar to the second, however, instead of the path going from inanimate to animate, the path goes from inanimate to another inanimate object.

When one thinks about the mechanics behind the activities of play and/or imitation, one may find that in order for children to engage in playful activities they must have two properties established. The first is that the children must be mindful they are partaking in the activity. This property encompasses the idea of cognition as well as the idea that children are using their minds to engage in the activities of play and/or imitation. The second is that the children must establish some sort of social structure in order for playing with other children to be possible. This may include becoming friends with another child/person, or perhaps just playing with another child/person for the time being. To further exhaust the subject at hand, in order for the activities of play and/or imitation to exist, there needs to be some correlation between cognition and social development.

In the article titled *It's Not What You Know, It's Who You Know: Older Siblings Facilitate Imitation during Infancy*, Barr and Hayne (2003) feel as though there has been much research on these two entities; however, the introduction of behaviorism slowed any further research between the two down to a halt. The authors state that Vygotsky's social constructionist theory stimulated the idea that social interaction plays a part in shaping children's cognitive development (p. 8). For Vygotsky, he feels as though, "...all cognitive functions develop in the course of social experience" (Barr and Hayne 2003). Furthermore, Vygotsky states that, "Only after a child has mastered a skill in a supportive social context will that skill be internalized so that it can be used outside the social context in which it was originally acquired" (Barr and Hayne, 1978). In a study by Barr and Hayne (2003), exploration of the role of older siblings in imitative learning during the infancy period took place. As I stated before, imitation plays a crucial role in the development of children and is a "potentially powerful mechanism" for incidental learning, especially during the infancy period. The authors continue by explaining that, "A small arsenal of studies has now shown that very young infants can acquire a wide range of new behaviors, simply by watching and repeating the actions of others" (Barr and Hayne, 2003, p. 9). To anyone reading this paper, they may have noticed that this argument has already been presented and supported in various studies. More so to anyone in general really, this argument, that children (infants) learn many new behaviors through imitation, is quite obviously true and makes the most common sense.

Much research was examined and recorded in the article by Barr and Hayne (2003), regarding play and imitation. The authors stated that the main goal of their research was to really analyze imitation in real-world settings. In order for the authors to execute this research, they asked parents to keep detailed diary records of their infant's imitations on a daily basis. Using the diary records enabled them to address two issues. The first issue dealt with age-related changes in imitation by 12-, 15-, and 18-month-old infants in the safety of their own home environment. The second issue dealt with the effect of siblings on the quantity and quality of behaviors acquired through imitation. Having formulated the two issues the authors were then able to directly compare imitation by age-related and sibling-related effects.

II. Observations/Case Study

My interest in play and imitation has grown throughout the years of my studies in psychology. Since childhood is the root of the human race, it must have a powerful impact on the development of children and eventually adults. I have recently been volunteering my time at the Early Childhood Center (ECC) at Wagner College. The Early Childhood Center is a positive environment for young children to learn and grow under the supervision of trained teachers as well as amongst each other. My particular volunteer work encompassed the youngest group of children at the ECC, the two-year-olds. The children in this group varied slightly in age from the youngest being two years, to the oldest being two years and seven months. It never really occurred to me how much of an effect one month can have on the development of a child until volunteering at the ECC. When using the word development, this includes speech and vocabulary, understanding concepts, as well as, simple directions, and even physical facial development!

One child, in particular, in which I took an unusual interest in was a boy named John (John's real name will be kept incognito due to rules of confidentiality). John was slightly younger than the other children. John was about 2 years of age while the other children averaged around 2 and 6 months years of age. To the average person this span of age may not seem to be of significance, however, after volunteering at the ECC it is a crucial difference. Due to this span of age, although not assumed as the only cause, John's vocabulary and speech were virtually non-existent. I say that the span of age may not be the only cause of his lack of speech because his nationality was not that of American descent. Rather, both of John's parents did not speak English at home, so a language barrier definitely hindered John's performance.

The first day at the ECC, John immediately took a liking to me. Until this day, I still am not sure why he felt so comfortable around me. It was quite hard to establish a relationship with him since he did not have much of a vocabulary. On the other hand, his emotions, interestingly enough, took the place of a vocabulary. The emotions I observed were mostly those of frustration and/or confusion. These emotions, I feel, originated at John's home. In the back of my head, while observing John, I couldn't help but feel as though something from home was bothering him. Perhaps it simply could have been that he was cranky, or over tired at that time of the morning, some people are simply not morning people (myself included)!

The second day volunteering at the ECC John noticed me as soon as I walked into the room. I felt as though his noticing me was a bit concealed because when I walked into the room he did not necessarily move toward me, however, his head turned and then focused back down to what he was doing prior to me walking into the room. John's interactions at the ECC were strictly solitary. He rarely interacted with the other children and only would interact with me. Our interactions together consisted of me mostly following him around the ECC, walking to and from the playground, and occasionally he would sit on my lap. I did not mind these limited interactions. Although John could not talk, his emotions spoke loud enough for me to hear.

One morning while observing at the ECC, John was rolling the fire truck on the floor contently. He appeared as though he was having fun and enjoying himself. At a random moment he let out a short four to five second cry, sounding most like frustration. He then stopped and acted as if nothing happened. It was as if a thought came into his head in which he did not like and so let out a cry, and as soon as the thought left his head he stopped crying. I am not sure if it was a coincidence or not but the day he was letting out these cries of frustration, he unusually wanted me to hold him in my arms. I correlated the random cries of frustration with the fact that John wanted to be held more than usual. The next couple of days I observed at the ECC John continued to let out the random cries, however, after about a week or two they subsided.

The children participated in a musical parade on one of the days I observed in the ECC. The majority of the children enjoyed the parade, including John. The children were given rhythm sticks and bells to play. Even though the children marched back and forth between the two classrooms, they seemed to have had fun.

Perhaps the most prominent example of imitation that I observed while volunteering at the ECC was when the children were on the playground. Once the children are let loose into the playground, the majority of them run wild all around as if the slides and toys are going to disappear. John was one of the children that did not

usually run while in the playground. On the contrary, there was this one boy who constantly ran to where he had to go. Even while in the classroom he often ran from toy to toy. John observed the boy run from one spot of the playground (point A) to another (point B). Once John had observed the boy run from point A to point B, he walked over to point A and walked slightly fast to point B. He seemed curious as to why the boy ran in that particular path, and it seemed as though he was testing it out to see what was so enthralling about it. After he had given it a trial run John retreated back to point A and again scurried over to point B, but this time a smile from ear to ear appeared on his face, and he immediately went back to point A. His last trial was at a running pace and he appeared to have loved every minute of it. Seeing his little legs scurry across the playground seemed to have made me especially happy. It was as though we both felt as if we had accomplished a great feat. The following observations could best be explained using the article by Barr and Hayne (2003), in which states that children learn to imitate simply by watching other children/people do certain things. John imitating the other boy running on the playground is exactly what Barr and Hayne (2003) talk about in their article.

Another prominent example of imitation was a time when I was observing John play in the sandbox in the classroom. He was playing with a bucket at the time and would fill the bucket with two handfuls of sand and then pick the bucket up and tilt it upside down. When he tilted it he spilt sand all over himself and the floor. After he repeatedly spilt the sand, I felt as though he did not understand that he had to keep the bucket over the sandbox, so I felt I needed to intervene. When he went to tilt the bucket upside down, I assisted him and helped him to keep it over the sandbox. I did this about four times. After a couple of attempts he would lift the bucket in the air and then briefly look over his shoulder to see if I was going to assist him in tilting it upside down. I felt this behavior was interesting because it appeared as though John knew that I was helping him in pouring the sand correctly back into the sandbox, however, looked to me to assist him in the process. He enjoyed the fact that he was able to imitate me pouring the sand into the sandbox but was not confident enough to do it himself.

Aside from John, all of the children at the ECC exhibited play and imitation one time or another. One girl, in particular, that comes to mind is a girl named Alice (Alice's real name will be kept incognito due to rules of confidentiality). Alice was not particularly close with me and actually, we really did not start talking and playing together until the last weeks of my volunteering. Compared to the other children her speech was quite impressive. Although she was somewhat shy, she spoke when she had to. One time at the ECC we were playing with play-dough and it seemed as though she

was imitating her mother make cookies. She verbally asked me to “make cookies” with her and insisted that we put “chocolate chips” on them (small rolled up balls of play-dough). Aside from “making cookies” with her she also wanted me to “make pancakes” with her. Once we “made the pancakes” she pretended to eat them. She did not necessarily put them in her mouth but it was close to it. Another time I was playing with play-dough with a boy and he was pretending that he was eating it however he actually put the play-dough in his mouth! His reaction was funny because play-dough does not necessarily taste that well and after putting the play-dough in his mouth he told me not to eat it. I thought him telling me not to eat the play-dough was also funny. Alice pretending to be her mother baking cookies with the play-dough would most likely support the information in the article by Rakoczy, Tomasello, and Striano about children engaging in the act of “make-believe”.

In my opinion, the beauty of life is that every person living or deceased has experienced a childhood at one time or another in their lives. As said before, whether enjoyable or something someone wants to forget, the memories will always be implanted in our heads. Childhood is a time when rules, norms, dos and don'ts are learned, however, at the same time we engage in that wonderful activity called play. Through play we learn to imitate which is a crucial part of development for children and is something we continue to do even when we get older. The unfortunate thing, however, is the fact that no one really remembers their childhood as vividly as one would like. Knowing this makes it difficult for people to understand why we imitate and how well it helps in the development in children. The fact that we continue to engage in play and imitation, as we grow older is helpful to psychologists and researchers; however, it is not the root of our play and imitation years, so knowing the cause of imitation may always be a mystery. As a growing society we must never forget the precious things we learned in our childhood, and play/imitation is definitely something we should never let leave our lives.

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Childhood: Social Interaction, Pretend Play and Imitation of Life

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The current paper aims to demonstrate the importance of social interaction, pretend play, and the imitation of life among children between the ages of 2.3 to 3 years old. It contains a literature review of past findings on how social interaction, pretend play, and the imitation of life play a major role in the development of a child. My own findings based on my placement of observing children at an Early Childhood Center help to confirm past findings as well.

I. Introduction

The current paper aims to discuss the importance of social interaction, pretend play, and the imitation of life among children between the ages of 2.3 to 3 years old. Play and interacting with others are the building blocks for proper child development and the foundation for adulthood. The paper discusses previous research and findings on childhood development as well as my own findings based on naturalistic observation of children in a preschool setting.

Social interaction, pretend play, and the imitation of life allow for a child to enter a world of imagination. By pretending, a child imitates life based on what they observe, acting in a way in which they believe they are socially expected to act. Pretending enables proper development for a child as well as strengthens their mental capacities through this fun process of learning. In addition, interacting with others trains them with the skills needed for forming relationships with others throughout life.

Burns & DeLoache (1994) believe the preschool curriculum is “designed to foster symbolic skills.” To introduce children to symbolic play in a preschool setting, a variety of objects must be available. These include dolls, trucks, play kitchen, stories, blocks, painting, and so on. With objects like these readily available for children, they are able to grasp their abstractedness and begin to engage in symbolic play by realizing what these objects may represent (Burns & DeLoache, 2004).

Koch & Leary (1992) explains how it was not until the 17th century that childhood was different than adulthood, that in fact, children were not small adults, it was

¹ Research performed under the direction of Dr. Miles Groth (Psychology) in partial fulfillment of the Senior Program requirements.

something more. Instead, childhood is a distinct period of life. In order to understand children, one must possess a “child sense”, “a special insight into the children and childhood that has roots in the investigator’s personal history” (Koch & Leary, 1992). In other words, it is an empathetic approach to children, a way of connecting to a young mind.

Meyers (2005) discusses Piaget’s theory of child development whereby a “child’s mind is not a miniature model of an adult’s”. Instead, “children reason in wildly logical ways about problems whose solutions are self-evident to adults”. Piaget believed that children between the ages of 2 and 6 are in the preoperational stage of development. In this stage, children represent things with words and images, lack logical reasoning, develop language, and think symbolically. During this stage of life, as the mental states develop, children interacting with others may engage in trying to understand what made a playmate angry as well as understanding the concept of sharing (Meyers, 2005).

In addition, Meyers (2005), discusses Erikson’s view on children at the preschool age. He believed that children around the age of 2 are in the “autonomy vs. shame and doubt” stage of development whereby they attempt to perform tasks independently. A child between the ages of 3 and 5 are in the “initiative vs. guilt” stage of development whereby they learn to begin tasks and be persistent in plans.

It is believed children learn how to develop relationships through pretend play (Bonawitz & Schulz, 2007). According to Piaget, he believed children learn about relationships through play and exploration of the environment. Piaget once stated “children construct knowledge by active exploration” (Bonawitz & Schulz, 2007).

Also, Meyers (2005) explains the egocentric self in that a child is unable to understand another point of view. Hence, the child believes only their point of view matters and can be perceived by others.

Around the age of two, children begin to associate abstract objects with the real world. By playing, they are better able to understand the relationship of both, as well as learn about communication and mental representations through symbolic play. Once again, Piaget’s theories are discussed in that he was a strong believer in mental representations through play, along with Vygotsky who believed symbolic play was significant in the development of a child (Bornstein, Haynes, O’Reilly, & painter, 1996).

Casby (2003) states “symbolic play is active, a purposeful use of symbols, something standing in for and representing something else.” Casby (2003), discusses how play is important in sensorimotor and preoperational stages of life, along with the development of communication and language skills (Casby, 2003). When analyzing children, the only qualities of a child that can be observed are play, behaviors, and

interactions. By observing children while engaging in such activities, observers are able to gain insight on how a child is developing (Casby, 2003). Early symbolic play demonstrates a child's mental representation of symbolic play and functioning (Casby, 2003). Children demonstrate functional-conventional play which includes the use of familiar objects while playing. A child will reproduce certain tasks with objects that are familiar to them. For example, a child may take a spoon and stir it in a bowl (Casby, 2003).

During early childhood, play progresses from the sensorimotor to pre-operational (Bornsetin et al., 1996), as mentioned above, a stage in childhood where children engage in pretend play, develop language, but lack abstract thinking. Children will engage in pretend scenarios, such as a child pretending to feed a doll, talking on a toy telephone, or using a block as if it were a camera to take pictures.

Bogdan (2005) discusses pretending in great depth, and how the earliest form of pretending is pretend play allowing for a child to act out imaginary scenarios. During pretend play, there are three types of activities taking place. A child usually engages in role playing, plays with functional objects, and bases their play on shared behavioral scripts (Bogdan, 2005).

Bogdan (2005) illustrates what pretend play is; an imitation of life. Pretend play occurs early in childhood and is caused by current and past interactions with adults as well as observing how others act in the environment. Pretend play is a solitary and interpersonal initiation of the young child into the ways of adult society and culture – a playful and often creative exercise in cultural conformity” (Bogdan, 2005). In other words, when a child pretends, they are imitating life and molding into the cultural norms, roles, and ways in which they are expected to act in society (Bogdan, 2005). “Young children must also figure out and emulate what adults do, how they do it, the norms they are obeying, and how they respond to and correct the youngster's progress” (Bogdan, 2005).

Most believe pretend play is crucial because it prepares a child for the adult world. Bogdan (2005) addresses the question “Why pretend play?” He believes playing is an “early fine-tuning” of adult behaviors, “rehearsing playfully is an old trick for self-training.” In addition, pretend play is a way in which a child is able to overcome temporary challenges (Bogdan, 2005). It allows for a child to create new experiences that help organize the ways in which they are developing.

El'Konin (1966), discusses symbolism and play “in which the use of objects and actions occurs is symbolical.” In addition, he explains a theory of two worlds that children possess; a world of reality and a world of play. The world of play is a child's

freedom, in which “the child leaves the world of restraint and reality” (El’Konin, 1966). In addition, he discusses Piaget’s conception of play as containing an integration or assimilation in which children alter their existing schema to fit new schemata. In other words, a child adjusts existing knowledge to fit new knowledge.

Fein (1989) suggests pretending is important because it “reflects the child’s growing capacity to create analogies (or symbols) which are increasingly ‘distant’ representations of events to which they refer.” It aids in a child’s growth and development of analogies and symbols. A child engaging in pretend play constructs internal representations of familiar objects with activities (Fein 1980).

Fein (1989) conducted a study addressing the question of how young children are able to pretend that one thing is another. When engaged in pretend play, there is a two role transformation whereby the child adopts the role of nurturing another while the other receives nourishment (Fein, 1989). The study consisted of sixty-six children exposed to cuplike objects and plush horse toys. The children were observed and results displayed 93% of the children engaged in pretend play by using the cuplike object to nourish the horse. Findings allow for a better understanding of previous research on pretend play in that “mental structures and processes underlie behavior in young children.”

