# WAGNER COLLEGE

# FORUM FOR UNDERGRADUATE RESEARCH

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# EDITOR'S INTRODUCTION

*The Wagner Forum for Undergraduate Research* is an interdisciplinary journal which provides an arena where students can publish their research. Papers are reviewed with respect to their intellectual merit and scope of contribution to a given field. To enhance readability the journal is subdivided into three sections entitled *The Natural Sciences and Quantitative Analysis*, *The Social Sciences* and *Critical Essays*. The first two of these sections are limited to papers and abstracts dealing with scientific research, clinical investigations and complex mathematical/statistical modeling. 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 fall edition commences with a reprint of the abstracts of papers and posters presented at the Eastern Colleges Science Conference.

Read on and enjoy!

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

# Section I: Eastern Colleges Science Conference[1]

## Abstracts



# Section II: The Natural Sciences & Quantitative Analysis

## Full Length Papers



# Section III: The Social Sciences

## Full Length Papers



[1] Papers and posters presented at the 76th Annual Eastern Colleges Science Conference held in New Rochelle, NY on April 2, 2022.

# Section IV: Critical Essays

## Full Length Papers

# Section I: Eastern Colleges Science Conference

## A Comparison of the Effects of Nitrate Concentration on Population Growth Dynamics of the Duckweed *Lemna minor* Grown in Distilled and Spring Water

Raven K. Pitt (Biology) and Dr. Donald Stearns (Biological Sciences)

For 13-30 days, the duckweed *Lemna minor* was grown in 50 mL test tubes under controlled conditions. Each test tube initially contained either distilled water prepared by the laboratory's distillation facility, 25 store-purchased distilled water, or store-purchased spring water. To some test tubes, no additional nitrate was added. To other test tubes, nitrate was added to alter the initial nitrate concentration levels while maintaining the initial total volume of 50 mL. One three-frond plant was added to each test tube and grown under continuous lighting (≈ 28.5 μEm-2s-1). Sample size for each group was n = 5 test tubes. Frond number was monitored; estimates of rmax (maximum per capita rate of population increase) and k (carrying capacity) were compared. Results using spring water showed an increase in k from 9.6 to 12 fronds when the nitrate level was increased from 10 ppm to ≈ 25 ppm as determined using nutrient strip indicators, after which higher nitrate levels up to 250 ppm showed a decrease in k suggestive of Liebig's law of the minimum and Shelford's law of tolerance. The rmax values similarly showed increases with increasing nitrate concentrations up to ≈ 50 ppm, after which rmax values declined. Using distilled water instead of spring water showed little population growth and low rmax values, regardless of nitrate concentrations, which were the same as those used in spring-water treatments. Distilled-water experiments were stopped after 13 days due to frond death. These results estimate the nitrate concentrations required for optimal population growth.

## Characterization of Novel Seed Endophytes in *M. Sativa*

Sarah Lott (Microbiology & Environmental Studies) and Dr. Katherine Moccia (Biological Sciences)

The microbiome of plants is essential in their development and health. Seed endophytes are microorganisms that live within the seeds of plants, the majority of which are believed to be nonpathogenic although more research is needed to better understand the function of seed endophytes. They are present from the beginning growth stages and play many important roles. A variety of bacterial species have been found as seed endophytes. They have also been found to have common functions for colonization, benefiting plant growth, and antifungal properties. In this project, seed endophytes were isolated from surface sterilized *Medicago sativa* seeds on selective media for potassium solubilization, actinomycetes, and nitrogen free media. Sterilized seeds were germinated and planted in Yosida agar. The

sterilized plants were then inoculated with the seed endophyte isolates and uptake of the isolates into the plant roots was measured. The methods were improved, germinating the seeds in sterile water often led to self-toxicity and the seeds germinated at a much higher rate using the Murashige and Skoog Medium. Several sources of contamination within the protocol were found and eliminated. The isolates also underwent DNA extraction and colony PCR for 16S rRNA gene sequencing. Using this method, a *Pseudomonas* species was identified. Seed endophytes from *Medicago sativa* were characterized.

## Novel Mounting of Biological Tissue Samples for 3D Model Reconstruction using Tandem Scanning Electron Microscopy and Photogrammetry Software

Ian T. Massaro (Microbiology), Alice Mashensky (Microbiology), Ricardo L. Peguero (Microbiology), Andras Bimbo-Szuhai (Microbiology), and Dr. Christopher P. Corbo (Biological Sciences)

Biological 3D models have a multitude of applications in both research and academic settings, however the generation of such models at an ultrastructural scale has remained a daunting task. Here our group presents a method by which ultrastructural 3D models can be generated using tandem scanning electron microscopy (SEM) and photogrammetry. Our methods include a novel technique for mounting specimens for SEM which allowed our group to capture images from all angles around the specimen. Our results demonstrate that using our technique is adequate for the construction of an interactive, ultrastructural 3D model that can be viewed from all orientations. We ultimately see use for these models in educational settings and research when the 3D analysis of ultrastructural anatomy is necessary.

## GABAA Receptor Activation Reduces Social Behavior in Planarians

Kendal Lascar (Biopsychology) and Michael Pepe (Biopsychology)

Planarians, a species of flatworm that belongs to the Phylum Platyhelminthes, are known for their regenerative properties. Planaria can regenerate a mature central nervous system within seven days following decapitation, making them an attractive model for studying early neurodevelopmental processes. Traditionally, planarians have been used in regenerative studies. Few studies have addressed behavioral phenotypes. Here, we use a novel assay to assess social behavior in the planarian by studying clumping behavior and nearest neighbor distance (NND) between planarians in an open field. In previous work, our lab group found that exposure to ethanol, a gamma-aminobutyric acid A (GABAA) receptor

agonist, results in less clumping and a larger NND between planaria. To confirm that GABAergic stimulation regulates social behavioral processes, we used the pharmacological GABAA receptor agonist muscimol to perturb GABAergic neuro-transmission. We found that exposure to 0.05% muscimol for ten minutes resulted in a decrease in clumping distance, or social interactions between planaria ($p < 0.001$; $F(1,61) = 37.07$; Mixed Effects Model). This effect was sustained at multiple time points after planaria were introduced to one another ($p < 0.001$ at 40 m and 60 m; Sidak'S Multiple Comparisons Test). Our data demonstrated that the GABAA receptor agonism reduces social interactions between planaria. The ability to perturb social interactions in planaria makes it an attractive high throughput model to study social behavior and neuro-developmental disorders, in which social behavior is often disrupted.

# Section II:
# The Natural Sciences & Quantitative Analysis

# A Comparison of the Effects of Phosphate Concentrations on Population Growth Dynamics of the Duckweed *Lemna minor* Grown in Distilled and Spring Water

Heather McLean (Biology)[1]

In this experiment duckweed *Lemna minor* was grown for 31 days under controlled laboratory conditions. Duckweed was grown in test tubes as control or treatment groups in the following solvents: spring water, lab-distilled water, or commercial-distilled water. Control groups had no additional phosphate. Treatment groups had phosphate added to make various phosphate concentrations. Five tubes were made for every nutrient condition with three-frond duckweed plants placed into each. The number of fronds was counted throughout the experimental period. Carrying capacity and $r_{max}$ were calculated to determine growth levels. Results for spring water showed a significant ($P \leq 0.05$) difference in the carrying capacity for 10 ppm compared to each treatment group. Carrying capacity followed Liebig's law of the minimum and r-max Shelford's law of tolerance. Lab-distilled water showed less growth and lower $r_{max}$ values compared to spring water. The results showed that 50-100 ppm had a significantly higher ($P \leq 0.05$) carrying capacity and r-max compared to 0 ppm. However, trends were not followed while using lab-distilled water. When comparing the controls of each solvent, it was found that lab-distilled water had a significantly lower carrying capacity compared to spring water and commercial-distilled water. It is most likely due to issues with the filtration system or plasticizers from the carboy. These results show the importance of determining phosphate concentrations required for optimal population growth and which concentrations have negative growth effects.