Elder and Pederson (1978), discuss how Piaget and Vygotsky believe symbolic play is linked to the development of representational skills. Vygotsky (1967) believed early skill representation development is a perception of an object which dominates over its meaning. “Symbolic play is part of the process of liberating thought and meaning from concrete objects” (Vygotsky, 1967). In addition, Vygotsky (1967) believed that children require a “concrete signifier before they can represent objects symbolically”. Elder and Pederson (1978) explain the difference of symbolic thinking which is absent in the mind of a young child in comparison to that of an older child. A young child would use part of their body to represent something whereas an older child will think symbolically. For example, a young child will use their finger to represent a toothbrush and an older child will pretend to hold a toothbrush.

A study conducted by Edler and Pederson (1978) examined two factors: objects presented within pretending activities and similarities between the objects and those objects represented. Children between the ages of 2.5 to 3.5 were presented with six realistic objects (comb, spoon, etc) and two dissimilar objects. They were asked if they were familiar with the objects and asked to perform the appropriate task with each. Also, when asked to perform a task in which the object was not intended to perform, some children stated “I can’t”. All age groups performed equally well except for the 2 ½ year olds because older children were able to relate certain objects with their appropriate task.

Kearsley, O’Leary, Ungerer, & Zelazo (1981) believe symbolic play is the most important of cognitive development for a child. Symbolic thought increases the mental processes. Kearsley et. al. (1981) stated, based on research by Piaget, “a gradual increase in the ability to use objects symbolically in play are physically dissimilar from those used in real life.”

Bornstein et al. (1996) analyzes the question on how much influencing parents have on their children. Parents assist in their children’s development by sharing in experiences with them such as play and other enjoyable activities. Parents shape their children and prepare them for the real world as they grow. Parents induce learning when playing with children, displaying to a child what is appropriate and what is not (Bornstein, et al., 1996). Since children imitate what they see, nonetheless are they reenacting based on their own observations.

In addition, Bornstein et al., (1996) explains the differences in language development among children in a play situation. Children whose language is more fully developed are expected to engage in more symbolic play. Girls tend to have more advanced language skills than boys.

Slade (1987) believes that symbolic play occurs in stages developed by Piaget. Early symbolic thought development leads to the appearance of representational function in objects as well as play. Symbolic play is one of the most noticeable and important transitions from infancy to childhood. Slade (1987) discusses how attachment styles affect the rate of symbolic exploratory play in children. The maternal relationship acts as the facilitator for the amount of symbolic play a child engages in (Slade, 1987).

II. Observations

At the Early Childhood Center (ECC), I observed children between the ages of 2.5 to 3 years old in a preschool environment. Each observation took place on Tuesdays and Thursdays from 1:00 to 4:00, and consisted of play time, snack time, story telling, sing a longs, playground, and arts/crafts. I observed ten children, Steven, Ava, Joey, Brian, Alex, Isabella, Natalie, Michael, Luke, and Leila.

Before working at the ECC, I was allowed to look around the classroom to obtain an idea of the type of setting I would be working in. The classroom was arranged exactly how Burns & DeLoache (1994) stated a preschool classroom should consist of. I observed a play kitchen, dolls, trucks, blocks, painting, books, and so on. Any object a young child is interested in was present in the classroom.

When I arrived at the ECC, it was the first day the children were without parents. I wanted to make an impression as if I was there to be a playmate, not an older

figure who they must listen to. My very first observation took place in the playground and I must admit I was a little overwhelmed. It took some time for me to adjust and learn how to connect with the children at their mind level considering I have never worked with children before.

Steven, Ava, and Joey were constantly crying asking for their mothers. I tried to comfort them as well as explain to them that school is a fun place where you play and make friends with others and mommy would be coming shortly. The first thing I noticed among the children was the attachment styles, anxious-resistant insecure attachment, secure attachment, and anxious-avoidant insecure attachment.

I was able to confirm Slade's (1987) theory on how attachment predicts a child's interest in playing and exploring an environment based on what I observed. Steven, Ava, and Joey were displaying signs of anxious-resistant insecure attachment, whereby they were not interested in playing or participating with other children. Isabella displayed signs of secure attachment in that she was slightly distressed when her mother would leave, quickly showing an interest in exploring and playing, then becoming very excited when her mother arrived for dismissal.

Midway during my placement, a new arrival, Leila, displayed extreme levels of anxious-resistant insecure attachment. She would cry the entire time, did not interact with any children, and constantly wanted an adult by her side. If at times she did calm down and you left her for a moment, she would begin crying once again. As weeks went on, she showed major improvement, crying every so often, only for a few minutes. Although I did notice she would cry when easily frustrated, not necessarily for her mother.

The remaining children displayed signs of anxious-avoidant insecure attachment in that they explored freely on their own, playing, somewhat interacting with each other.

At the start of my placement, Joey displayed signs of aggressive behavior whereby he was unable to keep his hands to himself several times. At times he would engage in rough and tumble play with others a little younger than himself. As a result, some children kept away from him, or backed away when approached. I believe this is due to his presence in a new setting with others his age and may be unsure how he is expected to act. He may have been upset or frustrated, not understanding why he is at the ECC. Therefore, he displayed his emotions through aggressive play, making sense because depression in children is expressed through aggression. Joey's behaviors improved throughout the placement as a result of adapting to his new surroundings and realizing it is a place of discipline.

On the other hand, Steven misbehaved throughout the entire placement. He did

not display signs of aggressive behaviors, only problems with listening. He ignored any instructions given, often told numerous times until he did listen. In addition, if others were not listening, he would approach them telling them what they should be doing. He exemplified the understanding that rules need to be followed but failed to do so himself.

As time progressed, I noticed the children were beginning to show an interest in being at the ECC. The attachment styles eventually dissipated, although some of the children did cry at arrival, which then stopped upon entering the classroom. They began interacting with others, but still displayed some signs of solitary play. As days passed, they began socializing taking part in playing with each other.

I was able to confirm theories on pretend play scenarios presented by Bornstein et al. (1996). When observing the children, I noticed make believe role playing occurring throughout the classroom with one another.

About three weeks into my placement, I noticed more significant amounts of pretend play occurring than in the beginning. Many of the children were taking part in make believe scenarios, particularly one child named Steven. Steven became fascinated with a doll insisting he play with and only with the doll. He was not interested in any other toys, or partaking in any activities. At some points he would place the doll in a highchair in the play kitchen, sitting alongside, feeding her and talking to her. A few times he asked me to wrap her in a blanket and put her in his shopping cart. He would take the doll shopping, placing some toys from around the room in the cart. When playtime was over, he would place her with the rest of the dolls telling her to go to sleep. One of the teachers believes this is due to him having an infant baby sister at home, and reenacting the role of taking care of a baby.

In addition, according to Bogdan (2005), he believes there are three types of activities taking place within pretend play. A child usually engages in role playing, plays with functional objects, and bases their play on shared behavioral scripts. Two of the children, Natalie and Michael, were both pushing a shopping cart around the classroom with a doll in the baby seat. Natalie stated "Come on honey, we need to buy the baby some toys" to Michael. By observing this, I was able to confirm role playing based on shared behavioral scripts.

Also, Joey would sometimes ask me to sit in the play kitchen so he can cook me dinner. He would set the table with dishes and utensils and tell me "The food is almost ready." He would then place food on the table telling me "It's hot don't touch!" At times, he pretended to have burned himself on the stove.

In addition, Michael would frequently pretend to be a cashier in the play kitchen. The remaining children were given play money by Michael and were asked to

come buy some food. The children lined up, some with dolls in shopping carts, and bought several foods. The first thought that came to mind was the imitation of life based on what they observed in both the household as well as settings outside the home.

Also, according to Bornstein et al. (1996) and their discussion in language competence among children in the play situation, I was able to confirm the differences between the males and females. When engaged in various activities throughout the classroom, girls tended to talk more than the boys. I was also better able to understand the girls, and observed they were more sociable than the boys. Those children who did not have fully developed language, only speaking in phrases, were engaged in more solitary play. I was unable to understand what these children were saying to me, only a few words, but realized other children did understand them. As a result, these children acted as a translator telling me what the child was trying to say.

According to Meyers (2005), egocentric self inability to understand another point of view, is present in children. In other words, the child believes only their point of view matters and can be perceived by others. This was clearly evident among the children in that they only care about their own reasoning, not an adult's. When the children were given instructions, some can be resistant at first asking "Why?". When given an explanation, they asked "But why?" It was an ongoing pattern among them.

Besides working with children between the ages of 2.5 and 3, I had the chance to observe children between the ages of 3 and 5. The major difference I observed among the children is independence. When I arrived for the first time to work with the older children, I was asked to assist them in the bathroom. I approached a young girl at the sink asking her if she needed any help, attempting to place some soap on her hand. She grabbed it from me saying "I can do it myself!" The first thought that came to my mind was how mature and independent they were compared to the younger children. It seemed as though she was offended when someone offered any assistance. I realized I was still at the mind level of 2 ½ year olds. At this point, I felt the need to once again connect with the children at yet another mind level.

I was able to relate my observations of the older children to Erikson's view discussed by Meyers (2005). He believed some children at the preschool age are in the "autonomy vs. shame and doubt" stage whereby they express independence.

III. Conclusions

Overall, social interaction, pretend play, and the imitation of life among children between the ages of 2.3 to 3 years old play a major role in child development. These activities during childhood are the building blocks for the development of a person.

Pretend play is considered a fun way of learning and what child does not want to play?

As mentioned above, social interaction, pretend play, and the imitation of life allow for a child to enter a world of imagination. Through imagination, a child leaves the world of reality and enters a world of play, a world of learning, free of restraints.

Of all previous research on pretend play in childhood, I believe Bogdan's (2005) view is the strongest when supporting the importance of pretend play in childhood. Pretending for a child is acting out imaginary scenarios. It is an imitation of life. What a child sees, a child does. Bogdan (2005) believes pretend play is a type of self-training which molds and prepares you for the real world.

In addition, I strongly agree with Piaget's beliefs mentioned in the previous literature. Piaget, believed children learn about relationships through play and exploration of the environment. I honestly feel if a child is able to interact with others starting at a young age, they will be able to form relationships throughout life very easily. Piaget once stated "children construct knowledge by active exploration" (Bonawitz & Schulz, 2007).

My placement at the Early Childhood Center was a wonderful learning experience. I was able to gain insight on how children learn through play. Being able to observe children has given me a better understanding of how children learn at an early age. I have been thinking of working with children in the future for a while now, but this experience has clearly made up my mind.

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Section IV: Critical Essays

Atonement, Guilt and Masochism in Fin-de-Siècle Europe: Charles Baudelaire, Thomas Mann and Stefan Zweig

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Rejection of modern post-industrial society and its subsequent lifestyle pervades throughout literature, art and science in fin-de-siècle Europe. This zeitgeist of historical pessimism led writers such as Charles Baudelaire, Thomas Mann and Stefan Zweig to a pessimistic view of the male, who as the sex charged with leadership of the human race, was guilty of leading humanity into the industrialized age which these writers found so unlivable. Man's folly was a sin against all humanity, but particularly against the patriarch's traditional charges: women who were seen as innocent victims led astray by their male leaders, and the next generation. In atonement for their sin Baudelaire, Zweig and Mann idolize these innocents, and this atonement is at the root of these writers' fascination with Masochism.

Heilleiner defines historical pessimism in his "Essay on the Rise of Historical Pessimism in the Nineteenth Century" (1942) as a pessimistic view of "what place men assigned their own epoch in relation to the past and particularly to the future...as defined by the contemporary 'time-consciousness' " (Helleiner 514-15). This "time consciousness", according to Helleiner, exists not only separately from the realms of Philosophy and History, but in fact serves as the edifice of the prevailing historical philosophy (Heilleiner 515). The time consciousness of fin-de-siècle Europe as defined through the theories of decadence and degeneration (West) is decidedly pessimistic; the prevailing thought of the late nineteenth century was that European society had run its course and factors such as the stress of life in the industrialized metropolis and the degeneration of the human gene pool would soon lead to the fall of the Modern European Empire.

These factors of society's degeneration seemed to have their roots in empirical science. As European society advanced itself towards industrialization, a higher standard of living and the centralization of different ethnicities in urban areas was to many scientists a society which had escaped from Darwin's "survival of the fittest" rule for the

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, Vienna and Berlin*.

advancement of a species (West). The evidence of this degeneration of the human gene pool was found in the “depopulation” of Europe in the late nineteenth century which France, already demoralized after the loss of the Franco-Prussian War, was the first to witness in the 1850s (Offen 650). Heilleiner suggests that “the invasion of History by Natural Science” (Heilleiner 535) such as the work of Darwin, not only provided a rationale for the pessimism of the fin-de-siècle, but also furthered pessimism towards an overall feeling of nihilism. By replacing God as the driving force of human history with science, mankind found that blame for his failures could only rest on his own shoulders. However, contemporary thought often did not place blame for society’s woes on all of mankind, but instead focused its blame on men. Offen describes the placement of guilt upon the male in relation to the European depopulation in “Depopulation, Nationalism, and Feminism in Fin-de-Siècle France” (1984). Using the views of Jacques Bertillon, the founder of the Alliance Nationale pour l’Accroissement de la Population Française, Offen demonstrates that the contemporary view of the cause of depopulation was that it was a “man’s issue” caused by a lack of “patriarchal pride” (Offen 648). As absurd as it may have been for Bertillon and his contemporaries to dismiss the role of women, they nonetheless remained innocent of any blame in the “time-consciousness” of the era. It seems that man, by replacing God with the ideals of progress and science had, by leading society into the industrialized age, taken the burden of original sin off of the shoulders of Eve and onto his own. The guilt of this new original sin prevails in the works of Charles Baudelaire, Thomas Mann and Stefan Zweig as these writers show the callous and self-destructive nature of man in relation to the women and children who they exonerate of their transgression through idolization.

Throughout his works, Baudelaire idolized the Vieux Paris which man had destroyed in his push towards industrialization. Baudelaire creates a manifesto for his view of the inhospitable Post-Industrialization Paris in his poem *The Swan* (1861). Using the metaphor of the Swan without water to symbolize mankind in a modern world devoid of humanity, Baudelaire expresses humankind’s inability to cope with a society that has progressed too fast for its people to keep pace; “The form of a city changes more quickly alas! than the human heart” (Baudelaire). Baudelaire’s description of the city where both he and the swan wander alludes to the Vieux Paris which Baudelaire loves; “the *new* Carousel” fails to match his nostalgia for the old Carousel, described in the third stanza. Baudelaire then mentions that the Carousel used to be the location of a menagerie. This allusion to royalty allows the reader to infer that the swan has been released from this menagerie to fend for itself in world which it is not suited, and creates a political message that man’s progress towards capitalistic republics may have been false. Without the

royalty there to care for the swan, the swan is free but lost; just as mankind is lost under the republic where his freedom has become a burden. This burden of personal responsibility leads Baudelaire to reminisce over the society which man has squandered in the name of progress, which make his memories “heavier than rocks”.

The following stanzas of *The Swan* shift their focus from Baudelaire and the swan to the story of Andromache weeping for her husband at the banks of the River Simoïs, thereby creating a parallel between the forsaken Paris and the forsaken woman. Andromache is the ultimate symbol for a woman’s devotion to her man. In fin-de-siècle Europe this devotion has become tragic, as the male has led women down the same self-destructive path he has taken. By alluding to the Greeks, Baudelaire also draws comparisons between Modern Europe and the fallen civilization of Ancient Greece. The modern Parisian woman replaces Andromache, using the Seine as her Simoïs, as she weeps over her man and his society as they rot in decay. Baudelaire furthers this idolization of women in *To a Passerby* (1861).

An ambiguous and universal “woman” passes Baudelaire on the streets of industrialized Paris as they “roar with a deafening sound”, which prevents communication between the two as they pass. The woman is described as being in “heavy morning (and) majestic grief”, much like the Simoïs mourning over decay in *The Swan*. However, in the context of the poem’s shifting narrative voice, “The street (3rd person)... I drank (1st) ... O you (2nd)”, Baudelaire could very well be the party in this majestic grief over the sins of the male. The passerby, unlike the Simoïs, does not allow the man (Baudelaire) to corrupt her as he has corrupted his world. The verse “For I know not where you fled, you know not where I go” tells the reader that this woman stopped following the man with blind faith, and instead runs from him and his self-destructive nature. However, it is “too late” for the woman to change her course because she is victim to the same fall of civilization as the rest of Europe. Baudelaire once again demonstrates this by alluding to Ancient Greece with the verse “Her leg was like statue’s” reminding the reader of that women are victims of the approaching “eternity”, which in the pessimistic philosophy of the time period connotes the approaching collapse of civilization into emptiness; Nietzsche described the contemporary view of the future as a belief that there would be no “day after (tomorrow)” (Heilleiner 536) because of the degeneration that man has brought upon himself.