## I. Introduction

### General Introduction to Population Growth Dynamics

Duckweed growth is characterized by population growth dynamics. Fluctuations constantly occur in communities as individuals are born and die. Growth defines the changes in size and structure over time. Exponential growth is when populations become greater in proportion to their total growing size, creating a rapid increase with passing time. It occurs when the size of the population increases by the same percentage per unit in

[1] Research conducted under the supervision of Dr. Donald Stearns in partial fulfillment of the Senior Program requirements.

time. The growth occurs at the same percentage, not necessarily the same amount. A graph shows an accelerated increase in the size of a population, which appears as a J-shaped curve. Exponential growth depends on the ability of individuals in a population to reproduce and survive under their environmental conditions (Freeman et al., 2017).

Growth can be described using per-capita rate of increase (r-value). It is each individual's contribution to the initial population, compared to the increase of the population. The value is positive when the birth rate is greater than the death rate and is negative when it is the opposite. Exponential growth occurs when the r-value does not change over time. The intrinsic rate of increase (r-max,) is the maximal r-value found in optimal conditions. These conditions are achieved when the birth rates per individual are maximized, and death rates are minimized (Freeman et al., 2017).

Populations cannot grow exponentially indefinitely and will eventually reach their carrying capacity (K) for environmental conditions. Carrying capacity is the maximum number of individuals supported in an environment. It depends on limiting factors such as nutrients, water, light, disease, and space. As a population approaches the carrying capacity, the growth rate slows. Carrying capacity is an important factor in logistic population growth. This growth begins as exponential growth but levels off at the carrying capacity. It appears as an S-shaped curve on a graph. Exponential growth is density independent, whereas logistic growth is density dependent (Freeman et al., 2017).

## Taxonomic Classification and Natural History of the Duckweed *Lemna minor*

The scientific name for duckweed is *Lemna minor* (*Lemna perpusilla*, 2021). The classification of duckweed is shown in *Table 1*. Duckweed is part of the domain eukarya, the kingdom plantae, the phylum tracheophyta (vascular plant), the class spermatophyta (plants that produce seeds), the order Magnoliopsida (flowering plants), the family araceae (borne on a type of inflorescence called a spadix), the genus lemna and the species *Lemna minor* (Lemna minor, 2021).

Duckweed is a flowering aquatic plant located in quiet waters. It is found in a variety of habitats, including ponds, marshes, lakes, or slow-moving streams. There are nine duckweed species in North America. The common duckweed is the most widespread species, ranging across Canada and the United States. Duckweed is composed of single, flat small oval leaves called fronds, and roots. The fronds float on the water's surface and roots submerge to absorb nutrients (Fertig, 2021). *Figure 1* shows a diagram of duckweed, with frond, frond buds, and roots labeled.

| **Classification** | **Classification in *Lemna minor*** |
|---|---|
| Domain | Eukarya |
| Kingdom | Plantae |
| Phylum | Tracheophyta |
| Class | Spermatophyta |
| Order | Magnoliopsida |
| Family | Araceae |
| Genus | Lemna |
| Species | *Lemna minor* |

Table 1. The classification of *Lemna minor* (duckweed), including domain, kingdom, phylum, class, order, family, genus, and species.

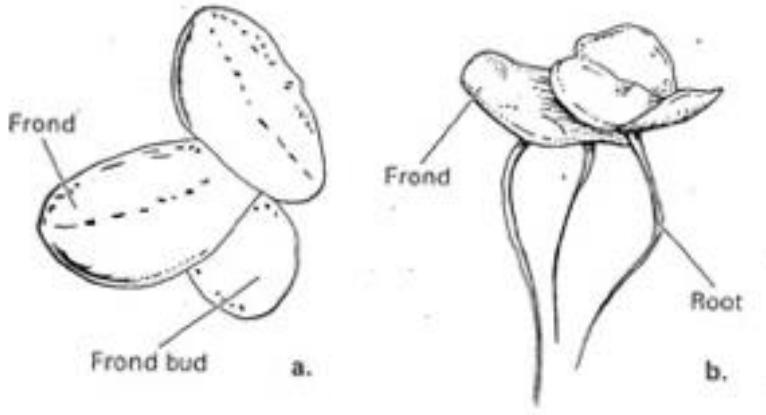


Figure 1. *Lemna minor* (duckweed) consists of small, oval leaves called fronds, new vegetative growth called buds, and roots submerged in water to absorb nutrients (Carolina Biological, 2008).

Duckweed grows in dense floating mats piled up in several layers. The biodiversity in the water under mats is often low. The environment is highly anaerobic and has substantial light competition (Driever et al., 2005). The flowering part of the duckweed consists of two microscopic staminate flowers and one tiny pistillate flower in a pouch-like sac. Duckweed is the world's smallest flowering plant. Their flowering structure is commonly not visible to the naked eye. Most duckweeds reproduce asexually by forming chains of new stems in the form of vegetative buds. Less commonly, duckweed will reproduce sexually through seeding. This process usually occurs during winter when seeds fall from old fronds and sink to the bottom to germinate. (Fertig, 2021). Duckweed can grow at temperatures ranging from 5°C to 35°C (Lasfar et al., 2007). Most species have an optimum growth at 26°C. Duckweed reproduces quickly until all nutrients have been consumed at this temperature. On either side of this optimal value, growth decreases significantly, as viewed in *Figure 2* (Lasfar et al., 2007).

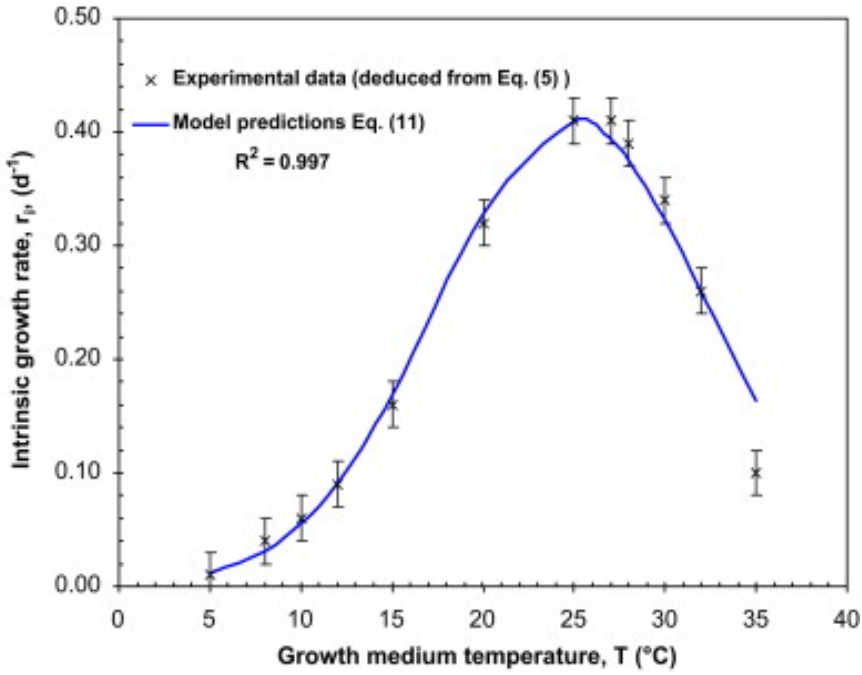


Figure 2. The growth rate of duckweed depends on temperature. Optimal growth is at 26°C. On either side of this value the growth rate decreases. Temperatures lower than 10°C or higher than 35°C strongly inhibits growth (Lasfar et al., 2007).

Duckweed is a valuable model organism for laboratory work due to its high reproduction rate, small size, and easy maintenance. Fast growth can be used for bioremediation of waterways from excessive agricultural runoff of phosphorus (Fertig, 2021). Duckweed can grow in different conditions such as, dirty, saline, or eutrophic waters, allowing for successful biological treatment of polluted waters (Sivaci et al., 2017). Research is also developing techniques to use genetically modified duckweeds to synthesize commercially valuable proteins, such as insulin (Fertig, 2021).