Similar to Baudelaire, Thomas Mann’s allusions to Ancient Greece build a metaphor about the hopelessness of modernity in the novella Death in Venice (1912). Like Baudelaire’s Paris, Mann presents his own city in decay with the romanticized city of Venice under the spread of cholera. The city itself had long been regarded in

nineteenth century thought as a “timeless” place (Leppman 67), which in combination with Mann’s use of a “classist” style, allows the author to disorient the reader’s sense of time reference. Mann uses this disorientation as a way to further the impact of his allusions to fallen civilizations (by the fourth paragraph he has already alluded to the Romans, Byzantines Greeks). By imparting his story with a timeless quality, he implies that this tale of a civilization’s downfall is not mere fiction, but rather the story of all great civilizations which must eventually perish. Aschenbach, the main character, lives in a “rustic cottage” and his dedicated work ethic recalls quiet, dignified nobility that seems out of place in the fin-de-siècle era. Mann describes Aschenbach as a man “ready for life in the world before its time” (Mann 12), however like Baudelaire, Aschenbach cannot escape the reality of man’s post-industrialized world.

This reality is that the post-industrialized world has no place for beauty or passion, and Aschenbach’s downfall results from his submission to passion over his restrained and professional persona. The young Polish boy Tadzio, the object of Aschenbach’s desire, is the representation of beauty itself and is described as “of consummate beauty” so great that he “had never beheld anything so accomplished, be it in nature or art” (Mann 45). For Aschenbach, Tadzio’s idealized beauty results from his innocence; as a young boy who has not yet entered the capitalist work force, Tadzio has escaped the burden of guilt described by Heilleiner. Mann furthers Tadzio’s innocence from the sin of the male by giving him an androgynous appearance “honey colored hair...lovely mouth” (Mann 45). Tadzio’s uncorrupted and natural beauty represents for Aschenbach the ideal of a natural “fiery, playful fancy, the product of joy” (Mann 9), which Aschenbach has never been able to achieve through his rigid work as a writer, but has always desired as his crowning achievement (Mann 9). Mann uses imagery in Tadzio’s description as a “Greek statue” (Mann 9), to further Tadzio as a symbol of natural and innocent beauty. The image of the Greek statue of pure white marble symbolizes a beauty which is untainted by history or reality and exists as a piece of beauty for the sake of beauty alone.

Unable to create the same natural beauty that Tadzio embodies, Aschenbach’s diligent and methodical creative process is overly stressful and likened to a clenched fist, rather than a hand at rest. However successful this method may be for Aschenbach, the constant demands he places upon himself lead him to illness (Mann 13). Aschenbach’s overly ambitious work habits serve as a metaphor for the male’s blind drive for progress which has led his society into the illness of the industrialized era. Man’s constant drive towards progress has made passion and beauty impossible, therefore when Aschenbach gives in to his passion, it leads to a complete loss of dignity, and ultimately to death.

Aschenbach's attempt at vanity and subsequent demise symbolize the futility of attempts at beauty in man's industrialized world; in man's drive for progress he has sacrificed art, and to believe that beauty still has a place within the industrialized world is as false as Aschenbach's makeup; therefore Aschenbach's only method of survival in the world the male has created for himself is to continue his constant drive for progress by ending his vacation early and escaping the plague (Mann 69). However, this same drive for progress has driven Aschenbach to illness in the past (Mann 13). This is Aschenbach's dilemma; Modernity and its frantic pace are too much for him and lead him to exhaustion, but to chase Tadzio's natural and innocent beauty will lead to illness as well.

This same paradox imposes itself on the city of Venice. The Venetian government denies the presence of the disease in order to maintain its industry which is based on the ideal of Venice as a city of beauty (Mann 98), however the disease itself stems from Venice's idealized beauty; cholera is a disease transmitted through contaminated water, and Venice's charm is largely based on its canal system. The Venetian government's corruption places guilt on to the male as the unsuspecting tourists fall victim to the disease. Throughout the epidemic, Tadzio and his other young playmates remain uninfected by the disease while the older Aschenbach and others die in Venice. However, Mann's description of Tadzio reveals that despite his beauty and innocence, he too will one day fall victim to the inhospitable industrialized world: "he is sickly, thought Aschenbach" (Mann 62). Mann foreshadows that eventually Tadzio will fall victim to the same fate as others in the industrialized world and his beauty will be lost.

Like Baudelaire and Mann, Stefan Zweig also idolizes the victims of man's industrialized world in his epistolary work *Letter from an Unknown Woman* (1922). Zweig's unnamed woman serves the same purpose as Baudelaire's anonymous passerby in *To a Passerby*; by leaving the woman's identity unknown, he presents a commentary on all women. Zweig also makes his man the anonymous "writer R." (Zweig 182) to symbolize the male in general. Zweig furthers the woman's ambiguity by classifying her in four traditional roles: the young girl, the young adult, the prostitute and the mother. Three of these four roles convey the innocence of the traditional view of women; the girl, the young woman, and the mother are devoid of sexuality and act towards the male with an innocent and naïve infatuation. The woman refers to R., a man who repeatedly rejects her love, as "darling" (Zweig) and despite the unrequited nature of their romance, she "remember(s) every passionate detail of their relationship" (Zweig 184). The woman's exaggerated naivety allows Zweig to create a strong sense of Pathos towards women who have been abused by their patriarchs. The woman follows her man back to Vienna and

gives him her virginity, but R. treats her callously and forsakes his patriarchal responsibilities as he takes on more and more partners without ever returning the love these women feel towards him. The writer's sexual conquests serve as a metaphor for the male's drive for progress, and like the men who brought about the Industrial Revolution, he forsakes women in his drive for the 'more is better' view of industrialized society. Much like Baudelaire's dying Paris and Mann's plague, Zweig's male protagonist is charged for his sins when he finds out about the death of this young child and the woman kills herself after sending him a farewell letter. This tragedy is a symbol for the decay of society brought about the inhumanity of the industrialized world; the death of a mother and child can only contribute to the plague of depopulation.

The fourth role of the woman in this text, however, is decidedly against the traditional role of the "fairer sex". The prostitute represents the notion of the "femme fatale" who uses her sexuality to prey on men rather than rely on them, but somehow the woman in this work retains the Pathos of a woman completely devoted to man. Zweig accomplishes this by showing that the woman's decision to sell herself is done only for the sake of R. The idolization of the innocence of femininity is never questioned.

The woman's devotion to R. and her willingness to sell her own body in order to serve him are classical characteristic of masochism as outlined in the novella *Venus In Furs* (1870) by Leopold von Sacher Masoch. Masoch's novella is the tale of a man named Severin, who in order to maintain a relationship with Wanda, the woman he idolizes, becomes her personal slave and relishes her abuse as it serves as proof of his devotion. Zweig's novella certainly portrays the description of a masochistic relationship as the female protagonist endures mistreatment all the while continuing to see her lover as the intellectual and moral superior, and lives vicariously through his happiness "I lived only through you in those days" (Zweig 193). The woman's Masochism serves as Zweig's greatest tool for Pathos as the reader sees the error of the woman's sacrificial relationship to a man who is beyond moral reproach. Zweig uses this Pathos through the use of metafiction; the woman's letter is actually a text within a text. Masoch's work also makes use of metafiction. The story of Severin and Wanda is actually a manuscript given to Severin by an unnamed mentor as a thinly veiled warning of the dangers of the submissive relationship he plans to develop with the real life Wanda. Both works also serve to teach lessons to their readers. As Zweig's story ends, R. has a revelation of the sin he has committed against his "undying love" and feels the "cold current" (Zweig 211) of remorse sweep over him. With this revelation, Zweig adds a final message that men are guilty of mistreating the women that rely on them, and if they do not resist their hunger for progress soon the "flowers in the vase" (Zweig 211) will be gone as their

world falls into decay. Zweig's open ending leaves room for R. to repent for his sins against women.

During the fin-de-siècle, the rise of feminism was certainly a source of blame for the depopulation phenomena which afflicted most of Europe, however the prevailing thought of the time, the era's "time consciousness", was that the inherent blame for the degeneration of society lied on the shoulders of men. Writers such as Baudelaire, Mann and Zweig all placed blame for the decay of society on man's decision to progress into modernity. In atonement for the sins of their gender, these writers idolized the feminine and used masochism to further their penance for the unworthy male.

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The Need for Creativity in the Physics Laboratory

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The United States is facing a great deficit of technical minds. Many would-be scientists are never discovered because of a negative experience with science in high school. The secondary level physics laboratory experiments as well as those at the introductory collegiate level are highly undervalued and a greater emphasis on creativity might be the solution. Physics should be taught in such a way that is engaging and effective; science classrooms should uphold the same academic integrity as other disciplines. Students should be expected to write research papers and laboratory reports, design and execute experimental procedures, analyze error analysis, and clearly present classroom material before their peers. All of these skills are true of scientists and other technical professionals. A special attempt to design low cost experiments that can be tailored to either educational level is essential to encourage young scientists and engineers. The teaching of these skills in high school and at the beginning of college will cultivate a new generation of technical minds.

I. Introduction

In March 2005, the National Center for Education Statistics (NCES) published “Trends in Undergraduate Career Education.” By comparing data from the Completions Survey of the National Center for Education Statistics (NCES) Integrated Postsecondary Education Data System (IPEDS) and the Higher Education General Information Survey (HEGIS), the NCES found that the number subbaccalaureate and baccalaureate degrees awarded in engineering and architectural fields (including science and math, but not medical or computer fields) declined from the 1984-1985 to 2000-2001 school years. Subbaccalaureate degrees in these areas declined by 5.8% and baccalaureate degrees declined by 4.2%. The NCES suggests that since the number of degrees awarded in these technical fields declined for both subbaccalaureate and baccalaureate students, there must also be a decline in the jobs available in that career market.² The United States Department of Labor (DoL) Occupation Statistics show a similar trend. In 1998, technical fields

¹ Research performed under the direction of Dr. Otto Rath (Physics) in partial fulfillment of the Senior Program requirements.

² Hudson, Lisa, and Ellen Carey. Trends in Undergraduate Career Education. National Center for Education Statistics. U.S. Department of Education, 2005. 1-3. 14 Mar. 2008 <<http://nces.ed.gov>>.

comprised 4.7% of the American workforce. As predicted, in 2001 the figures fell to 4.52%.³ Yet, statistics in 2006 do not follow this trend. The percentage of engineering and architectural baccalaureate degrees fell from 6.5% in 2001 to 5.4% in 2006,⁴ while the percentage of jobs in the same fields rose from 4.52% to 5.0%.⁵ This discrepancy in statistical data suggests that when the current technical workers retire, there will not be enough qualified people to fill the open jobs. Since there are not enough people graduating in science related fields, it might be assumed students are not given adequate exposure to technical fields before postsecondary education.

Organizations such as the American Association of Physics Teachers (AAPT) and the National Science Teacher's Association (NSTA) have released guidelines for science classrooms in order to pursue excellence in the quality of education as well as to provide students with an in depth exposure to science in high school. As explained by the National Research Council (NRC), "A school laboratory investigation (also referred to as a lab) is defined as an experience in the laboratory, classroom, or the field that provides students with opportunities to interact directly with natural phenomena or with data collected by others using tools, materials, data collection techniques, and models."⁶ The writers of these criteria are specific that a lab should be an "experience" that allows students to "interact directly" with physical properties. The NSTA's formal position statement on science courses explains specific skills students should acquire as a result of these experiences.

Throughout the process, students should have opportunities to design investigations, engage in scientific reasoning, manipulate equipment, record data, analyze results, and discuss their findings. These skills and knowledge, fostered by laboratory investigations, are an important part of inquiry—the process of asking questions and conducting experiments as a way to understand the natural world.⁷

With this in mind, laboratory experiments should not simply allow students interaction with phenomena, but challenge them to create, discover, present, and analyze the phenomena as

³ "Occupational Employment Statistics." U.S. Department of Labor: Bureau of Labor Statistics. 24 Oct. 2007. 01 Mar. 2008 <<http://www.bls.gov>>.

⁴ "Digest of Education Statistics." National Center for Education Statistics. June 2007. Integrated Postsecondary Education Data System. 04 Apr. 2008 <<http://nces.ed.gov>>.

⁵ "Occupational Employment Statistics."

⁶ National Research Council (NRC). 2006. *America's lab report: Investigations in high school science*. Washington, DC: National Academy Press. p3.

⁷ National Science Teachers Association (NSTA). 2004. NSTA Position Statement: Scientific Inquiry.

well. These ideals also give teachers ideas of how to create diverse lesson plans to allow students with different learning styles opportunities to fully understand the material.

The NSTA has certain expectations for lesson plans in the high school physics classroom. Students should receive instruction every day and have opportunities to collect data weekly. Laboratory experiments should help increase students' understanding of the concepts being explored and the group work involved should challenge students to complete complex tasks together and to assume different roles within the group.⁸ With so much for the physics teacher to consider, the guidelines of the NSTA and AAPT help give a teacher clear goals to follow during class. According to the NSTA and NRC a laboratory course should:

- have a definite purpose that is communicated clearly to students.
- focus on the processes of science as a way to convey content.
- incorporate ongoing student reflection and discussion
- enable students to develop safe and conscientious lab habits and procedures.⁹

Similarly, the AAPT's Classroom Guidelines are clear that effective physics teaching includes:

- laboratory activities as an integral part of classroom instruction.
- interactive demonstrations
- opportunities to make presentations to classmates on topics being studied.¹⁰

According to these standards, teachers should make their purpose and goals for the class and make those goals clear to students. Teachers can use experiments, reports, and presentations to teach content in alternative ways to lecture-based lessons. By making reflection and discussion an integral part of the classroom, students might begin to feel more comfortable using their critical thinking skills and presenting information to groups of people. Laboratory activities and procedures are important for students to participate in, in order to learn laboratory etiquette. Even the students who are not pursuing science any further than high school will have the opportunity to learn to how to work with their peers, follow directions, solve problems, and present information. When using demonstrations, teachers should make sure to do so in such a way to keep students involved.

⁸ National Science Teachers Association (NSTA). 2007. NSTA Position Statement: The Integral Role of Laboratory Investigations in Science Instruction. p2.

⁹ NRC 2006, 101-102

¹⁰ American Association of Physics Teachers (AAPT). 2002. AAPT Guidelines for High School Physics Programs. p10.

The use of interactive demonstrations is also helpful for teachers to appeal to students of all learning styles. To illustrate magnetic fields, a teacher could make a three-dimensional magnetic field in a bottle as suggested by Richard Cannon of Southeast Missouri State University of Cape Girardeau, Missouri. Cannon suggests using a 250-ml gas bottle, 15-cm test tube, #12 cork stopper, clear tubing, a cow magnet, and 25 g of iron filings.¹¹ Students can look at and hold the bottle to gain greater understanding of magnetic fields. Similarly, students can demonstrate the properties of friction as in Jonathan Reichert's article "How Did Friction Get So 'Smart'?"

Imagine a block of plastic on a smooth wooden horizontal plane. Is there any frictional force acting on the block? Certainly not any in the horizontal direction. If there were such a force, it would cause the block to accelerate in the particular horizontal direction that this frictional force was acting. Since the block remains at rest, there is no frictional force. Now tilt the wooden plane an angle. Suppose the block remains at the same location on the plane; it does not slide. There must be a frictional force acting on the block in the direction along the plane and to the right. Tilt the plane in the other direction at [the same] angle and again the block remains at rest along the plane. There must be a frictional force acting, this time to the left. If the plane is returned to its original horizontal position, the friction disappears.¹²

According to Reichert, the most important question is "How did the friction 'know' to change direction when we changed the [direction of the] plane's angle?"¹³ Students have the opportunity to lift the horizontal plane themselves, change its direction, and find how much to tilt it in order to get the box to slide. This might be an excellent introduction to friction; after seeing this demonstration, students will have a foundation of understanding to then learn the equations and properties associated with friction. A third useful demonstration illustrates lens polarization. Gerd Kortemeyer from Michigan State University suggests using the Liquid Crystal Displays (LCDs) of basic pocket calculators to illustrate the use of lens polarization in students' daily lives. Kortemeyer suggests that a teacher should remove all the top polarizer layers from the calculators before class. During the lesson, the students will perform a simple calculation on the calculator. Since the top polarizer is gone, the students will not be able to see their results. The teacher will pass out the polarizer layers to each student and they can hold it over the screen to see his

¹¹ Cannon, Richard. "Three-Dimensional Magnetic Field in a Bottle". The Physics Teacher. Volume 29. Number 5. May 1991. p311.

¹² Reichert, Jonathan F. "How Did Friction Get So 'Smart'?" The Physics Teacher. Volume 39. Number 1. January 2001. p29-31.

¹³ Reichert, 29.

or her results.¹⁴ This demonstration, coupled with lecture based learning about lens polarization, will aid in students' in depth understanding of polarization concepts.

Another tool for teachers to illustrate classroom concepts is the NSTA Science Objects. The NSTA has created these computer-based tools to enhance the science classroom and give teachers an alternative way of introducing new concepts. These Science Objects can be used for a whole class, but are best suited for individual exploration. For example, the Science Object based on Newton's First Law of Motion, begins with two videos. In the first, a plastic cup is placed on a table with an index card on top. A quarter is placed on the index card. Next, someone flicks the index card off the cup in such a way that the quarter falls into the cup. The second video is similar, but shows a man pulling the tablecloth out from underneath three place settings on a table. At the end of this section, students are encouraged to try one, or both, themselves.¹⁵ The cup, index card, and quarter would be easy and inexpensive to demonstrate in class. The next section of this Science Object leads students through a logic-based discovery of the Inertia Law; they establish this law as "Objects at rest tend to remain at rest unless acted on by an unbalanced external force."¹⁶ To finish this section, the students have a moment to gain clarification and then check their understanding by answering a series of questions. They are able to check their answers immediately to aid in the learning process. The next section challenges the first by showing a video of objects such as a book and a golf ball being pushed, but eventually stopping. There is an optional hands-on activity is as follows:

Grab a few things from around the house---some you can roll across the floor (a ball, toy car, rolling pin, or glass) and some you can slide across the floor (a box, a book, or your cat, who won't get out from in front of the refrigerator). Roll and slide these things across various level surfaces, such as tile and carpet. Watch carefully what happens. What do they do? Speed up, slow down, or keep going forever?¹⁷

Students will discover that ultimately, the things they pushed or rolled across the floor will slow down and stop. Next, they are asked to think of examples of objects in every day life that move without slowing down or stopping. There are several examples on the page with descriptions as to their validity. To begin to describe the phenomena of

¹⁴ Kortemeyer, Gerd. "Little Gems: A Polarizer Demo Using LCDs". The Physics Teacher. Volume 46. Number 1. January 2008. p58.

¹⁵ "Learning Objects: Newton's First Law." The NSTA Learning Center. National Science Teacher Association. 16 Mar. 2008 <<http://www.nsta.org>>.

¹⁶ Learning Objects: Newton's First Law.

¹⁷ Learning Objects: Newton's First Law.

friction, there are videos of a ball rolling on three differently sloped tracks and asking questions for understanding. The next activity allows students to change the amount of friction on a track to model ice, hardwood flooring, sandpaper, low pile carpet, deep pile carpet, grass, and Velcro. The computer program models how a ball would roll on these materials. Once friction is established, the final law is written as, “Every object persists in its state of rest or uniform motion in a straight line unless it is compelled to change that state by forces impressed upon it”¹⁸ and the word “inertia” is introduced. To conclude the Science Object, common misconceptions are addressed and a short quiz is presented to evaluate understanding. A teacher would be best to do one section at a time with students to be sure students understand the concepts and to keep their attention. Other Science Objects from the NSTA include Mechanics, Energy, Matter, Sound, and Light, as well as topics in Astronomy, Biology, Ecology, Earth Science, and Chemistry. These free, computer-based teaching tools are excellent ways for a teacher to introduce technology into the classroom.

While these demonstrations and computer activities are helpful tools for learning and teaching, a teacher should not depend on them. The NRC has stated, “While reading about science, using computer simulations, and observing teacher demonstrations may be valuable, they are not a substitute for laboratory investigations by students.”¹⁹ Actual, hands-on laboratory experiments are the best way for students to learn concepts from an inquiry point of view. Creativity on the part of the teacher, as well as the student, is crucial.

The NSTA and AAPT are both clear that creativity is an integral part of the learning process. One way of including creativity in the lab course would be to give students a problem to solve and allow them to create their own process and method of solving it. Students will have to practice problem solving skills as well as reasoning skills to be able to assess the success of an experimental design. This type of experiment will give students the opportunity to present their procedure and results to the class. The opportunity to present in the physics classroom is not only important to learning professional laboratory skills, but will be beneficial to students in every area of life. Every profession includes opportunities to present information to an audience.

Giving students the opportunity to present gives them confidence and pride in their work. Undergraduate institutions continue to be involved in science conferences to share research and foster a sense of scientific community. High school level science conferences would encourage pride and confidence as well as get students excited about

¹⁸ Learning Objects: Newton’s First Law.

¹⁹ NRC 2006, 3.

science. When students spend time designing an experiment, carrying it out, and analyzing their data, they will be eager to share what happened. Students might even want to participate in such an event multiple times.

Allowing teachers to be creative is just as important. Perhaps a more appropriate word for creative, in this instance, would be innovative. Teachers must find new and exciting ways to introduce material. They should be able to peak students' interest, hold their attention, and still be able to communicate the lesson content clearly so students gain understanding of the material. The use of innovation in laboratory experiments will keep material fresh, as well as exciting. An innovative teacher will, hopefully, encourage and inspire creativity in his or her students. It is especially important that experiments are designed so that it is possible for students to gather incorrect data. This way students must problem solve to correct their procedure requiring active participation. All too often, experiments are cut and dry and students rush through the procedure in order to finish and end up missing the intent of the experiment. Creativity on the part of the teacher is essential in keeping a class of students engaged. If students are engaged, they are more likely to absorb material and less likely to be distracted from the lesson.

Second in importance to students understanding lesson material, students should learn laboratory procedures. A critical component of this should be the discussion and application of data analysis and error. Students should know how to read a graph and interpret what it might mean. Teachers can encourage this by assigning graphing projects along with each experiment. For example, if the experiment was to find the gravitational force by dropping tennis balls from some height, students should be expected to plot the distance the balls fell over what time and interpret their graph to find their experimental terminal velocity. As well as being a useful tool for data interpretation, these graphing assignments will help to enforce the subject matter addressed in the experiment.

Error analysis is equally as important as data analysis. A good scientist will use their points of error to help refine an experimental procedure. However, the concepts of data analysis are not simple. Some college students may be able to handle statistical analysis with X^2 tables, but that would be too much to expect from a high school classroom. If a teacher's goal is to teach students the skill of analyzing error, then the traditional method is not appropriate either. When the following equation is used, it gives students an unrealistic perception of experimental error analysis:

$$\frac{\text{Measured Value} - \text{Expected Value}}{\text{Expected Value}} \times 100 = \text{Percent Error}$$

The flaw in this equation is the “Expected Value”. If teachers are trying to train a generation of scientists and other technical professionals, they cannot assume an expected value for anything. In any type of industry laboratory, the experiments have never been performed and, therefore, no expected value exists. In his article “Having Fun With Error Analysis”, Peter Siegel of California State Polytechnic University proposes an alternative way to introduce error analysis to his students. He states the importance of teaching uncertainty to physics students,

For the most part, students are more interested in the value of measurement itself than its uncertainty. They tend to view error analysis as tedious busy work, which takes away from the enjoyment of the experiment. This is unfortunate but understandable since in undergraduate laboratory experiments, uncertainties usually seem neither particularly relevant nor exciting to determine. To best motivate the students, activities should be designed for which the uncertainty is as important as the value of measurement itself.²⁰

Siegel splits his class into several small groups and gives each group an empty M&M bag, 10 loose M&Ms, and a scale. There is one unopened bag of M&Ms that each group is given the opportunity to take measurements from. The class is told to figure out how many M&Ms are in the bag as well as to estimate an amount of uncertainty. The group closest to the actual number of M&Ms in the bag with the smallest uncertainty wins the bag of M&Ms. Each group is given the freedom to establish their own procedure, but most groups will measure the weight of the M&Ms in the bag by subtracting the empty bag weight from the full bag weight. Students then acquire the weight of an individual M&M by measuring all 10 loose candies and dividing by 10. Most groups will find an amount of uncertainty by guessing. In a post-lab discussion, Siegel teaches his class a technique for finding uncertainty:

We need to estimate the uncertainty for each of the three measurements and propagate the errors. The absolute uncertainty in M is the sum of the absolute uncertainties in M_{bag} and M_{wrapper} , i.e., $\Delta M = \Delta M_{\text{bag}} + \Delta M_{\text{wrapper}}$. The relative uncertainty in N is the sum of the relative uncertainties in M and m [where m is the mass of the individual M&Ms], i.e., $\Delta N/N = \Delta M/M + \Delta m/m$. Using our balance, whose smallest division on the scale is 0.1g, the engineering students first estimated an instrument uncertainty of 0.1g for a single mass measurement: $M_{\text{bag}} = (90.2 \pm 0.1)$ g and $M_{\text{wrapper}} = (2.2 \pm 0.1)$ g. This gives $M = (88.0 \pm 0.2)$ g, or a .25% error in M . . . Adding the [percent error of M and m] results in a 1.45% error or ± 1.5 in N . Since N for the different groups varied by more than one

²⁰ Siegel, Peter. “Having Fun With Error Analysis.” The Physics Teacher. Volume 45, Number 4. April 2007. p232.

M&M, students felt that this error estimate was too small. . . . After some discussion, the class as a whole was comfortable with a 2.2% error [found with a scale on 0.15g increments] or an uncertainty of N of 2 or 3.²¹

Using this classroom activity, students have an engaging, creative, and fun first experience with error analysis and uncertainty. This type of analysis can be used with each experimental assignment throughout the semester to reinforce practical laboratory skills with students.

Participating in laboratory experiments is the most effective way to teach both classroom material and laboratory skills. Therefore, it is essential that a physics teacher have well thought out experiments and questions for students to consider. The following are discussions on sample laboratory experiments for high school as well as introductory physics laboratories.

II. Laboratory Experimental Procedures

Circuits LEDs

Light Emitting Diodes (LEDs) are an inexpensive and effective indicator for use in electricity experiments. Inspiration for this experiment came from Martha Lietz's article "Make a Mystery Circuit with a Bar Light Fixture" from the April 2007 publication of *The Physics Teacher*. The original experiment used "black box circuits".

In a black box circuit, only the light bulbs are visible and the wiring in these circuits is hidden from the students. The students are then presented with the challenge of deducing the nature of the electrical connections hidden by the black box. The students may remove one or more light bulbs from the circuit to watch how the brightness of the other bulbs changes and, from this, deduce which bulbs are connected in series and which are connected in parallel.²²

In the case of this particular experiment, light bulbs were originally considered, but the LEDs are a much safer option when used with a breadboard. The intention for this experiment was to allow students exposure to technical materials while also exploring the properties of series and parallel circuits. In order to create specific instructions for this assignment, I spent time in the laboratory, building simple circuits and more complex ones. I found that the circuits would short out if there were not equal amounts of LEDs used. For example, if a parallel circuit were to be set up as in figure 1, only the green

²¹ Siegel, 233.

²² Lietz, Martha. "Make a Mystery Circuit with a Bar Light Fixture." *The Physics Teacher*. Volume 45, Number 4. April 2007. p244-245.

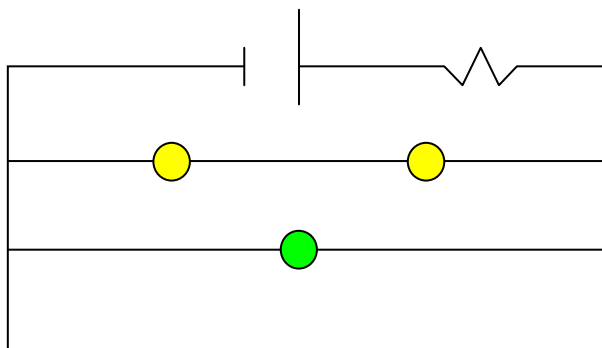


Figure 1: Parallel Circuit

LED would light up because there would be too much resistance. However, if there were two green LEDs and two yellow LEDs, all four would light up. This posed a problem since one of my requirements for the college level students would be to construct a complex circuit made of series and parallel LEDs. So, I spent more time working with the circuits until I found my final design.

The use of LEDs in the classroom will also help students to make connections to every day examples of circuits. Most traffic lights now use LEDs instead of a single bulb. The LED Light website has a whole list of household and other products using LEDs instead of more traditional light bulbs. Students will be able to observe the Physics concepts learned in class outside of the classroom.

High School Experiment:

Goal: For students to make drawings of circuits. Several circuit boards will be set up around the room and groups have an allotted time at each station. They can turn the power source on to see the LEDs light up and make a conceptual drawing of how the circuit is wired.

Materials:

- 9 LEDs (three yellow, green, red, or white LEDs)
- Breadboard
- Wires for connecting circuits
- A 1ohm resistor
- Voltmeter and Ammeter (for College level experiment)
- Power Source

Procedure:

1. Connect the power source to the circuit board.
2. Plug in the power source and turn it on.
3. Write a few sentences of observations.
4. Draw a diagram of the circuit.
5. Turn off the power supply, unplug it, and disconnect it from the circuit board.
6. Repeat above procedure at each station.

Thinking Points:

- What did you notice about the LEDs in series? Why were they not all along the same line?
- What did you notice about the LEDs in parallel? Why were there even numbers of LEDs?
- What was difficult or simple about making drawings from the circuits observed?

College Experiment:

Goal: For students to construct several circuits based on drawings given in the assignment. Each group will have a breadboard, a voltmeter, an ammeter, ten LEDs, a 1ohm resistor, wires, and a power source.

Materials:

- 9 LEDs (three yellow, green, red, or white LEDs)
- Breadboard
- Wires for connecting circuits
- A 1ohm resistor
- Voltmeter and Ammeter (for College level experiment)
- Power Source

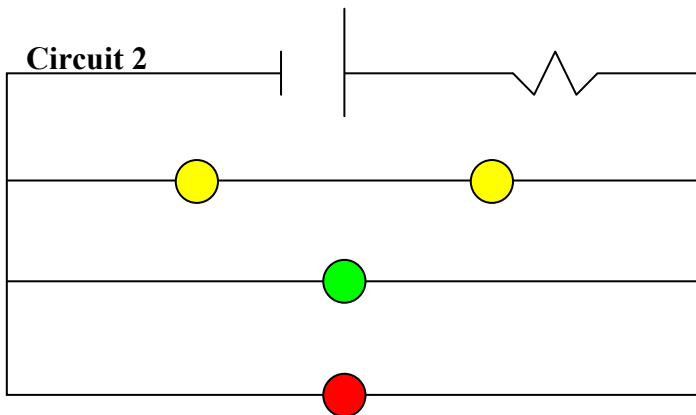
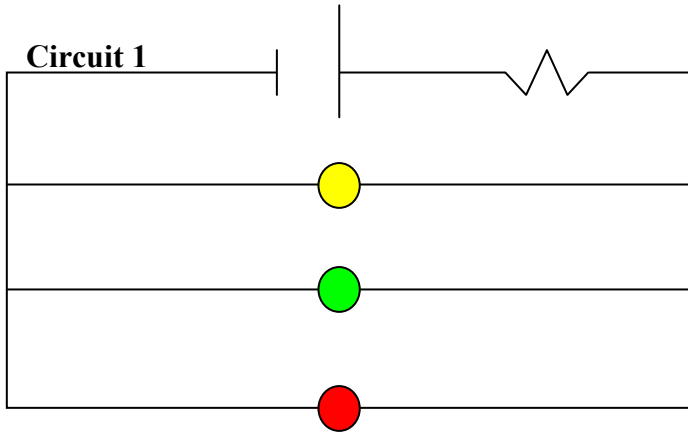
Procedure:

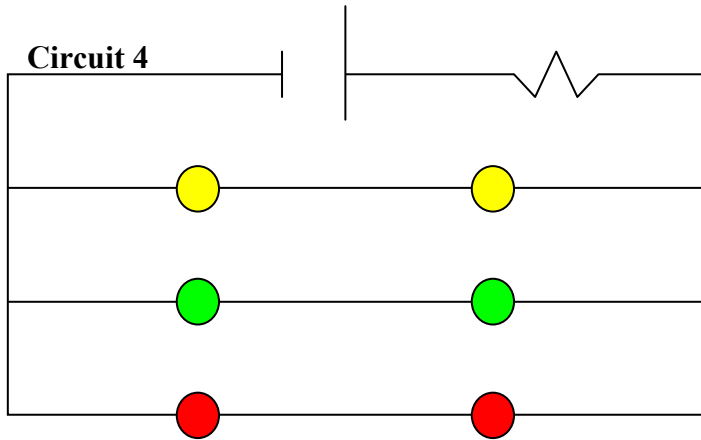
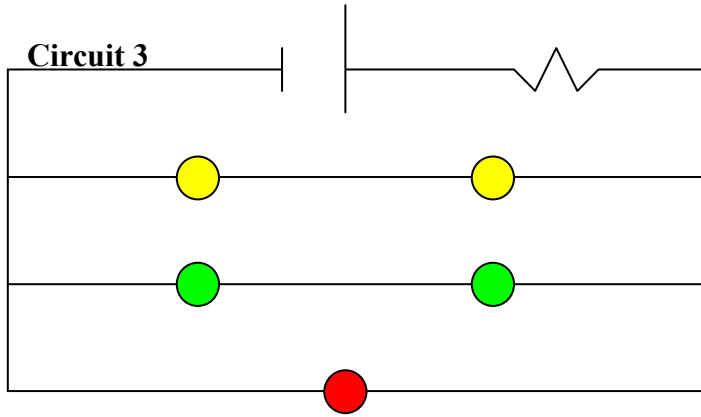
1. Measure the resistance for each LED. You will need this information in the Thinking Points section, so it may be helpful to label your diagrams based on which resistance LED is used.
2. Construct a circuit based on the drawings in the lab experiment assignment.
3. Connect the power source to the circuit board and turn it on.
4. Make note of which LEDs light up and which do not.
5. Turn off the power supply and disconnect it from the board.
6. Repeat for each diagram.