## The Importance of Macronutrients on Population Dynamics, in General, with a Particular Focus on *Lemna minor*

Nutrients needed in large quantities (exceeding 1.0 mg/L) are macronutrients. (Sharma, 2006). Regular growth, development, fruiting, and blooming of duckweed require macronutrients (Subramanian et al., 2021). Carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur are macronutrients required by duckweed. With the exemption of oxygen, all nutrients can be obtained through fertilizers. Macronutrients are used to produce carbohydrates, lipids, proteins, and nucleic acids. These biological molecules are essential for life (Broyer & Stout, 1959). Carbohydrates are made up of carbon, hydrogen, and oxygen. The covalent bonds connect the macronutrients with frequent polar hydroxyl (-OH) groups (Grindley, 2001). Carbohydrates create duckweed's structure, store energy, and make up the bulk of organic material moving through the phloem. Additionally, glucose formed during photosynthesis is used in cellular respiration to release energy (Wardlaw, 1968). Lipids are a family of molecules composed of carbon, hydrogen, and oxygen. The carbon atom makes a single covalent bond with other carbon and hydrogen atoms to form saturated or unsaturated fatty acids (Meara, 1955). Lipids function in membranes and energy sources for seed germination (Mumtaz et al., 2020). Proteins are composed of carbon, hydrogen, oxygen, and nitrogen. Amino acids are linked creating proteins, and they consist of an amino group ($-NH_2$), a carboxyl group (-COOH), and a variable R-group (Branden & Tooze, 1991). Proteins have several enzymatic, structural, and functional roles in duckweed. They additionally act as storage mediums for the nutritional demands of developing seedlings (Rasheed et al., 2020). Nucleic acids, such as DNA and RNA, contain carbon, hydrogen, oxygen, nitrogen, and phosphorus. Nucleotides consist of a nitrogen-containing aromatic base, pentose five-carbon sugar, and a phosphate group. Nucleic acids make up the genetic material of duckweed (Neidle, 2008).

### Chemical Introduction to the Phosphate Molecule

Phosphate is an important molecule for duckweed physiology. The charged ion ($[PO_4]^{-3}$) has a molar mass of 94.97 g/mol. The structure consists of a central phosphorus

atom surrounded by four oxygen atoms in a tetrahedral arrangement, as seen in *Figure 3* (Schirber, 2012).

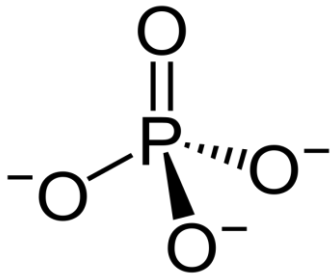

Figure 3. The structure of phosphate ($[PO_4]^{-3}$) with a central phosphate atom surrounded by four oxygen atoms in a tetrahedral shape (Wypych, 2013).

Phosphate has many cellular functions. It makes up the hydrophilic heads of the phospholipid bilayer of cell membranes. Membranes are semi-permeable allowing only select molecules to diffuse across. Small hydrophobic molecules, such as $O_2$ and $CO_2$, can cross membranes rapidly. Larger molecules, like glucose; require active transport to pass through. Phosphate also makes up part of the structure of adenosine triphosphate (ATP), the energy carrier of cells. ATP consists of a chain of three phosphate groups, along with a nitrogenous base and ribose sugar. When one of three phosphate groups are removed energy is released. The energy can perform many cellular functions, such as DNA replication, cell division, or protein synthesis. Phosphate is also necessary for the structure of DNA and RNA, which consists of a 5-carbon deoxyribose sugar, nucleotide, and phosphate group. Phosphate is also involved in phosphorylation, which is an important mechanism for altering the activity of proteins after they have been synthesized. In the process, a phosphate group is added to a protein by specific enzymes called kinases. The removal of a phosphate group is called dephosphorylation (Schirber, 2012).

Phosphate Concentrations and Population Density Affect the Growth of the Duckweed *Lemna minor*

Phosphate is considered a primary nutrient for duckweed growth, development, and reproduction. It is vital for many cellular components (Sivaci et al., 2017). The capacity of phosphate uptake affects biomass, growth, production, and quality of duckweed (Abdolzadeh et al., 2010). Duckweed must receive correct phosphate levels to maintain homeostasis (Razaq et al., 2017). Reviewing the literature on how phosphate and

density affect duckweed creates an understanding of growth dynamics (Lasfar et al., 2007).

The article *Intrinsic growth rate: A new approach to evaluate the effects of temperature, photoperiod, and phosphorus–nitrogen concentrations on duckweed growth under controlled eutrophication* determined duckweed intrinsic growth rate as a function of temperature, photoperiod, and phosphorus-nitrogen concentrations. The experiment found optimal growth ranges for each condition. The results for phosphorus showed that intrinsic growth rate was practically constant for phosphorus concentrations ranging from 1 to 20 ppm (parts per million). It decreased rapidly for concentrations less than 1 ppm, and for concentrations more than 20 ppm, it was slightly inhibited. It was hypothesized that concentrations of phosphorus higher than 1 ppm do not significantly influence intrinsic growth. The results are demonstrated in *Figure 4* (Lasfar et al., 2007).

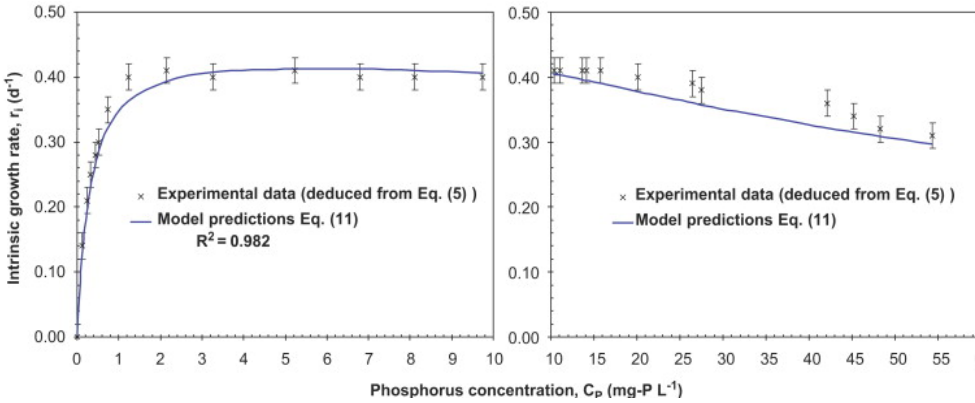


Figure 4. Intrinsic growth rate in dependence of phosphorus concentrations (1 mg phosphorus /L = 1 ppm). It was constant from 1-20 ppm, decreased rapidly at less than 1 ppm, and slightly inhibited at more than 20 ppm (Lasfar et al., 2007).

The study *Evaluation of Some Physiological Parameters of Lemna Minor L. Exposed to Different Hypertrophic Phosphate Levels* evaluated several biochemical properties, such as Chlorophyll a, chlorophyll b, carotenoids, phenolic compounds, thiobarbituric acid reactive substances, and protein contents with antioxidant enzyme activities (glutathione reductase and catalase). Duckweed was exposed to different phosphate concentrations for 24, 48, 96, and 144 hours in laboratory conditions. The results showed that an oversupply of phosphorus for long periods of time decreased protein amounts and increased chlorophyll b. These function as adaptive responses to phosphate overexposure (Sivaci et al., 2017).

The experiment *Influence of Nitrogen and Phosphorus on the Growth and Root Morphology of Acer Mono* studied the influence of phosphorus on *Acer mono* (commonly known as maple). The results found that phosphorus fertilization significantly affected the growth and root morphology of *A. mono* seedlings. When the seedlings did not receive sufficient nutrients, they showed lower plant height, root collar diameter, chlorophyll, carotene content, and several root morphology parameters. When seedlings were supplied with optimal phosphorus (8 g plant$^{-1}$), maximum values of the parameters were recorded. This study hypothesized that optimal phosphorus levels can be used to ensure the production of healthy *A. mono* seedlings with high levels of growth (Razaq et al., 2017).

The study *Growth Limitation of Lemna Minor Due to High Plant Density* tested growth limitations in *Lemna minor* populations due to high plant density. Results found at high densities (biomass above 180 g DW/m$^2$) there were slightly negative growth rates. Fronds grow as dense mats piled up in several layers. This piling creates an upper part with nutrient limitations, mostly phosphate and nitrate, and a lower part with light and $CO_2$ limitations. Negative growth rates are the result of limiting factors of carrying capacity. The experiment also found that at low densities (biomass below 9.5 g DW/m$^2$) increasing density increased growth rate. The increase was most likely due to higher temperatures caused by solar radiation being trapped in mats at low densities. The experiment proposed growth increase at low densities due to an initial piling of fronds, but as piles reach higher densities there is a decrease due to carrying capacity. This creates a logarithmic model dependent on carrying capacity, displayed in *Figure 5.* The competition for phosphate, nitrate, light, and space also follows this model (Driever et al., 2005).

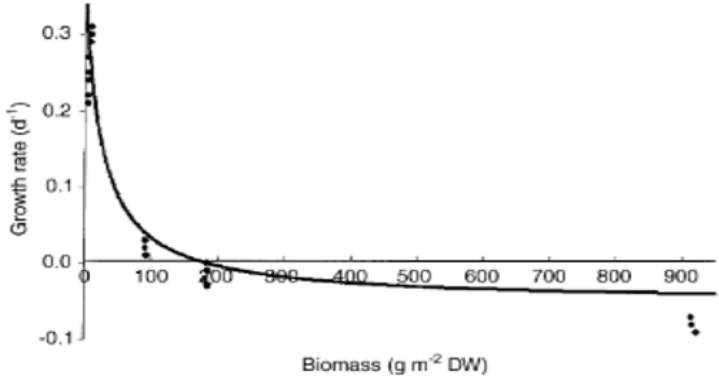


Figure 5. Growth rate as a function of the initial biomass of duckweed. The growth initially increased with increasing density (below 9.5 g DW/m$^2$), before leveling off at carrying capacity, and eventually at high densities (above 180 g DW/m$^2$) showed a negative growth rate (Driever et al., 2005)

The Importance of Micronutrients (Trace Elements) on Plant Growth with a Particular Focus on *Lemna minor* and Phosphate

Micronutrients are important for the life cycle of duckweed. All autotrophic plants require the use of the following micronutrients: potassium, calcium, magnesium, iron, manganese, copper, zinc, molybdenum, boron, and chlorine. These nutrients are specific and cannot be replaced. They are obtained from soil-forming minerals. Micronutrients have many important roles, including structurally in organic compounds, such as membranes. Alterations in plasma membranes have been linked to zinc deficiency. Micronutrients also have a catalytic role as drivers and regulators of enzyme-catalyzed reactions. Another function is electron receptors. Micronutrients assist in controlling the flow of electrons between molecules in enzyme redox reactions. This phenomenon is seen in the mitochondria and chloroplast as part of the electron transport chain. Osmoregulation is affected by the number of micronutrients. Chlorine and potassium fluxes regulate water flow, inducing turgor changes that control the stoma opening. Lastly, micronutrients have an important role in reproduction. Low reproduction rates have been linked to a deficiency in micronutrients. This reduction is due to the lowering of photosynthetic efficiency. There is a quantitative requirement for micronutrients for optimal growth. If there are not enough micronutrients, the structure, function, and development of plants is negatively affected (Sharma, 2006).

Micronutrients and phosphorus together impact duckweed development. The buildup of phosphorus in environments decreases growth or causes death in plants. Excessive soil phosphorus reduces the plant's ability to take up required micronutrients, especially iron and zinc. In high phosphorus conditions, iron and zinc are quickly converted to non-available forms. Iron deficiencies are characterized by yellowing between the leaf veins, and zinc by the bleaching of tissue (Provin & Pitt, 2008).

Significance of this Research

The significance of this research was to empirically show the population growth dynamics of the duckweed *Lemna minor* under experimental conditions. It specifically showed how the concentration of available phosphate affects population growth dynamics ($r_{max}$ and K). It is important to know which phosphate concentrations are required for optimal population growth and which concentrations have negative effects. The study also provided important insights into how storage of distilled water in carboys can potentially inhibit duckweed growth.

## II. Objectives

The research objective was to examine and compare the effects of phosphate on the population growth dynamics of the duckweed *Lemna minor* growing in spring water and distilled waters.

The study idea was to vary the amount of phosphate available while duckweed grew in a controlled environment. Each test tube contained either lab-distilled water, commercial-distilled water, or spring water. Some test tubes were control groups, having no added phosphate. The other test tubes were treatment groups with additional phosphate. A three-frond duckweed was added to each test tube and placed under continuous lighting and temperature. The number of fronds was monitored throughout the experimental period of 31 days.

Growth was characterized by the appearance of a new frond. The number of fronds in tubes was monitored and compared. The results were statistically analyzed for interpretation and graphed on a line plot. The data were used to determine the growth dynamics in terms of $r_{max}$ and K. Statistical analysis was conducted to see if the results were significant.

## III. Materials and Methods

### Experimental Species

*Lemna minor* duckweed was the experimental species in the experiment. Duckweed was ordered from Carolina Biological Supply Company. It was kept in a finger bowl (seen in *Figure 6*) filled with Poland Spring® 100% Natural Spring Water to mimic the abundance of macronutrients and micronutrients found in their natural environment. The spring water promoted growth producing dense floating mats on the water surface. The bowl was kept in a laboratory at a room temperature of approximately 21°C and under a grow light as described in the experimental setup.

### Procedure for Preparing All Experimental Frond Populations

A long-term experiment was used to collect data on duckweed population growth dynamics. Each time the experiment was conducted it followed the same general procedure with phosphate, but various solvents were used. The solvent was measured with a graduated cylinder. Phosphate was added using the dropper on the bottle. Phosphate was obtained from Carolina Biological Supply Company. It was a phosphate solution composed of water (99.63%), potassium phosphate monobasic (0.20%), and potassium phosphate dibasic (0.17%). When making the test tubes, phosphate was always added before the solvent for mixing. Five nutrient concentrations were created with varying amounts of solvent and phosphate. Five tubes were made for each nutrient concentration,

Figure 6. The experimental species *Lemna minor* at room temperature (about 21°C) under a grow light. They grew on top of spring water in the finger bowl.

creating a sample size of n = 5. In the control tubes, only 50 mL of solvent was added. There was no phosphate to achieve a baseline. In the next test tubes, 49.5 mL of solvent and 10 drops of phosphate were put into each test tube. The 0.5 mL was added with a pipette. Next, 49 mL of solvent and 20 drops of phosphate were used. The following phosphate environment was created with 40 drops of phosphate and a solvent concentration of 48 mL. Lastly, 47 mL of solvent was added to 60 drops of phosphate. After the nutrient concentrations were created, duckweed was added to each tube. Duckweed was picked from a colony growing in a finger bowl and added to the surface of the water. The collection tool had a slender metal end. Duckweed was chosen which had only three fronds. All three fronds had to be attached, but they could be a variety of sizes, including small buds. A three-frond duckweed selected is observed in *Figure 7*.

Figure 7. A duckweed chosen from the colony with exactly three fronds. It was added to the surface of a test tube with the desired solvent and phosphate concentration.

After adding duckweed, plastic wrap was placed around the top of the tube and secured with elastic bands. This technique aimed to prevent spillage and evaporation. The last step was to poke eight holes in the plastic wrap to allow gas exchange to occur. Tubes were placed in a test tube rack under a growth light. Grow lights are electric lights used to assist plant growth by providing a light spectrum like the sun. Finalized test tubes under the grow light are seen in *Figure 8*.