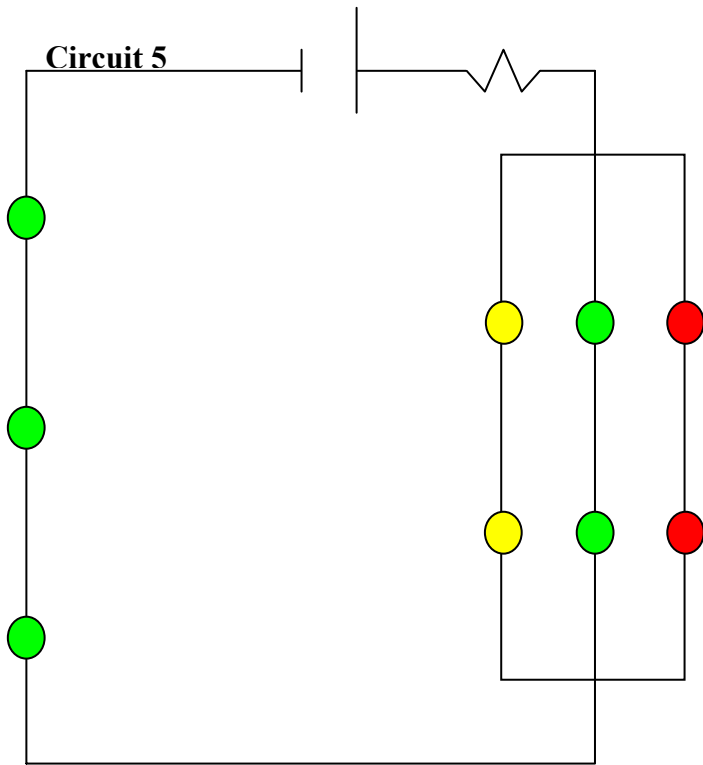
Thinking Points:

- Calculate the total resistance over each circuit.
- What reasons might account for the LEDs that did not light up? What changes could you make to the diagram in order that they all light up?
- What makes LEDs practical and useful? What are some examples of common uses of LEDs

Diagrams:







Collisions

It is difficult to illustrate collisions in the physics classroom in such a way to help students to understand the equations and lecture material; this is especially true of the high school classroom when the force due to friction is traditionally ignored. Also, many of the collision illustrations students are familiar with are not completely inelastic and, therefore, more complicated. For example, many students are familiar with the game of pool and can identify and explain what happens when a cue ball hits another ball. They might say one ball goes in one direction and one goes in the other, or that the second will follow the first and slowly roll to a stop. Yet, these are illustrations of elastic and partially inelastic collisions.

This particular experiment was designed in an effort to show clearly an inelastic collision in an inexpensive fashion. Cathy Abbot of Lexington High School in Lexington, Massachusetts created the original experimental design as an alternative to the traditional ballistic pendulum design. In her article in *The Physics Teacher*, Abbot says,

The basic physics treatment for this situation is similar to the ballistic-pendulum problems that appear in every introductory text... While trying this as a

demonstration with my class this year, I was pleased both with the level of interest it generated, and the apparently reasonable results we got from our calculations...Students were able to produce accurate, confirmable results using very inexpensive materials (less than \$3 for a complete classroom set.)²³

Abbot's experience with this experiment shows its effectiveness as an experiment in allowing students the ability to get quality measurements that can be analyzed.

High School Experiment:

Goal: To observe inelastic collisions and compare expected (calculated) results to experimental results.

Materials:

- 1 inch steel balls
- Grooved Rulers
- Stop watches
- Clipboards
- Graph paper
- Balances
- Paper cups or Chinese food cartons
- Thick, light weight foam sponges

Procedure: Before the experiment is performed, the teacher will have assembled the cup or food cartons with the sponges in order that the ball will fit securely without rolling out.

1. Assemble a ramp by placing one end of the ruler on a stack of two textbooks.
2. Measure the weight of the steel ball and the cup/food carton with sponges secure inside.
3. Tape the graph paper to the clipboard and place at the end of the ramp.
4. Place the cup/food carton at the end of the ramp so that the ball can roll into it.
5. Roll the ball down the ramp and measure the distance the ball and cup/food carton travel.
6. Perform 10 trials, recording data each time, and finding the average travel distance.
7. Use the measured weight of the ball and cup/food carton to discover the theoretical distance the ball and cup/food carton will travel.

²³ Abbot, Cathy. "'Pretty Cool' Collision Experiment". *The Physics Teacher*. Volume 35, Number 7. October 1997. p397-398.

Thinking Points:

- Were the theoretical and experimental values the same or different?
- If the values were different, by what factor were they different? (Divide the theoretical value by the experimental value).
- Why do you think the values were different?

College Experiment:

Goal: To observe inelastic collisions and compare expected (calculated) results to experimental results and to calculate the force due to friction and find the velocity of the ball.

Materials:

- 1 inch steel balls
- Grooved Rulers
- Stop watches
- Clipboards
- Graph paper
- Balances
- Paper cups or Chinese food cartons
- Thick, light weight foam sponges

Procedure: Before the experiment is performed, the teacher will have assembled the cup or food cartons with the sponges in order that the ball will fit securely without rolling out.

Part 1:

1. Assemble a ramp by placing one end of the ruler on a stack of two textbooks.
2. Measure the weight of the steel ball and the cup/food carton with sponges secure inside.
3. Tape the graph paper to the clipboard and place at the end of the ramp.
4. Place the cup/food carton at the end of the ramp so that the ball can roll into it.
5. Roll the ball down the ramp and measure the distance the ball and cup/food carton travel.
6. Perform 10 trials, recording the distance the ball and cup/food carton travel and the time that elapses between the collision of the ball and when the ball and cup/food carton stop moving.
7. Find the average travel distance and time elapsed.

8. Use the measured weight of the ball and cup/food carton to discover the theoretical distance the ball and cup/food carton will travel.
9. Find the velocity of the ball and cup/food carton after collision.

Part 2:

1. Place the ball and cup/food carton on the clipboard and tilt it until the ball and cup/food carton begin to slide. Measure the height of the clipboard in order to find the angle it makes with the table.
2. Find the force of sliding friction by multiplying the weight of the ball and cup/food carton with the gravitational force and the angle found in the first step.
3. Using the equations for conservation of energy and conservation of momentum, find the velocity of the ball.

$$\text{Conservation of Energy: } \frac{1}{2} (M + m) v'^2 = fad$$

$$\text{Conservation of Momentum: } Mv = (M + m) v'$$

NOTE: M is the mass of the ball, m is the mass of the cup/food carton, f is the force of friction, d is the distance the ball and cup/food carton slide, v is the velocity of the ball, and v' is the velocity of the ball and cup/food carton.

Thinking Points:

- What was the difference in values when friction was ignored and when it was taken in to account?
- What was difficult in this experiment?

Center of Mass

Inspiration for a center of mass experiment comes from Joseph L. Spradley's article "Meter-Stick Mechanics" in the May 1990 edition of *The Physics Teacher* publication. Spradley explains experiments for reaction time, center of mass and friction, equilibrium, acceleration greater than 'g', and pendulums, using meter sticks almost exclusively. Spradley explains, "Opportunities to teach introductory physics overseas or in a small school are often hindered by a lack of adequate scientific equipment. The possibilities of innovation can be illustrated by several quantitative demonstrations that

use meter sticks and require little else than a few known weights.”²⁴ These demonstrations provide inexpensive, simple, and effective ways to use investigative experiments as a teaching tool.

Spradley’s equilibrium demonstration is the foundation for this center of mass experiment. He stacks meter sticks off the end of a table to show that equilibrium will cause the meter sticks to stay balanced and not fall. For this experiment, students will be expected to calculate the center of mass for the system.

It might be best for students if the table is taped before the beginning of the experiment in order to have a physical and visual reference point for zero. If 1/8 of the bottom meter stick hangs over the table (that is, 12 centimeters), the table should be taped 88 cm from the end; the end of the table will be the reference point. The first stick’s center of mass will be at -32 cm. The second stick will hang over the edge of the table so its end is at 28 cm (with the end of the table as the reference point). Therefore, the center of mass of this meter stick will be at -22 cm. The third stick will hang over the table by 53 cm and its center of mass will be at 3 cm. The fourth stick will hang over the table by 103 cm (it will not be over the table at all) and its center of mass will be at 52 cm. The equation to find total center of mass for the system will include all this information:

$$x_{cm} = \frac{m_1x_1 + m_2x_2 + m_3x_3 + m_4x_4}{m_1 + m_2 + m_3 + m_4}$$

Considering all the masses are equal, the equation can simplify to:

$$x_{cm} = \frac{mx_1 + mx_2 + mx_3 + mx_4}{4m} = \frac{x_1 + x_2 + x_3 + x_4}{4}$$

The masses cancel, making the center of mass the sum of the individual center of masses: $x_{cm} = (-38) + (-22) + 3 + 53 = -4$ cm. As this indicates, the center of mass is over the table, so the meter sticks do not fall. The goal of the experiment is for students to make this connection. Introductory college students should also be able to make the assumption that this holds true for all different shapes.

High School Experiment:

Goal: To observe and discover the properties of center of mass.

Materials:

- Four meter sticks per group

²⁴ Spradley, Joseph L. “Meter-Stick Mechanics”. The Physics Teacher. Volume 28. Number 5. May 1990. p312-314.

- Scale or given weight of meter stick

Procedure:

1. Place the first meter stick on the table so that $1/8$ of the stick hangs over the edge of the table.
2. Place the second meter stick on the first stick so that $1/6$ of the stick hangs over the edge.
3. Place the third meter stick on the second so that $1/4$ hangs over the edge.
4. Place the fourth meter stick so that all four are balanced without toppling over.

Thinking Points:

- What length of the fourth stick hangs over the one underneath it?
- How much of the fourth stick is still on the table?
- What can you determine about center of mass for these meter sticks?
- In general, what can you assume about center of mass?

College Experiment:

Goal: To observe and discover the properties of center of mass by designing an experimental procedure for multiple shapes of materials.

Materials:

- Four meters sticks per group
- Four Jenga blocks per group
- Four building blocks per group
- Any other rectangular shaped material (four per group)
- Scale or given weight of materials

Procedure:

Part 1:

1. Find a way to balance all four meter sticks one on top of the other, off the edge of the table without any of them lying directly on top of or below another. The end of two touching meter sticks should not be at the same point.
2. Record how far each meter stick hangs off the one below it.
3. Calculate the center of mass for the given system. (Measure the weight of the meter sticks if not provided)

Part 2:

1. Choose another material and find the theoretical center of mass based on the information found in Part 1.
2. Perform the experiment with the second material.
3. Record how far each block hangs off the one below it.

Part 3:

1. Choose a last material and find the theoretical center of mass based on the information found in Part 1 and 2.
2. Perform the experiment with the second material.
3. Record how far each block hangs off the one below it.

Thinking Points:

- Was the center of mass proportional for each system?
- Were your results surprising?
- How was your experimental procedure? What would you have done differently?

Rotational Motion & Inertia

This experiment originated as an activity for the 2001 Eastern Massachusetts Physics Olympics. Karen Bouffard explains, “This activity was first demonstrated for me by Bill Franklin as part of his [Physics Teaching Resource Agents] workshop...[I was] pleased to find it an important teaching tool for the concept of circular motion.”²⁵ In this activity, students push a heavy ball through a masking tape course and into a goal without crossing the tape or hitting any obstacles. They are timed and given penalties for leaving the course, hitting obstacles, or missing the goal. The competitive nature of the game allows students to work together in teams towards a common goal. It also allows for interesting class discussions because students are thinking more about winning and less about physics.

We observed that our students, without thinking about it, exerted an inward (centripetal) force on the ball with a broom a number of times to keep it going in the circle. So at the end of the activity we asked the students in what direction a force must be exerted to keep an object in circular motion. Some replied with the standard “outward” or “centrifugal” force. When we called attention to their

²⁵ Bouffard, Karen. “Physics Olympics.” The Physics Teacher. Volume 39. Number 1. January 2001. p46-47.

behaviors in executing the course, grins appeared on their faces as they confronted their preconception. The relationship between inertia and straight-line motion, with an added centripetal force, suddenly gave them a kinesthetic appreciation of what had previously been a theory many of them never took to heart. It is a wonderful bonus when an Olympics activity provides such a “teachable moment”.²⁶

This activity uses creativity from all participants. Teams must figure out how to complete the course quickly without error and teachers must create a course that will challenge students, but not be so difficult so that they are unable to realize the forces at work. The original activity used an old bowling ball, acquired from a bowling alley. If one is not available, bocce balls are a good substitute.

High School Experiment:

Goal: To discover some properties of rotational motion and inertia by using this experiment as a race.

Materials:

- Bocce Ball or Bowling Ball
- Broom
- Cones and Other Obstacles
- Some sort of goal
- Stop watches

Procedure:

1. The course will be set up before hand by the teacher to include a starting line, two complete circles, some swerving, and a goal.
2. Each team gets 5 minutes to “sweep” the ball through the course as a warm-up and decide who will be their “sweeper”. The ball can be pushed with the broom from behind to get it rolling, but not dragged with the broom from in front or behind – the ball must be rolling at all times.
3. Each team runs the course while the other teams time them.
4. The team with the shortest time wins. Time penalties are as follows: Knocking over an obstacle – 10 seconds; Going off course – 20 seconds; Missing the goal – 30 seconds.

²⁶ Bouffard, 47.

Thinking Points:

- How much force did it take to get the ball rolling?
- What was your team's technique to win? What worked and what did not?
- Were the circles easy or hard? What did you have to do to stay on course? Did you rotate centrifugally or centripetally?

College Experiment:

Goal: To discover some properties of rotational motion and inertia by using this experiment as a race and to calculate a theoretical time for a constant velocity.

Materials:

- Bocce Ball or Bowling Ball
- Broom
- Cones and Other Obstacles
- Some sort of goal
- Stop watches

Procedure:

Part 1:

1. The course will be set up before hand by the teacher to include a starting line, two complete circles, some swerving, and a goal.
2. Each team gets 5 minutes to "sweep" the ball through the course as a warm-up and decide who will be their "sweeper". The ball can be pushed with the broom from behind to get it rolling, but not dragged with the broom from in front or behind – the ball must be rolling at all times.
3. Each team runs the course while the other teams time them.
4. The team with the shortest time wins. Time penalties are as follows: Knocking over an obstacle – 10 seconds; Going off course – 20 seconds; Missing the goal – 30 seconds.

Part 2:

1. Measure the length of the course, including the radius of the circles, and calculate the total distance.
2. Determine a reasonable velocity by having someone push the ball across the room and timing them.

3. Given the coefficient of friction for the surface, find the amount of power needed to keep the ball moving.
4. Calculate the time it would take, theoretically, to run the course.

Thinking Points:

- How much force did it take to get the ball rolling?
- What was your team's technique to win? What worked and what did not?
- Were the circles easy or hard? What did you have to do to stay on course? Did you rotate centrifugally or centripetally?
- How did the experimental and theoretical values compare? What would be an explanation for any discrepancies?