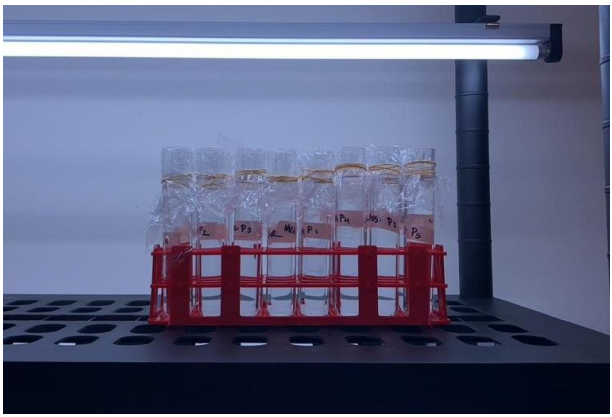

Figure 8. The final setup of the duckweed experiment with test tubes in a rack with various phosphate and solvent concentrations, duckweed with three fonds, plastic wrap, and elastic bands sitting under the grow light.

Solvents Used for Experimental Frond Populations

During the experiment three different solvents were used: lab-distilled water, commercial-distilled water, and spring water. Lab-distilled water was purified using a Thermo Fisher Scientific Barnstead Classic Electric Still with a model number A1016-X003 in the Wagner College laboratory. Commercial-distilled water was purchased from ShopRite by the brand Bowl and Basket. It was purified by steam distillation, micron filtration, and UV disinfection to ensure quality. Distilled water removed 99.9% of all minerals found in water. Spring water was Poland Spring® 100% Natural Spring Water. The following nutrients were reported in the 2020 Poland Spring® 100% Natural Spring Water analysis: 0-0.014 ppm of bromide, 3.7-12 ppm of calcium, 0-14 ppm of chloride, 0-0.25 ppm of fluoride, 0.67-1.6 ppm of magnesium, 1.6-9.1 ppm of sodium, 0-0.88 ppm of nitrate, and 0-8.1 ppm of sulfate. All other nutrients tested were not detected (Poland Spring®, 2020).

Procedure Used to Measure Changes in Population Size Over Time

The growth of the duckweed was recorded three days a week: Mondays, Wednesdays, and Fridays. The days since the experiment began were noted every day. The experiment setup was day 0. The daily frond growth was also recorded. On day 0, the frond growth for all tubes was three. The total number of fronds in each tube were counted. Every frond, even small buds, were included. Each frond on duckweed plants were considered an "individual", instead of each duckweed plant being the “individual”. The results were analyzed using the number of counted fronds in each test tube as the population size. When counting fronds, it was noted if they were together or broken apart, the color, and any other significant observations. Magnifying glasses were used to view the small buds. The counting ended when the fronds had fallen apart, became brown, and ceased to grow. The room temperature was also recorded using a thermometer in a beaker filled with water also placed under the grow light.

Additional results were obtained through light readings. The readings were taken using a LI-COR LI-250A light meter. The sensor used was LI-COR Quantum 47836. The light detector was placed in the front, middle, and back of the grow light station. Three readings were recorded for the front and back, and four were recorded for the middle. The average of the readings determined light activity in each position. The units used were $\mu mol/m^2/s$. Micromoles are the number of photons coming down from the light area per unit of area per second.

Nutrient strips were used to determine the concentration of phosphate in each test tube used in the experiment. The strips were Phosphate 0-100 ppm Test’s from the company Bartvation. The nutrient strips were dipped in the test solution for one second, and then after three minutes were held up to the color comparison on the bottle. The results were recorded in ppm phosphate.

Calculations of r-max and K

To display population growth dynamics carrying capacity and r-max were calculated. Data from each of the five tubes were averaged to create only a singular table with average daily frond growth. Carrying capacity and r-max calculations used the averaged data. Carrying capacity was the maximum amount of growth for a specific nutrient treatment. The r-max values were found through a sequence of calculations. The first step was to subtract the daily frond growth by the prior day’s growth. This found new frond growth. Next, days since the previous count was found by subtracting the days since the experiment started by the prior day’s number. The change in the number of fronds per day was determined by dividing the new frond growth by the days since the previous count. Lastly, the change in the number per day was divided by the daily frond growth of

the previous day. This value was the change in the number of fronds per day per frond, or the r-values. The r-max value was the highest r-value found for a specific nutrient treatment.

Statistical Analysis of Collected Data

Statistical analysis was done with a widely used program called IBM® SPSS® (International Business Machines Corporation Statistical Package for the Social Sciences). A comparative mean analysis called One-Way ANOVA (analysis of variance) with four different tests was used. Firstly, descriptive statistics found statistics of location and dispersion for each group. Mean and standard deviation were relevant to the study. Next was a test of homogeneity of variances based on the mean. This tested if the samples had equal variances. If the P-value was greater than 0.05, the variances were not statistically different, and ANOVA test could be conducted without data transformation. ANOVA determined if there were statistical differences between the means of the groups. When P-values were less than 0.05 it indicated that the mean of at least one of the groups significantly differed from the mean of at least one other group. The last analysis was a Tukey test. The purpose of this test was to determine which group significantly differed from which other group. It compared the means of all groups to the mean of every other group to determine if the relationship between two sets of data were statistically significant. When the P-value was less than 0.05 it was statistically significant. Statistical analyses comparing carrying capacities and r-max values were performed for the following groups: spring water, lab-distilled water, and control of all three solvent groups.

## IV. Results

Numerical Data

The experiment data was organized into spring water, lab-distilled water, and commercial-distilled water results. The data were collected for a total of 31 days. The first 12 days had a sample size of 10 while the remaining days had a sample size of 5. Results were displayed in tables and graphically as line plots.

### Spring Water

The data for spring water are displayed in *Table 2*. In the 10 ppm tubes there was a carrying capacity of 9.4 fronds and an r-max of 0.13 per day. The 10-25 ppm showed a carrying capacity of 18.2 fronds and r-max of 0.24 per day. The carrying capacity for 25 ppm was 17.8 fronds with an r-max of 0.27 per day. The tubes which were 50-100 ppm yielded a carrying capacity of 17 fronds and r-max of 0.24 per day. Lastly, >100 ppm had a carrying capacity of 17.2 fronds and r-max of 0.16 per day.

*Spring Water: 10 ppm*

| Days Since Experiment Began | Daily Fond Growth | New Frond Growth | Days Since Previous Count | Change in the Number of Fronds per Day | Change in the Number of Fronds per Day per Frond (per day) |
|---|---|---|---|---|---|
| 0 | 3 | XXXXXX | XXXXXX | XXXXXX | XXXXXX |
| 3 | 4 | 1 | 3 | 0.33 | 0.11 |
| 5 | 5 | 1 | 2 | 0.5 | 0.13 |
| 7 | 6 | 1 | 2 | 0.5 | 0.1 |
| 10 | 7.2 | 1.2 | 3 | 0.4 | 0.067 |
| 12 | 7.4 | 0.2 | 2 | 0.1 | 0.014 |
| 14 | 8 | 0.6 | 2 | 0.3 | 0.041 |
| 17 | 8.6 | 0.6 | 3 | 0.2 | 0.025 |
| 19 | 8.6 | 0 | 2 | 0 | 0 |
| 21 | 8.6 | 0 | 2 | 0 | 0 |
| 24 | 8.6 | 0 | 3 | 0 | 0 |
| 26 | 8.6 | 0 | 2 | 0 | 0 |
| 28 | 9 | 0.4 | 2 | 0.2 | 0.023 |
| 31 | 9.4 | 0.4 | 3 | 0.14 | 0.015 |