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Emilie Flöhe: A Modern Figure of Correspondence amongst the Arts in Fin-de-Siècle Vienna

Courtney Perez (Arts Administration)¹

During the turn of the century in Vienna, the attitudes of a select group of artists and scholars began to change along with the exterior aesthetics of the city. The Secession group and its followers strived to break free from the restraints of a country controlled by conservative and Christian bourgeoisie in order to obtain political and economic freedoms. Women in particular played an important role in the reform movements in Vienna, especially Emilie Flöhe, a predecessor to feminists and leader of the dress reform movement. Emilie Flöhe was a vital figure in Viennese culture during the fin-de-siècle, representing the correspondence of all art forms emerging from fashion, jewelry, design, architecture and painting.

The youngest of four children, Emilie Flöhe was born in the suburbs of Vienna on August 30th, 1874. Her mother, Barbara Martin Flöhe, was Catholic and her father was a Protestant art school graduate named Hermann August Flöhe. After years studying French, piano, and needlework, at the age of thirty Flöhe and her two sisters, Pauline and Helene, opened a fashion salon specializing in the new reform dress. The salon, called *Schwestern Flöhe*, was created by three middle class women thanks to an important award won by the Flöhe sisters for successfully designing commissioned outfits.



Emilie Flöhe. Vienna

The reform dress was the specialty of the *Schwestern Flöhe*, granting women comfort and freedom in movement. This new dress was to replace the restricting and unhygienic corset which doctors and feminists were denouncing at the time as it led to disease and fertility problems. “Turn-of-the-century Vienna, with a population of nearly two million, was the political, cultural, and fashion center of the multinational Austro-Hungarian Empire” (Wagener 1). With such a growing population and

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, Vienna and Berlin*.

the corset outdated by the year 1902, the Schwestern Flöge salon was in a prime position to sell their newly designed dresses.

Flöge was truly a model for the feminist woman of the fin-de-siècle. Not only was she the owner of a successful business, she was a truly independent woman dedicated to her craft. The only relationship that has ever been documented between Emile Flöge and a man was her tie to the Viennese artist Gustav Klimt, which appeared to be based on platonic companionship. According to Isabella Ackerl, Flöge “remained the woman he always worshipped from afar and the only one he called to his deathbed” (24). Although Klimt had the reputation of being a very sexual individual (he was the father to at least fourteen illegitimate children), he always maintained a deep respect for Flöge and never grew tired of her as he did with his models. The two belonged to the same social circle and influenced each other greatly in design and style.

Emilie Flöge and Gustav Klimt’s relationship formally began when Flöge’s sister Helene and Gustav’s brother Ernst married in 1891. Although the two families had been friendly prior to this engagement, the marriage strengthened the bond between the Klimts and the Flöges. However, fifteen months after the marriage between Ernst and Helene, Ernest passed away, leaving Klimt to be the guardian of Helene as the uncle of her child. At this point the relationship between eighteen-year old Emilie Flöge and Klimt began to emerge. Flöge not only respected Klimt’s commitment to her family but also admired his impressive artistic talents.

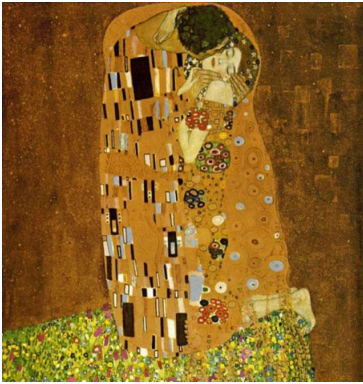
Emilie Flöge’s first step into the artistic world took place when she was only fifteen years old and possibly before she was even aware of her interest in the arts. For economic purposes and convenience, “The Flöge sisters and their mother as well as the Klimt girls were used as models in the Burgtheater frescos” (Fischer 16). Emilie Flöge was not originally included in the first version of the sketch entitled *The Harlequin at the Fair in Rothenburg ob der Tauber* (1982) that hung in the Burgtheater. However, she was added to the second version of the painting. Not only did this painting assist Klimt in displaying his affections towards Flöge but it foreshadowed her future as one of the most influential women of the Secession Movement. In the second version of the Harlequin sketch, Flöge is positioned front and center, standing in an evening dress amongst the Viennese elite.

The Harlequin sketch was only the beginning of Emilie Flöge’s role as a model for Gustav’s paintings. As their relationship became more intimate and exclusive,

Klimt painted Emilie in many guises – as a young girl in the Burgtheater fresco, conventionally sweet, as a young woman in the portrait at the Historisches Museum der Stadt Wien – confident and at the beginning of her professional

career, and finally as a model for his most famous painting *Der Kuß*... The models for the embracing couple in Klimt's famous picture, which has since become a twentieth-century icon, were none other than Emilie Flöge and Klimt himself. (Fischer 125)

Throughout his lifetime, Klimt completed three paintings of Emilie Flöge, each at a different stage of her life and all equally important and majestic. His second painting of her entitled *Portrait of Emilie Flöge* (1902) displayed many qualities of Viennese art.



Klimt, Gustav. The Kiss.
Österreichische Galerie, Vienna

Flöge is positioned in the center of the painting wearing a long dress, one of her own designs, covered with black, white and gold circles and other geometrical patterns. The geometrically designed circle displayed behind Flöge's head resembles a halo, portraying her as an angelic figure, a depiction common among Symbolist painters. The fact that Flöge is a concentrated figure in a painting otherwise displaying a plain and unornamented background typifies the overall principles of functional artwork being created in Vienna at the turn-of-the-century.

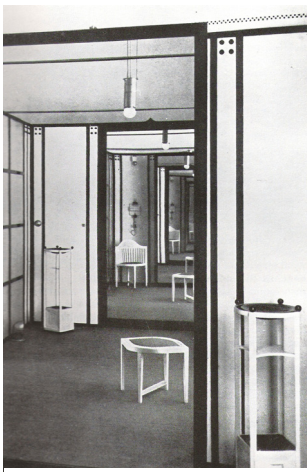
The third and final painting of Emilie Flöge by Gustav Klimt is one of his most famous works: *Der Kuß* or *The Kiss* (1907/1908). This work incorporates two lovers who appear to be Klimt and Flöge embracing as the man leans over to kiss the woman kneeling on the floor. Once again the figures in this painting are concentrated in the middle of a bare background, similarly to the *Portrait of Emilie Flöge*. Klimt is wearing a smock-like dress like those seen in Flöge's salon, covered in black and white rectangular designs. In this painting Flöge is illustrated as an object of fantasy, as she so gently accepts Klimt's kiss submissively. The pale tone of her skin and exaggerated tilt of her neck calls to mind the image of the Vampire, popular in the art and literature of the fin-de-siècle. Furthermore, *The Kiss* is an "allegory about the power of love to draw lovers out of their individuality and merge them with another person, and with the universe" (Kränsel 41). The allegory of the lovers and their vampire-like traits not only reveals Klimt's views of love but also the public opinion of love amongst the Viennese as the cause of a loss of self-identity. In *The Kiss*, Klimt magnifies Emilie Flöge's role as the femme fatale which he had earlier established in his second painting of her. Painting was only one avenue of the arts that Flöge and Klimt were committed to. For instance, "Emile helped Gustav in the production of cartoons for the *Stoclet frieze*, and Gustav

encouraged Emilie to design new Reform-style fashions” (Kränsel 94). Since Flöge’s expertise was in fashion design, she and Klimt were constantly designing and wearing new styles of clothing. Often inspired by Japanese art, Klimt and Flöge created original dresses tailored to the personality and body type of the client. These reform dresses and “smocks” have been documented in many photographs, another art form that Flöge was interested in. Photographs of both Flöge and Klimt were printed in various magazines featuring articles on feminism or fashion at the time. It is important to note, however, that the dresses sold by Schwestern Flöge were not worn by the mass population in Vienna:



Nähr, Moriz. Gustav and Emilie
Österreichische Nationalbibliothek, Vienna

Flöge wore flowing caftans, which resembled workers’ smocks ... [and] these were a success within their circle as several friends-male and female-ordered similar garments, among them writer Herman Bahf (1863-1934) and sculptor Anton Hanak (1875-1934). Carl Moll (1861-1945) a Secession artist (and stepfather of Alma Mahler-Werfel), depicted his wife, Anna, attired in reform garb in his painting *My Living Room* ... All members of the Viennese cultural elite, supported the modern reform movement in the fine arts as well as the applied arts (Wagener 31).



Schwestern Flöge. Vienna

The union of the fine and applied arts is greatly attributed to Emilie Flöge. Within Vienna she was the one artist who truly brought together all forms of art through fashion. The styles of her clothing were seen in paintings and hung throughout various artistic venues in the city. Furthermore, her designs were incorporated in architectural patterns, furniture and jewelry creation.

The Wiener Werkstätte was one place in which the importance of Emilie Flöge’s designs in architecture, furniture and jewelry was extremely prevalent. Owners Josef Hoffmann and Kolo Moser based their products mainly on the style of the arts and crafts movement and used many of the decors seen in Emilie Flöge’s works.

One style that epitomized the Wiener Werkstätte and was seen in the interior design of both Flöge's salon and Klimt's studio was "quite justifiably called 'Constructive Jugendstil': black and white articulation in vertical and horizontals, undecorated geometrical designs in elongated rectangles...and square panels corresponding to the preferred pictorial formats of the Klimt circle and the Secession" (Fischer 32). Patrons of Schwestern Flöge were very familiar with these simple geometric patterns which were not only displayed around the salon but also used in concentrated areas of the bonnets, wrap skirts, scarves and dresses designed by Flöge. Josef Hoffmann and Kolo Moser were not the only ones to incorporate their styles into the architecture of Flöge's salon. According to Flöge's apprentice Herta, "In Emilie's large flat a room adjoining the salon was set apart as a 'museum' or 'Klimt room' with the two tall chairs and the table from Klimt's studio...and a collection of Klimt's drawings and oriental silk garments" (Fischer 33). Flöge's salon was a space in which all of the elements of art in fin-de-siècle Vienna emerged and blended.

In addition to the Wiener Werkstätte's influence on the architecture of Flöge's salon, the jewelry that Flöge wore in many of her photographs to ornament her dresses are also products of Kolo Moser and Josef Hoffmann. Many of these pieces are made of silver and small colorful geometric stones. The black and white judendstil décor of Schwestern Flöge is even seen in the design of various brooches created by the Wiener Werkstätte. According to Wolfgang G. Fischer,

The finest of the Wiener Werkstätte objects in Emilie's private collection are the pieces of jewellery she wears in the Klimt fashion photographs...The long silver chain with the heart-shaped pendant was designed by Joseph Hoffmann and the initials 'JH' can be found on the back of the extension clasp. (60)



Hoffmann, Josef. Pendant .
Neue Gallery, New York City

By wearing the jewelry of the Wiener Werkstätte with her new reform dresses, Flöge was definitely a model of the Secession Movement. She represents the ideals behind a Viennese culture obsessed with creating everything to be both functional and aesthetic.

Everything that Emilie Flöge owned or designed in some way or another had an imprint of the Secession Movement attached to it. Flöge's relationship with Gustav Klimt made her the center of a group of artists and scholars of the avant-garde. Her network of friends and business partners were essential in establishing her fame and popularizing her creations. The Secession Group truly was one that fostered creativity

and functionality. Each member of the group was constantly striving to create products that would be acceptable and adored by its contradicting society. Flöge herself was a collector of crafts created by members of the Secession. In Flöge's estate, unknown until 1981, discoveries were made of

(...) approximately 400 letters and postcards from Klimt to Emilie, spanning a period of twenty years, and a collection of jewelry and silver work from the Weiner Werkstätte which Klimt had given her as presents. No less important is the famous photo album containing the fashion photographs, already published on numerous occasions, in which Emilie presents Klimt designs made by her. (Fischer 7)

With this evidence it is made apparent that Emilie Flöge truly tore down the lines drawn between different art forms in order to portray Viennese art as a collective ideal.

Although the *Schwester Flöge* was closed down in 1938 when Hitler took power, its creations, along with the creations of the *Weiner Werkstätte*, continued to live on through the photographs and letters between Gustav Klimt and Emilie Flöge. Flöge was not only an artist but also a model who constantly displayed the patterns and designs of fin-de-siècle Viennese art through fashion. She represented liberation through modernism and was the one public figure to display multiple facets of modern art simultaneously. Flöge was not only a monumental figure in the Viennese art world of the 1900's, she inspired the entire fashion industry through her dress reform movement by liberating women from the physical and psychological restraints of the corset. As a modern and advanced woman of her era, Emilie was unquestionably a figure to inspire the feminist movement soon to emerge.

Although Emilie Flöge may not be a well-known name amongst the general public today, her effects on the fashion and art world are astounding. She was a vital influence in the life of Gustav Klimt and an important figure amongst the Secessionists. With a network of architects, jewelry makers, craftsmen, painters, and photographers, Emilie Flöge can be seen as a canvas displaying all the elements of Viennese art and design. She truly represented the Secessionists beliefs in the *Gesamtkunstwerk* or a 'symbiosis of the arts', which was to comprise all areas of

Life. ... Josef Hoffman expressed the Secessionist point of view as follows: "It can never be sufficient merely to acquire paintings, even if they are truly magnificent. Unless our towns, our houses, our rooms, our cupboards, our tools, our clothes and our jewelry, unless our language and our feelings express the spirit of our time in a clear, simple and beautiful manner, we fall incredibly far behind our predecessors, and no lie will dissimulate these weaknesses. (Ackerl 17).

In light of the profound impact she had on the cultural life of Vienna at the turn-of-the-century, it is clear that Emilie Flöge set the standard for years to come. Every aspect of her life emerged through the artistic creations of the time, and in return every facet of art that came in contact with Emilie Flöge became blessed with the gifts of her influence and designs.

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Forster's Symbolic Use of Female Characters

Marina McFarland (English)¹

Though generally considered a scathing indictment of imperialism, Forster's *A Passage to India* is rarely addressed for its curious depiction of females, particularly the characters of Adela Quested and Mrs. Moore. Whereas the male characters' actions hold symbolic significance, they nevertheless stand alone as actions worthy in themselves. Forster's women, however, are ultimately reduced to the meaning they evoke—both in assisting the literary plot and in what they represent in the frame of the narrative. Rather than portray women as characters of substance and innate worth, Forster employs them as instruments between characters and in satirizing imperialistic rhetoric. Furthermore, the importance placed on homosocial relations—not only in the context of Aziz and Fielding, but also in the Empire's interactions with India—serves to marginalize and depreciate the novel's female characters.

In a novel that focuses primarily on the importance of homosocial relationships, Maria M. Davidis asserts that the onerous presence of women disrupts the system of “New Chivalry” practiced by the male protagonists. This form of New Chivalry, which depreciates traditional heterosexual romance in favor of homosocial friendship, renders the novel's female characters irrelevant, if not an unwelcome intrusion. Davidis attests that the novel's male-centric New Chivalry is an integral component of Forster's anti-imperialism, as it stresses the racial transcendence of male friendship. Indeed, the central theme of *A Passage to India* lies in the question of “whether or no it is possible” for an Englishman and an Indian to be friends (6—7). Given that this concern—chronicled through the vacillating relationship between Aziz and Fielding—comprises the heart of the novel, all outlying forces are judged according to their influence on this friendship. This relegates the novel's women, particularly Adela and Mrs. Moore, to the role of secondary characters in relation to the plot surrounding Aziz and Fielding. Their worth—both as characters and literary tools—is contingent on their ability to impel or undermine relations between English and Indian men.

The amorphous character of Adela Quested, who Davidis describes as “the chief scapegoat in the novel” (260), is most conveniently contrived to serve the novel's overriding themes. Her unformed identity is easily manipulated, both by other characters

¹ Written under the direction of Dr. Erica Johnson for the honors course EN311: *Modern English & Irish Literature*.

and Forster himself, to represent the various ideals projected onto her. Like the majority of the novel's females, however, Adela's primary purpose derives from her influence on homosocial relationships. Initially, Adela enters the text as the archetypal "New Woman" of feminist England, determined to "see the *real* India" (Forster 22) that has thus far eluded her privileged scope. Because of her masculine desire for adventure, Davidis argues, Adela "represents an intrusion from the future" (265) to the relationship of Fielding and Aziz, a microcosm of British-Indian relations as a whole. Not only does Adela's individualism defy Anglo-India's traditional gender roles; her intellectual curiosity of Indian culture is crucial in the disintegration of British-Indian relations. It is in the form of New Woman that Adela, accompanied by Mrs. Moore, first impedes the development of Fielding and Aziz's friendship, by truncating the intimacy of their first meeting. Enamored of his new acquaintance, Aziz finds himself "disappointed that other guests were coming, for he preferred to be alone with his new friend" (69). In fact, this instance proves prescient of a pattern of intrusion that ultimately severs their relationship.