*Spring Water: 10-25 ppm*

| Days Since Experiment Began | Daily Fond Growth | New Frond Growth | Days Since Previous Count | Change in the Number of Fronds per Day | Change in the Number of Fronds per Day per Frond (per day) |
|---|---|---|---|---|---|
| 0 | 3 | XXXXXX | XXXXXX | XXXXXX | XXXXXX |
| 3 | 5.2 | 2.2 | 3 | 0.73 | 0.24 |
| 5 | 6.6 | 1.4 | 2 | 0.7 | 0.13 |
| 7 | 8.6 | 2 | 2 | 1 | 0.15 |
| 10 | 11.6 | 3 | 3 | 1 | 0.12 |
| 12 | 12.8 | 1.2 | 2 | 0.6 | 0.052 |
| 14 | 13.2 | 0.4 | 2 | 0.2 | 0.016 |
| 17 | 14.2 | 1 | 3 | 0.33 | 0.025 |
| 19 | 15 | 0.8 | 2 | 0.4 | 0.028 |
| 21 | 15.2 | 0.2 | 2 | 0.1 | 0.0067 |
| 24 | 15.2 | 0 | 3 | 0 | 0 |
| 26 | 16.6 | 1.4 | 2 | 0.7 | 0.046 |
| 28 | 16.8 | 0.2 | 2 | 0.1 | 0.0060 |
| 31 | 18.2 | 1.4 | 3 | 0.47 | 0.027 |

*Spring Water: 25 ppm*

| Days Since Experiment Began | Daily Fond Growth | New Frond Growth | Days Since Previous Count | Change in the Number of Fronds per Day | Change in the Number of Fronds per Day per Frond (per day) |
|---|---|---|---|---|---|
| 0 | 3 | XXXXXX | XXXXXX | XXXXXX | XXXXXX |
| 3 | 5.4 | 2.4 | 3 | 0.8 | 0.27 |
| 5 | 6.4 | 1 | 2 | 0.5 | 0.093 |
| 7 | 8.6 | 2.2 | 2 | 1.1 | 0.17 |
| 10 | 11.8 | 3.2 | 3 | 1.07 | 0.12 |
| 12 | 12.8 | 1 | 2 | 0.5 | 0.04 |
| 14 | 13.2 | 0.4 | 2 | 0.2 | 0.016 |
| 17 | 13.6 | 0.4 | 3 | 0.13 | 0.0098 |
| 19 | 15 | 1.4 | 2 | 0.7 | 0.051 |
| 21 | 15.2 | 0.2 | 2 | 0.1 | 0.0067 |
| 24 | 16.2 | 1 | 3 | 0.33 | 0.022 |
| 26 | 16.8 | 0.6 | 2 | 0.3 | 0.019 |
| 28 | 17.2 | 0.4 | 2 | 0.2 | 0.012 |
| 31 | 17.8 | 0.6 | 3 | 0.2 | 0.012 |

*Spring Water: 50-100 ppm*

| Days Since Experiment Began | Daily Fond Growth | New Frond Growth | Days Since Previous Count | Change in the Number of Fronds per Day | Change in the Number of Fronds per Day per Frond (per day) |
|---|---|---|---|---|---|
| 0 | 3 | XXXXXX | XXXXXX | XXXXXX | XXXXXX |
| 3 | 5.2 | 2.2 | 3 | 0.73 | 0.24 |
| 5 | 7 | 1.8 | 2 | 0.9 | 0.17 |
| 7 | 10 | 3 | 2 | 1.5 | 0.21 |
| 10 | 12.4 | 2.4 | 3 | 0.8 | 0.08 |
| 12 | 12.8 | 0.4 | 2 | 0.2 | 0.016 |
| 14 | 13.4 | 0.6 | 2 | 0.3 | 0.023 |
| 17 | 14.4 | 1 | 3 | 0.33 | 0.025 |
| 19 | 14.8 | 0.4 | 2 | 0.2 | 0.014 |
| 21 | 15 | 0.2 | 2 | 0.1 | 0.0068 |
| 24 | 15.6 | 0.6 | 3 | 0.2 | 0.013 |
| 26 | 15.6 | 0 | 2 | 0 | 0 |
| 28 | 15.8 | 0.2 | 2 | 0.1 | 0.0064 |
| 31 | 17 | 1.2 | 3 | 0.4 | 0.025 |

*Spring Water: >100 ppm*

| Days Since Experiment Began | Daily Fond Growth | New Frond Growth | Days Since Previous Count | Change in the Number of Fronds per Day | Change in the Number of Fronds per Day per Frond (per day) |
|---|---|---|---|---|---|
| 0 | 3 | XXXXXX | XXXXXX | XXXXXX | XXXXXX |
| 3 | 5.2 | 2.2 | 3 | 0.73 | 0.024 |
| 5 | 6.4 | 1.2 | 2 | 0.6 | 0.12 |
| 7 | 8.4 | 2 | 2 | 1 | 0.16 |
| 10 | 12.4 | 4 | 3 | 1.33 | 0.16 |
| 12 | 12.4 | 0 | 2 | 0 | 0 |
| 14 | 12.6 | 0.2 | 2 | 0.1 | 0.0081 |
| 17 | 13.6 | 1 | 3 | 0.33 | 0.026 |
| 19 | 13.8 | 0.2 | 2 | 0.1 | 0.0074 |
| 21 | 14.6 | 0.8 | 2 | 0.4 | 0.029 |
| 24 | 14.8 | 0.2 | 3 | 0.067 | 0.0046 |
| 26 | 15.6 | 0.8 | 2 | 0.4 | 0.027 |
| 28 | 15.6 | 0 | 2 | 0 | 0 |
| 31 | 17.2 | 1.6 | 3 | 0.53 | 0.034 |

Table 2. Results of duckweed grown in spring water with various phosphate concentrations. Carrying capacity is the maximum daily frond growth and r-max the maximum change in the number of fronds per day per frond.

The line plot in *Figure 10* displays the daily frond growth in spring water for each phosphate concentration. Each line shows an upward trend as growth occurred continuously. The y-axis goes up to 20 fronds. At the concentration of 0 ppm there was significantly lower growth than the treatment groups. The 10 ppm, 25 ppm, 50-100 ppm, and >100 ppm tubes all had similar growth levels.

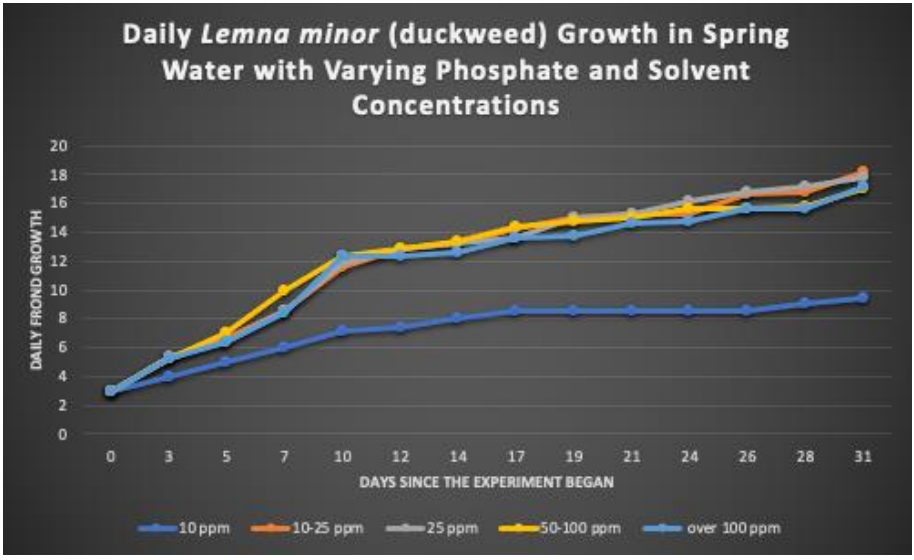


Figure 9. Line plot of the average daily frond growth of duckweed grown in spring water with varied phosphate concentrations.

**Lab-Distilled Water**

Results for lab-distilled water are displayed in *Table 3*. The 0 ppm tubes had a carrying capacity of 4.6 fronds and an r-max of 0.057 per day. At 10 ppm it yielded a carrying capacity of 4.8 fronds and r-max of 0.14 per day. The carrying capacity for 10-25 ppm was 5.6 fronds with an r-max of 0.11 per day. At 50 ppm the carrying capacity was 4.8 fronds and r-max was 0.085 per day. Lastly, 50-100 ppm had a carrying capacity of 5.6 fronds with an r-max of 0.15 per day.