Adela's eventual use as a symbol wielded by the British Empire is reminiscent of actual events, of which Forster was keenly aware at the time he wrote the novel. Jenny Sharpe, in her analysis of the Anglo-Indian woman in fiction, attributes great importance to the events of the 1857 Mutiny in Cawnpore in shaping the rhetoric of the British Empire. Details of this anti-colonial rebellion were libelously skewed in favor of the British, with reports quickly circulated of "the barbarous attack of mutinous sepoys on innocent women and children" (Sharpe 61), including the systematic raping of Englishwomen. These rumors, though quickly denounced, permeated the context of colonial discourse: "The domestic virtues of self-sacrifice, moral duty, and devotion to others gained currency only after the violent upheavals that encouraged the colonizers to see themselves as the innocent victims of native hostility" (Sharpe 8). The fictional accounts of rape, in particular, justified the elevation of English womanhood to national status symbol, meant to confer honor on those men who avenge her violation. Within this context, of course, the violence of rape was not seen as a violation of the woman, but of the British Empire. Such dire circumstances called for the old system of chivalry "that called on Victorian men to protect the weak and defenseless" (76), thus justifying any retributive violence from the British.

This historical context is necessary in understanding Forster's portrayal of Adela as a tool of imperialism, implicit in McBryde's allusion to "the Mutiny records; which... should be your Bible in this country" (187). Rather than use Adela solely for her literary convenience, here Forster demonstrates the pretext on which the British Empire justified

its fierce rule over a rebellious nation. Adela escapes the label of Memsahib (acquired after accepting Ronny's marriage proposal) by becoming the alleged victim of attempted rape, which transforms her into a nationalist symbol for her fellow Anglo-Indians. Though initially unpopular among the English, "she brought out all that was fine in their character" (199) by offering them a cause to rally behind. Once again, Adela's importance lies not in her character, but in what it represents: a justification of Britain's chokehold on India.

Adela's passive symbolic position is not solid, but rather easily transferred to those who better represent English ideals. Forster describes a young mother whose "abundant figure and masses of corn-gold hair" qualify her as a "more permanent symbol, perhaps, than poor Adela" (200). In fact, Adela's victimization further marginalizes women by extolling the bravery and martyrdom of their male counterparts (like Ronny Heaslop) who so valiantly bear "the sahib's cross" (205). Although this form of discourse shifts the focus from womanhood to male superiority, the female is reserved for her use as scapegoat following any male conflict. Declaring that Adela's trauma "is a damn good thing really... It'll make them squeal and it's time they did squeal" (239—40), the Major implies Adela's unimportance in the frame of imperialism. As her position "conveniently exculpates English men from any wrongdoing" (Sharpe 124), she can subsequently be blamed for whatever tension such wrongdoing creates.

They had started speaking of 'women and children'—that phrase that exempts the male from sanity when it has been repeated a few times. Each felt that all he loved best in the world was at stake, demanded revenge, and was filled with a not unpleasing glow, in which the chilly and half-known features of Miss Quested vanished, and were replaced by all that is sweetest and warmest in the private life. (203)

Sharpe accurately interprets this passage as a "sobering reminder of the retributions against a rebellious Indian population that were committed in the name of English womanhood" (124). With the exception of Fielding, who remains loyal to his principles of new chivalry, members of the Anglo-Indian community rally behind the pretense of traditional chivalry in avenging this grave insult to England. Characteristic of her treatment throughout the novel, Adela herself is cast aside in light of the issues she has raised. "[O]nly a victim" (205), Adela is merely a weapon for the British vendetta against India; indeed, whether or not her assault actually occurred is irrelevant to the case. "You know you're right, and the whole station knows it" (229), Ronny asserts in face of Adela's uncertainty. That Adela is denied a voice in the recounting of her own story underlines her role as a symbol; valued only for the front she provides, she is forced

to mirror the ideology of Empire. Any independent thought or action on her part amounts to a betrayal—not only of her country, but of the values it claims to uphold. As Davidis asserts, “the fact of her sex permits men to silence her, victimize her sexually, and use her as a justification for imperial rule” (264). As a result, she too places her sense of worth on her use to the empire, feeling “emptied, valueless... [of] no more virtue” (258) following her retraction of the assault charge.

Forster’s caricature of the Memsahib (master’s wife), characterized by Mrs. Turton and her fellow Englishwomen, acts as another dividing force within the colonial/male relationship. Forster is generally fair in his portrayals of the reigning English men in Chandrapore, critiquing their hypocrisy and small-mindedness yet allowing for ambiguities that soften their image. Despite the implicit satire in his sketches of the Collector and other male officials, Forster remains sympathetic to their redeeming qualities. The English men’s wives, however, epitomize the most extreme malevolence of British imperialism. This gender standard is established early in the novel, in a comparison between Mr. and Mrs. Turton’s attitudes toward Adela: while she disparages Adela for not being “pukka”, her husband attempts to maintain neutrality from a more humanizing view (27). Mrs. Turton, for instance, epitomizes the cruelties of Empire in her harsh, prejudiced attitudes toward natives. Incredibly arrogant and blinded by her racial hatred, she reminds Adela and Mrs. Moore that, being Englishwomen, they are “superior to everyone in India” (42). This unwavering feminine hostility prompts the Collector to note, “it’s our women who make everything more difficult out here” (237), implying that women are to blame for the deterioration of British-Indian relations.

Indeed, Sharpe focuses on the role of the Memsahib—whose notoriety reached its peak following the Mutiny period—as “a scapegoat for imperialism, the remedy and poison that both ensures racial segregation and threatens to undermine race relations” (91). Not only does the Memsahib reveal the worst sides of imperialism; her very presence serves to further alienate the colonizers from the colonized. The figure of the Englishwoman in India functions as an emblem of English domesticity and femininity, her presence serving to remind the men of their national obligations abroad. Her feminine fragility emphasizes the sanctity of Empire and its need to be protected, thus underlining the need for stern rule over India. Furthermore, the Englishwoman’s presence emphasizes the racial disparity between the two races by offering a distinctly different image in comparison with native women. These combined factors lead Sara Suleri to conclude that the Anglo-Indian woman acts “as a segregated and segregating presence” (80). Effectively, Forster casts the blame on Anglo-Indian women for both the evils of Empire and its accompanying racial antagonism, which undermines the British imperial mission.

In focusing on the “English woman as an absent center around which a colonial discourse of rape, race, and gender turns” (8), Jenny Sharpe addresses Forster’s original description of Adela’s rape scene, which drastically differs from that which he eventually published. In contrast with Adela’s vague, ambiguous recollection of her assault in the caves, Forster’s original draft posits her assault as a triumphant struggle of self-defense against a clear attack:

Silent, though the echo still raged up and down, she waited and when the breath was on her wrenched a hand free, got hold of the glasses and pushed them at /into/ her assailant’s mouth. She could not push hard, but it was enough to <free her> hurt him. He let go, and then with both hands on her weapon/ she smashed <him to pieces>... She was strong and had horrible joy in revenge. ‘Not this time,’ she cried... (qtd. in Sharpe 126)

It is significant that Forster chose to portray Adela as the passive victim of an equivocal crime, leaving her actions and the event itself open to interpretation. Rather than allow Adela a substantive story to flesh out her character, the mystery of her assault renders it purely symbolic. Sharpe stresses the “resemblance between the absent text of her struggle and an official discourse that erases colonial women’s agency” (126), contending that Forster deliberately cut the rape scene to indict the empire’s symbolic use of women. In a similar vein, Sara Suleri insists that Adela’s delusional rape was necessary “in order that her body may be transmogrified into that legal space over which Fielding and Aziz can stake out... their mutual loyalty” (77). Despite the motive of undermining imperial pretense, however, Forster’s deletion of Adela’s agency contributes to the ultimate silencing of women in his novel.

In view of the ideological usage of woman as symbol and ideal within the context of Anglo-India, it is crucial to examine Forster’s literary representation of women, in which their purpose is best achieved in absence. As a novel focusing on the importance of homosocial relationships, female characters are often rendered irrelevant to Forster’s primary narrative of Aziz and Fielding. Given the feminine intrusion on and disruption of male alliances, women are appreciated solely as symbols to be manipulated by their male invokers. This is best exemplified through the spectral shadow of Aziz’s deceased wife, who enters the text in the form of a photograph. Primarily, she serves as Aziz’s ideal of feminine perfection, representing an unattainable, immutable love achieved in retrospect—“no woman could ever take her place; a friend would come nearer to her than another woman” (57). Thus, his undying devotion to an intangible woman becomes his pretext for romantic unavailability, distancing him from heterosexual relationships (and therefore removing potential obstacles to his friendship

with Fielding). However, the image of Aziz's wife is also offered as a token of trust in his budding relationship with Fielding, who understands its connotations. "Put it away, she is of no importance... I showed her to you because I have nothing else to show" (126), Aziz explains. As Davidis attests, "The action of showing takes on a greater importance than the substance shown" (262), thus establishing women's value as contingent on her benefit to the male bonding experience.

The specter of Aziz's dead wife is aroused for various reasons throughout the novel, usually (but not always) as a point of reference for Aziz. It is significant that she enters the text not as a living memory but as a motif indulging Aziz's fluctuating moods. When plagued by depression, Aziz evokes her as the object of his despair, becoming happier as he reflects on his profound unhappiness. When able to otherwise amuse himself, he admits to forgetting her, musing that "he mourned his wife the more sincerely because he mourned her seldom" (58). Her memory later arises upon Aziz's lament that "he wanted to send sweets too and had no wife to cook them" (78). In absence of his wife's assets, he better appreciates her instrumental worth. He again reflects on her posthumous use when in the caves with Adela, who asks whether Aziz is married. Perhaps feeling threatened by Adela's intimacy, Aziz responds with an invitation to see his wife, feeling "it more artistic to have [her] alive for a moment" (168). In an ironic reversal of symbolism, the picture of Aziz's wife is also used as "evidence" of his perversion, implicating him for possessing "photographs of women" (190). In this, Forster emphasizes the vulnerability of symbols, which can be used in unexpectedly sinister ways.

Heterosexual interaction (albeit that which effectively excludes women) seems to dominate the beginning of Aziz and Fielding's friendship, as their discussion of Adela's physique and exchange of the wife's photograph cement their homosocial connection. A true appreciation of women, however, is lacking in their discourse. When faced with Fielding's objections to marriage, for instance, Aziz's sole concern is that his "name will entirely die out" (128) due to lack of progeny—designating women as instruments of reproduction. Fielding's freedom in being a "light traveler", he suggests, enables him to "keep in with Indians and Englishmen" (66), as he has no wife invoking racial animosity. Such conversation, Sara Suleri claims, indicates that the men are operating from "a secret gesture of intimacy" (138) that was established when Aziz offered Fielding his collar stud. Having created an instant connection, they remain immune to the distracting intrusion of women—until, of course, said women interfere with their connection.

For the majority of the text, the absent figure of Adela—both directly and indirectly—impedes the burgeoning relationship of Aziz and Fielding. The most obvious instance, of course, is Adela's accusation of rape against Aziz, which unleashes "a mass of madness" (180) that engulfs all of Anglo-India into a fierce battle. Fielding, in his unabashed loyalty to Aziz, "hoped to save the man" (182) by aligning himself with Indians rather than his fellow British. Fielding's reluctance to choose sides, however, means that he is drawn into British affairs whenever Aziz most needs him—"Cyril, again you desert" (261), Aziz despairs. Fielding's innate compassion proves most damaging in the wake of Aziz's acquittal, once Adela has morphed from National Symbol to Damsel in Distress. Due to Fielding's "natural sympathy for the down-trodden" (272), he grudgingly takes the pathetic Adela under his patronage, eventually developing genuine respect for her. Initially, Fielding resents his chivalric obligation to "die in her defense" if necessary, preferring "to be rejoicing with Aziz" (260). Indeed, Adela's desperation "forces Fielding into the old chivalric code even as he desires to move beyond it" (Davidis 273). Adela's subsequent monopoly of Fielding's attention further severs his bond with Aziz, who is loathe to show compassion to his accuser. Aziz's snobbery and insensitivity towards Adela, with which Fielding cannot sympathize, creates "a barrier between himself and Aziz whenever it arose" (268). Furthermore, Fielding's allegiance to Adela links him once again to the British, with whom Aziz desires to break all ties.

Fielding's rumored affair with Adela proves fatal to his friendship with Aziz, who declares, "All are traitors" (301) upon hearing the slander. At first, the misunderstanding about Adela provokes a "tragic coolness" (302) in the men's friendship, inciting awkwardness even after the truth is discovered. Upon Fielding's departure for England, however, Aziz's insatiable suspicion "built a satanic castle" (311) confirming his friend's treachery, and he ultimately convinces himself that Fielding and Adela had wed (313). Davidis contends that Aziz's paranoia rests on the frightening prospect of his friend at home in England, where "not only are Fielding and Quedsted racially equivalent, they are complementary in the heterosexual economy of the domestic marriage plot" (273). Aziz's mistrust of Fielding and hatred of Adela blinds him to the real circumstances of their alienation, which is effectively achieved through his delusion. The novel's conclusion suggests that multiple factors are responsible for the British-Indian divide; yet Aziz chooses to focus solely on Adela, who represents a tainting feminine influence on politics. Despite her return to England, Adela continues to be "a sacrifice for advancing a plot centered on the impossibility of a friendship between men across the colonial divide" (Sharpe 130). Once again, Adela's involvement in a non-event employs her image as fuel for folly, invoked as a curse on homosocial relations.

The character of Mrs. Moore, on the other hand, is celebrated as a unifying presence in India—largely due to her fostering of homosocial alliances. Whereas Adela’s interaction with Aziz and Fielding only corrodes their bond, Mrs. Moore is instrumental in securing their connection. The “Oriental” compassion that appeals to Aziz in their first encounter in the mosque also attracts Fielding, and thus Mrs. Moore is the impetus behind their first official meeting. Though a character of greater substance than Adela, Mrs. Moore performs the similar function of existing on a largely symbolic level. This is first apparent in the aftermath of Adela’s alleged assault in the Marabar caves, when Mrs. Moore’s reticence incites Adela to question Aziz’s guilt. In spite of the older woman’s silence, Adela insists that she has attested to Aziz’s innocence—“Doctor Aziz never did it” (226). Yet when interrogated by an irate Ronny, she admits that Mrs. Moore had implied “the idea more than the words” (226)—an accurate summation of her ultimate use to the novel.

As if to confirm the disposable nature of women within the text, Ronny hastens the departure of his mother—who “was doing no good to herself or to anyone else there” (229)—upon her refusal to cooperate in Aziz’s trial. It is at this point in the novel that Mrs. Moore achieves potency as a symbolic presence, which “allows her transformation into a text that may be written upon” (Davidis 10) in the discourse of Aziz’s trial. Indeed, Davidis argues that Mrs. Moore’s absence “is crucial for Aziz’s acquittal” (10), as the defense invokes her as a potential witness to his innocence. Despite the Magistrate’s insistence that “as a witness, Mrs. Moore does not exist” (Forster 252), her name “became Indianized into Esmis Esmoor” (250), which is adopted as a mantra by the Indian crowds outside the courtroom. This marks the inception of Mrs. Moore as an “eternal goddess” (350), who continues to symbolize the Hindu ideals of unity and oneness long after her death at sea.

Indeed, the ideal of Mrs. Moore extends to support multiple causes in the novel. Attesting to women’s use-value, Ronny reflects that his mother may benefit him better from a distance, as she could “stamp [his name] on Lady Mellanby’s imagination” (230) by accompanying her on a ship leaving India. Just as Adela’s assault made him a celebrity within the Government House, Ronny hopes his mother to be equally useful. Just as Fielding once implemented the discussion of women in establishing a bond with Aziz, he now “appeal[s] to the memory of Mrs. Moore” (290) in persuading his friend to spare Adela’s fortune. Though not particularly fond of the woman in life, Fielding is content to wield her name for Adela’s sake. To Aziz, Mrs. Moore represents his highest ideals of compassion and love, eluding the racial boundaries that separate him from Fielding. She thus establishes herself, to Aziz and many other Indians, as a haunting,

unifying presence, capable of bridging the gap between East and West. Her ghost has an undying influence over Aziz, even appeasing the damage to his friendship with Fielding. Mrs. Moore's son Ralph revives her spirit in the final part of the novel, inciting Aziz to pronounce him an "Oriental", just like his mother (349). The presence of Ralph, acting as a surrogate Mrs. Moore, softens Aziz's attitude towards Fielding. The fact of Fielding's marriage, however, impels the demise of their reunion as friends. Generally considered to represent Forster's personal voice in the novel, Fielding ceases to fill this role upon his marriage, an act Forster himself could not identify with. Thus, Fielding effectively separates himself from the man Aziz once loved, rendering any future relations impossible. Despite the encompassing spirit of Mrs. Moore (perhaps the most enduring character of the novel), Aziz and Fielding are unable to overcome the obstacles women present to a British-Indian relationship.