*Lab-Distilled Water: 0 ppm*

| Days Since Experiment Began | Daily Fond Growth | New Frond Growth | Days Since Previous Count | Change in the Number of Fronds per Day | Change in the Number of Fronds per Day per Frond (per day) |
|---|---|---|---|---|---|
| 0 | 3 | XXXXXX | XXXXXX | XXXXXX | XXXXXX |
| 3 | 3.5 | 0.5 | 3 | 0.17 | 0.057 |
| 5 | 3.6 | 0.1 | 2 | 0.05 | 0.014 |
| 7 | 3.9 | 0.3 | 2 | 0.15 | 0.042 |
| 10 | 3.7 | 0 | 3 | 0 | 0 |
| 12 | 3.9 | 0.2 | 2 | 0.1 | 0.027 |
| 14 | 4.2 | 0.3 | 2 | 0 | 0 |
| 17 | 4.4 | 0.2 | 3 | 0.067 | 0.016 |
| 19 | 4.6 | 0.2 | 2 | 0.1 | 0.023 |
| 21 | 4.6 | 0 | 2 | 0 | 0 |
| 24 | 4.4 | 0 | 3 | 0 | 0 |
| 26 | 4.6 | 0.2 | 2 | 0.1 | 0.023 |
| 28 | 4.6 | 0 | 2 | 0 | 0 |
| 31 | 4.6 | 0 | 3 | 0 | 0 |

*Lab-Distilled Water: 10 ppm*

| Days Since Experiment Began | Daily Fond Growth | New Frond Growth | Days Since Previous Count | Change in the Number of Fronds per Day | Change in the Number of Fronds per Day per Frond (per day) |
|---|---|---|---|---|---|
| 0 | 3 | XXXXXX | XXXXXX | XXXXXX | XXXXXX |
| 3 | 3.6 | 0.6 | 3 | 0.2 | 0.067 |
| 5 | 4.6 | 1 | 2 | 0.5 | 0.14 |
| 7 | 4.5 | 0 | 2 | 0 | 0 |
| 10 | 4.7 | 0.2 | 3 | 0.067 | 0.015 |
| 12 | 4.8 | 0.1 | 2 | 0.05 | 0.011 |
| 14 | 4.6 | 0 | 2 | 0 | 0 |
| 17 | 4.6 | 0 | 3 | 0 | 0 |
| 19 | 4.6 | 0 | 2 | 0 | 0 |
| 21 | 5 | 0.4 | 2 | 0.2 | 0.043 |
| 24 | 5 | 0 | 3 | 0 | 0 |
| 26 | 5 | 0 | 2 | 0 | 0 |
| 28 | 5 | 0 | 2 | 0 | 0 |
| 31 | 4.6 | 0 | 3 | 0 | 0 |

*Lab-Distilled Water: 10-25 ppm*

| Days Since Experiment Began | Daily Fond Growth | New Frond Growth | Days Since Previous Count | Change in the Number of Fronds per Day | Change in the Number of Fronds per Day per Frond (per day) |
|---|---|---|---|---|---|
| 0 | 3 | XXXXXX | XXXXXX | XXXXXX | XXXXXX |
| 3 | 4 | 1 | 3 | 0.33 | 0.11 |
| 5 | 4.6 | 0.6 | 2 | 0.3 | 0.075 |
| 7 | 4.7 | 0.1 | 2 | 0.05 | 0.011 |
| 10 | 4.7 | 0 | 3 | 0 | 0 |
| 12 | 4.9 | 0.2 | 2 | 0.1 | 0.021 |
| 14 | 5.6 | 0.7 | 2 | 0.35 | 0.071 |
| 17 | 5.4 | 0 | 3 | 0 | 0 |
| 19 | 5.4 | 0 | 2 | 0 | 0 |
| 21 | 5.4 | 0 | 2 | 0 | 0 |
| 24 | 5.4 | 0 | 3 | 0 | 0 |
| 26 | 5.4 | 0 | 2 | 0 | 0 |
| 28 | 5.4 | 0 | 2 | 0 | 0 |
| 31 | 5.4 | 0 | 3 | 0 | 0 |

*Lab-Distilled Water: 50 ppm*

| Days Since Experiment Began | Daily Fond Growth | New Frond Growth | Days Since Previous Count | Change in the Number of Fronds per Day | Change in the Number of Fronds per Day per Frond (per day) |
|---|---|---|---|---|---|
| 0 | 3 | XXXXXX | XXXXXX | XXXXXX | XXXXXX |
| 3 | 3.5 | 0.5 | 3 | 0.17 | 0.057 |
| 5 | 3.8 | 0.3 | 2 | 0.15 | 0.043 |
| 7 | 4.1 | 0.3 | 2 | 0.15 | 0.039 |
| 10 | 4 | 0 | 3 | 0 | 0 |
| 12 | 4.1 | 0.1 | 2 | 0.05 | 0.013 |
| 14 | 4.8 | 0.7 | 2 | 0.35 | 0.085 |
| 17 | 4.6 | 0 | 3 | 0 | 0 |
| 19 | 4.6 | 0 | 2 | 0 | 0 |
| 21 | 4.6 | 0 | 2 | 0 | 0 |
| 24 | 4.8 | 0.2 | 3 | 0.067 | 0.015 |
| 26 | 4.8 | 0 | 2 | 0 | 0 |
| 28 | 4.6 | 0 | 2 | 0 | 0 |
| 31 | 4.6 | 0 | 3 | 0 | 0 |

*Lab-Distilled Water: 50-100 ppm*

| Days Since Experiment Began | Daily Fond Growth | New Frond Growth | Days Since Previous Count | Change in the Number of Fronds per Day | Change in the Number of Fronds per Day per Frond (per day) |
|---|---|---|---|---|---|
| 0 | 3 | XXXXXX | XXXXXX | XXXXXX | XXXXXX |
| 3 | 3.5 | 0.5 | 3 | 0.17 | 0.057 |
| 5 | 4.3 | 0.8 | 2 | 0.4 | 0.15 |
| 7 | 5.4 | 1.1 | 2 | 0.55 | 0.13 |
| 10 | 5.5 | 0.1 | 3 | 0.033 | 0.0061 |
| 12 | 5.6 | 0.1 | 2 | 0.05 | 0.0091 |
| 14 | 4.8 | 0 | 2 | 0 | 0 |
| 17 | 5.2 | 0.4 | 3 | 0.13 | 0.043 |
| 19 | 5.4 | 0.2 | 2 | 0.1 | 0.05 |
| 21 | 5 | 0 | 2 | 0 | 0 |
| 24 | 5.4 | 0.4 | 3 | 0.13 | 0.043 |
| 26 | 5.4 | 0 | 2 | 0 | 0 |
| 28 | 5.4 | 0 | 2 | 0 | 0 |
| 31 | 5.2 | 0 | 3 | 0 | 0 |

Table 3. Results of duckweed grown in lab-distilled water with various phosphate concentrations. Carrying capacity is the maximum daily frond growth and r-max the maximum change in the number of fronds per day per frond.

The line plot in *Figure 11* displays the daily frond growth in lab-distilled water. The line plot shows that each nutrient concentration had similar growth levels, but the growth was sporadic as the lines were not constantly increasing. The y-axis only went up to 6 fronds. Tubes at 0 ppm, 10 ppm, and 50 ppm all had the exact same growth, whereas 10-25 ppm and 50-100 ppm had slightly greater growth.