For further proof of the value Forster places on feminine absence, one must also examine the presence (or lack thereof) of Indian women in the text. The reader's first impression of these native women is through Adela and Mrs. Moore's initial encounter, which occurs at the Bridging Party held in their honor. Most striking about these women (who are rarely mentioned by name) is their apparent inability to speak or think for themselves. The arrogant Mrs. Turton, after cursorily greeting the ladies in a condescending Indian dialect, proceeds to refer to them in the third-person, ignoring the possibility of real conversation. A male onlooker, one of the women's husbands, provides Adela and Mrs. Moore with a more thorough introduction of the Indian women; yet the reader is never privy to any personal insight. Meant to evoke the mysterious inconsistency and unknowability of their native land, the Indian women are described as "uncertain, cowering" (43) figures, unable to communicate on a Western level. Denied the agency of individual voices and characteristics, Indian women merge to form one defining Indian Woman, which is subsequently reduced to a silenced, negated presence.

Indeed, Forster himself seems conscious of this characterization, wryly noting that the death of Indian ladies by hunger strike "would make little difference... being invisible, they seemed dead already" (238). This excerpt suggests a subtle criticism of the cross-cultural misogyny of Anglo-India, in which women are considered negligible from both a political and cultural perspective. Later in the novel, Nawab Bahadur accuses Maharinis (Indian princesses) of being "uneducated... superstitious", declaring that "superstition... is the great defect of our Indian character" (99). By thus equating Indian women with his race's worst shortcomings, Bahadur attempts to feminize the nation's flaws. Aziz, too, is opinionated on the subject of Indian women, as his poems upon leaving Chandrapore "were all on one topic—Oriental womanhood" (329). This suggests

that Indian women are merely ideas for men to express through art, without the privilege of expressing themselves. Although Aziz is married again in the final part of the novel, he fails to mention her name or allude to her character, suggesting that he forgets her as frequently as he does his dead wife. Like Adela and her fellow Englishwomen, Indian women are exploited for their confirmation and justification of male superiority, becoming tools of political rhetoric rather than characters in their own right.

The prevalently enforced system of purdah (the practice of isolating women from the male gaze) in India at this time could explain Forster's depiction of Indian women as vacuous mimickers, as his gender would have restricted much access to the feminine population. Nevertheless, Sharpe argues that Forster's fleeting references "work to contain Indian women's noisy resistance within the figure of the silent and hidden purdah woman... not because they do not have a historical voice as such but because the novel cannot deliver their agency" (Sharpe 131).

It is clear that Forster's female characters were intended to perform a figurative purpose, either through his tacit representation or the way they are exploited by other characters. His portrayal of Adela, for instance, exposes the ease with which ordinary people become instruments of political ideologies. In fact, one could argue that all of his characters (including Aziz and Fielding) are at times relegated to serve symbolic functions. However, his treatment of Adela and Mrs. Moore differs in the sense that they are discarded after fulfilling their narrative functions. Adela, for instance, is quickly dismissed after her active power is exhausted, rejected by Ronny lest she damage his career and reputation. Both she and Mrs. Moore exercise greater power in their absence, when their literal actions cannot interfere with others' interpretations—perhaps indicative of Forster's discomfort in detailing femininity. Given the author's lack of personal interest in the female sex, it is possible that women enter the text only as an afterthought. Disregarding biographical interpretations, however, Sara Suleri argues that women "play a subservient role to [Fielding and Aziz's] friendship... They remain peripheries upon which male discourse locates constraints upon the operation of autonomous desires" (147—8).

Forster's largely symbolic depiction of women serves his anti-imperialist motives by exploiting the sanctimony and self-righteousness that drives empirical missions. However, his social critique comes at the price of compromising their humanity. The use of Adela as a weapon within imperialist rhetoric has great literary power, despite her solely instrumental value. While the character of Mrs. Moore is done justice in spite of her symbolic absence, the non-entities presented as English and Indian women demand greater substance. Overall, the women of *A Passage to India* play

inferior roles to those afforded the novel's male characters, ultimately marginalizing them to the point of irrelevance.

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Mother's Kiss and the Madeleine: The Feminization of Time and Space in Marcel Proust's Swann's Way

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Space is often recognized as a non-existent element, and sometimes merely a theory. Time, on the other hand, is acknowledged as having a more clear-cut existence, but still proves to be ambiguous in many ways. In Marcel Proust's first volume of the seven part semi-autobiographical work A La Recherche du Temps Perdu (In Search of Lost Time, 1913-1927) the notion of time and space are challenged by the influence of femininity. Many of the physical spaces in the novel are recognized in relation to a woman, and time seems to move forward only through the memory of various female protagonists. The prevalence of femininity in the physical spaces of the novel can also be linked to the strong relationship that Proust had with his own mother. Throughout his life, Proust clung to his mother, especially after his first traumatic asthma experience (Barker, 8). Also, the nature of Proust's style as stream of consciousness adds to the passing of time in relation to femininity. The references to time and space in the first volume, entitled Swann's Way, are indeed tied to the feminine; both time and space are recognized through the presence or the thought of a woman, especially in relation to the author's childhood bedroom, the memory of the "Madeleine" and his mother's good night kiss.

To understand the representation of space in Swann's Way, it is important to understand the role of space in narrative. In the article, "Space, Ideology, and Literary Representation", Mitchell explores the idea of space and its representation in literature, including the way in which space is portrayed. According to Mitchell, "...the relation between literary time and space...is filled with ambivalence," (92). He describes space as a "dubious fiction", taking the shape of many different literary elements in readers' minds. An interesting point that Mitchell makes is the concept of space as being dead and static until some force, particularly a violent one, pushes it into motion. Only then is space filled and brought to life. Space is always alien and questionable, and the non-existent space is seen as a utopia. However, the word "space" in everyday life can have many different meanings. In his article, Mitchell notes that William Blake once said,

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, Vienna and Berlin*.

“Time is a man, space is a woman.” This statement brings up the idea of the femininity of space. Mitchell explains this first by noting how anthropologists recognize primitive cultures as existing only in the realm of space, usually outside the realm of time. Therefore, space can place women in a prejudicial state of prehistoric condition; they are only there for visual display. Since space is looked at as describing a primitive state, it can also suspend “historical process”. Furthermore, the sense of space, as Mitchell says, can be referred to as “Other”, much like women are portrayed as Other according to feminist author Simone de Beauvoir.

“Space and spacing of theory are being radically transformed by women,” states literary critic Ruth Salvaggio. In her study “Theory and Space, Space and Woman,” Salvaggio focuses on feminine space and its relationship to the idea of “écriture feminine” or writing through the female body. Women have often been associated with “inner spaces”, since their function in society is traditionally linked to the domestic realm as maternal figures and homemakers. Salvaggio claims the female space has been highly transformed, and these transformative effects save women from mere objectification in literature (271). She also ties the space of women to the female body and the notion of “écriture feminine” in the contemporary works of French women writers (275). Once the body is able to speak, she says, it can break free of its imprisonment, including that of patriarchal language. By writing the space of their bodies, women can go beyond stereotypical representations in the arts. Though Marcel Proust was neither a woman nor a feminist writer, his works are highly praised by many feminists critics who greatly admire his exploration with language and his unconventional representation of gender roles.

On July 10, 1871, Marcel Proust was born in Auteuil, a small town outside of Paris. At first, he was not expected to live. As a timid and emotional child, he clung to both parents, but centered most of his affection towards his mother. Monsieur Proust was a notorious pathologist who published books and articles on medicine, while Madame Proust was the well-read daughter of a wealthy Jewish family. At the age of nine, Proust suffered his first asthma attack, and from thereafter he became even more attached to his mother, feeling secured by her presence and affection (Barker, 8). In school, he did not fit in with the other boys; he was frail, emotional, and seen as too feminine. He found the most comfort amongst older women, especially those who were well educated. After graduating from the “lycée” he enlisted in the French army, where he served for one year despite his poor health. During this time he became determined to be a writer and grew particularly fascinated with the workings of upper-class society. Proust also discovered his homosexuality, though he continued to spend most of his time in the company of

older women (Barker 25). He climbed the social ladder as he worked on his writings, attending and throwing lavish dinner parties for other socialites. When his mother died in 1905, Proust's health began to deteriorate: "he was either ill or afraid of being ill," (Barker, 139). He spent most of his time indoors and in his bed, sleeping during the day and writing throughout the night. During the last three years of his life, he spent the greater part of his time in his cork-lined bedroom working on A La Recherche du Temps Perdu. The last three volumes were published after his death in 1922.

The first volume, Swann's Way, follows the stories of the narrator, Marcel, and the love affair of Swann and Odette. In the first story, Marcel recounts his memories of the small French town Combray. This section, entitled "Overture", describes Marcel's fear of going to bed without his mother's good-night kiss. He recalls waking up in the middle of the night and looking around the room, unsure of where he is, and longing to be with his mother. One night, a friend of his grandparents', Charles Swann, visits the house and prevents his mother from giving him a good-night kiss. The young Marcel stays up all night and eventually convinces his mother to spend the night in his room to comfort him.

"Combray", the second section of the novel, is largely about Marcel's discovery of his desire to become a writer. His friends and grandparents urge him to spend his time reading, and soon all he wants to do is read and write. He loves the pastoral surroundings of Combray, and often walks through the blossoming flowers on the path to Swann's house. The church on the outskirts of Combray inspires Marcel to write about its beauty. He becomes a great observer and writes down what he sees. One day while on a walk, he runs into Swann, his wife Odette and their daughter Gilberte. Marcel instantly falls in love with Gilberte, so much so that he makes up characteristics about her that do not exist, like her "black eyes" being blue.

The third section of the novel takes the reader back fifteen years to tell the story of the love affair between Swann and Odette. Swann begins to have an interest in Odette once he meets her, but is not aware of her questionable reputation. One day, after realizing that she resembles Botticelli's painting of Jethro's daughter, he falls hopelessly in love as he sees in Odette the same beauty as in Botticelli's work. They begin a passionate love affair which turns into an obsession for Swann, as he associates art and music to Odette and her classical beauty. Eventually, Swann finds out about Odette's promiscuity. He suffers greatly, and by the end of the novel he is astonished by the realization that Odette was not who he had perceived her to be.

In writing the seven parts of A La Recherche du Temps Perdu, Proust reinvented the modern Bildungsroman. He established a new form by involving readers in "a return

journey from the past the present again” (Kristeva, 3). Though the plot itself has a seemingly simple quality, Proust’s narrative techniques redefine the role of memory in the protagonist’s journey. Simple events are intertwined with the narrator’s memories, reflecting the nature of “involuntary memory” and reorganizing the present world through memories of the past. What is especially interesting about Proust is the way in which he tackles the confliction in human consciousness; for every person, time has a different meaning, but it is never linear. It is only through fragmented time that one can appreciate and understand all that has happened throughout one’s life, and Proust expresses this through his style. “Proustian time,” according to Kristeva, “is a metamorphosis,” (5).

The element of space in Swann’s Way is often presented as a space of memory rather than a physical space. According to Mitchell, “space is static, visual, empty, and dead,” (93). It is through something else that a space is created, and this is seen through the space of memory which Proust creates. For example, in the very first section of the novel, “Overture”, the childhood bedroom which the narrator describes comes to life through the eyes of memory. Marcel looks back on his young life and recalls the times in which he could not fall asleep and would stay up late looking around the room at various objects and pieces of furniture:

...I would be awake again... to settle the shifting kaleidoscope of the darkness, to savor, in an instantaneous flash of perception, the sleep which lay heavy upon furniture...the whole surroundings which I formed but an insignificant part and whose unconsciousness I should very soon return to share (10).

The space presented appears through memory. In the darkness of the early morning hours, Marcel is consumed by thoughts, memories, and the heightened state of his senses as he drifts in and out of sleep in his bedroom.

The representation of space in literature, though it is an entity which captures certain aspects of a text, can be ambiguous. It never has a “recognized and clear-cut status”, but can be often described as completeness in the world (Zoran, 310). For Proust, “space” can be as complex as the various settings in which characters find themselves, or as simple as the mere passing of time. Space can even be represented in the characters themselves, because “time is also psychic time, and consequently the factor which determines our bodily life,” (Kristeva, 4). In other words, it is memory as experienced through the characters that creates space, because memory and time often determine one’s physical life.

Another interesting point on space that is made in “Space, Ideology, and Literary Representation” is the relationship between a presence of some form of

“intrusion” and the empty existence of space (93). Because space in Proust is often represented by memory, it is the nature of the memory that determines the nature of the space. Especially in the first two sections of Swann’s Way, space is often connected directly to a woman. In the beginning of the text, the narrator dreads each night when he must retire to his room alone; left to his own vices, he fears the darkness and solitude of his bedroom. He must wait for his mother while she sits outside in the garden with the rest of his family, and it is only after he receives a good night kiss from his mother that he can fall asleep soundly:

My sole consolation when I went upstairs for the night was that Mamma would come in and kiss me after I was in bed. . . . So much did I love that good night kiss that I reached the stage of hoping that it would come as late as possible, so as to prolong the time of respite during which Mamma would have not yet appeared, (20).

As a young child, his bedroom becomes a place where he waits, longs, and hopes for his mother’s presence. It is only when she kisses him good night that he feels safe; before the presence of his mother, the bedroom is an unkind and foreboding space. The mother’s presence, however, changes the room into a safe and comfortable space for the narrator; the room is at first an empty space, but is transformed into a meaningful one through the presence of the feminine.

One night, when Swann is visiting, Marcel is told to go to his room and he is not allowed to receive a good night kiss from his mother. Unable to sleep, the spaces surrounding the narrator are described as violent and unfamiliar; the staircase becomes “hateful”, and the smell of the varnish is “a far more poisonous thing than any moral penetration,” (37). Once he enters his room, he feels like a prisoner in bed, clothed beneath the “shroud” of his nightdress. The absence of the mother in Marcel’s room creates a cruel and alien surrounding.

One of the most prevalent themes throughout the novel is the representation of time. By playing with the temperament of time, Proust forces the reader to delve “deep down into ourselves, in regaining the time of our inner lives, which has been so subtly reordered that this time now comes to seem the only reality worth taking into account,” (Kristeva, 6). Human beings remember past events through fragmented time, and Proust successfully captures this idea by jumping from past to present often throughout his work. The novel begins with a series of memories and jumps from the present time of the narrator to his distant past. In his concluding paragraph in the final volume of In Search of Lost Time, Proust states that the passing of time can only be saved through art

(Quennell, 195). In contrast to the trouble and disarray of the world surrounding the characters, time and memory ultimately provide safety.

Though time itself is extremely broad and ambiguous, the time represented in Swann's Way is feminine. It does not move forwards without the presence of a woman, and memory is not present in the narrator's mind without a woman. Every memory that Marcel, the narrator, produces coincides with a woman who is important in the text. The most prevalent example of this concept of time passing in relation to a woman is the passage involving the Madeleine cookie. After coming in from the cold, Marcel's mother offers him a cup of tea and a Madeleine. The smell and taste of the Madeleine throws him into a whirlwind of involuntary memory as he remembers the Madeleines of this aunt in Combray. He also begins to question the nature of consciousness and reality, and the fact that memory is vital in order to move forward with life.

The passage of the Madeleine represents the nature of time as feminine, because of its association with his mother, as well as with Combray, where most of his memories are inhabited by his grandmother and his aunt. But it is not only the physical presence of women that makes time feminine; it is also the association of time with the senses. It is the taste and the smell of the Madeleine that sends Marcel through a journey of memory, and it is through the senses – thus through the body -- that he remembers:

I place in position before my mind's eye the still recent taste of that first mouthful, and I feel something start within me, something that leaves its resting-place and attempts to rise, something that has been embedding like an anchor at a great depth; I do not know yet what it is, but I can feel it mounting slowly; I can measure the resistance, I can hear the echo of great spaces traversed, (57).

Memory is created involuntarily through the senses. In this way, Proust's use of the body as a tool for transcendence recalls the strategies employed by feminist French women writers.

In Swann's Way, time and space are intimately linked to femininity; whether it is through the physical presence of a woman or through the appreciation of the senses and the arts, femininity dominates the text. In his own lifetime, Proust associated time and space with the women he was close to, and believed that the purest way to capture both time and space was through the act of writing.

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