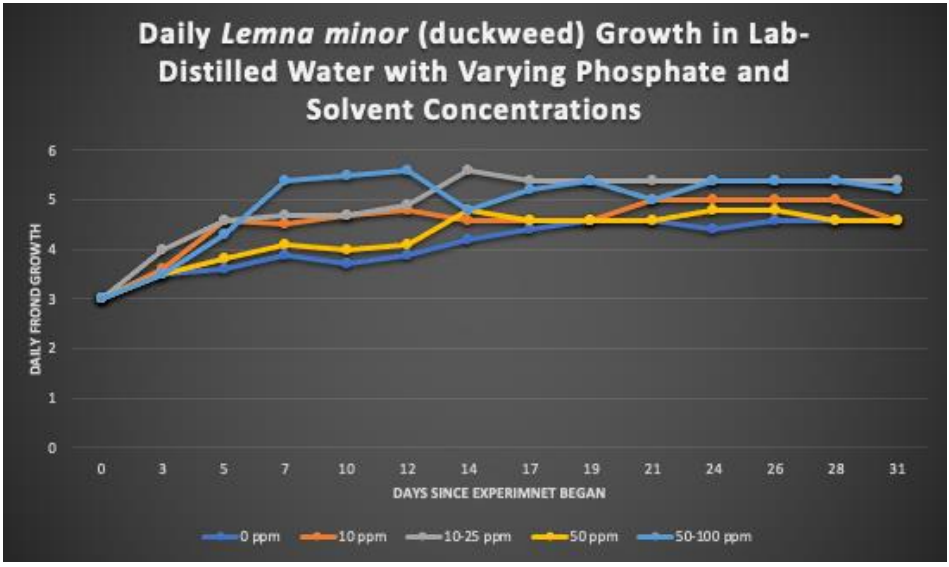


Figure 10. Line plot of the average daily frond growth of duckweed grown in lab-distilled water with varied phosphate concentrations.

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**Commercial-Distilled Water**

Lastly is the data from duckweed grown in commercial-distilled water. Results are viewed in *Table 4*. The carrying capacity for 0 ppm was 9.4 fronds with an r-max of 0.14 per day. The line plot in *Figure 12* displays commercial-distilled water duckweed growth. It included only 0 ppm. The graph displays growth increasing steadily upward.

**Light Readings**

The last results were light readings taken under the grow light in multiple positions. The front had an average reading of 25.9 µmol/$m^2$/s. The back's average reading was 28.28 µmol/$m^2$/s. Lastly, the middle had an average reading of 31.33 µmol/$m^2$/s.

*Commercial-Distilled Water: 0 ppm*

| Days Since Experiment Began | Daily Fond Growth | New Frond Growth | Days Since Previous Count | Change in the Number of Fronds per Day | Change in the Number of Fronds per Day per Frond (per day) |
|---|---|---|---|---|---|
| 0 | 3 | XXXXXX | XXXXXX | XXXXXX | XXXXXX |
| 3 | 3.6 | 0.6 | 3 | 0.2 | 0.067 |
| 5 | 4.6 | 1 | 2 | 0.5 | 0.14 |
| 7 | 5.4 | 0.8 | 2 | 0.4 | 0.087 |
| 10 | 6 | 0.6 | 3 | 0.2 | 0.037 |
| 12 | 6.2 | 0.2 | 2 | 0.1 | 0.017 |
| 14 | 7 | 0.8 | 2 | 0.4 | 0.016 |
| 17 | 8 | 1 | 3 | 0.33 | 0.047 |
| 19 | 8.6 | 0.6 | 2 | 0.3 | 0.038 |
| 21 | 8.6 | 0 | 2 | 0 | 0 |
| 24 | 8.8 | 0.2 | 3 | 0.067 | 0.077 |
| 26 | 9 | 0.2 | 2 | 0.1 | 0.011 |
| 28 | 9 | 0 | 2 | 0 | 0 |
| 31 | 9.4 | 0.4 | 3 | 0.13 | 0.014 |

Table 4. Results of duckweed grown in commercial-distilled water with various phosphate concentrations. Carrying capacity is the maximum daily frond growth and r-max the maximum change in the number of fronds per day per frond.

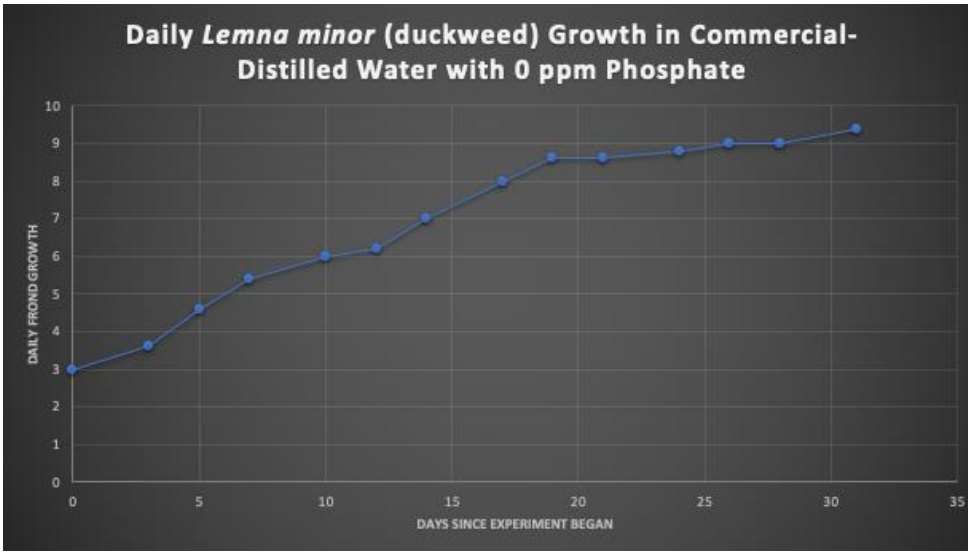


Figure 11. Line plot of the average daily frond growth of duckweed grown in commercial-distilled water at 0 ppm.

| Position | Readings (µmol/$m^2$/s) | Average (µmol/$m^2$/s) |
|---|---|---|
| Front | 26.0, 26.0, 25.7 | 25.9 |
| Back | 28.4, 28.0, 30.0, 26.7 | 28.28 |
| Middle | 31.3, 31.2 , 31.5 | 31.33 |

Table 5. Average light readings under the experimental grow light. Readings were taken three times in the front and back, four times in the middle, and averaged.

Statistical Analysis Data

**Spring Water**

Statistical analysis was performed to determine significance in the data. The first analysis used carrying capacity values for spring water. Descriptive statistics yielded standard deviations of: 1.517 for 10 ppm, 1.304 for 10-25 ppm, 3.564 for 25 ppm, 2.280 for 50-100 ppm, and 3.564 for > 100 ppm. The following were the mean values: 9.4 fronds

for 10 ppm, 16.8 fronds for 10-25 ppm, 17.8 fronds for 25 ppm, 17.2 fronds for 50-100 ppm, and 17.2 fronds for > 100 ppm. The homogeneity of variance had a Levene statistic of 2.488 and a P-value of 0.076. Since $P \geq 0.05$, the variances were not significantly different from each other. This condition must be met before ANOVA can be performed. The ANOVA test found a F-value of 8.997 for 4 and 20 degrees of freedom. The P-value was 0.001 meaning at least one group was significantly ($P \leq 0.05$) different from at least one other group. Lastly, the Tukey test found that all four phosphate treatments had significantly ($P \leq 0.05$) higher carrying capacities compared to the control group at 10 ppm. The four treatment groups did not significantly differ from each other.

Next, statistical analysis was determined between spring water r-max values. The descriptive statistics found the following standard deviations: 0.0850 for 10 ppm, 0.0508 for 10-25 ppm, 0.0677 for 25 ppm, 0.0492 for 50-100 ppm, and 0.0966 for > 100 ppm. The mean values were: 0.212 per day for 10 ppm, 0.276 per day for 10-25 ppm, 0.336 per day for 25 ppm, 0.242 per day for 50-100 ppm, and 0.274 per day for > 100 ppm. The homogeneity of variance had a Levene statistic of 1.264 and a P-value of 0.317, meaning the variances were not significantly ($P \geq 0.05$) different from each other. ANOVA yielded an F-value of 2.042 with 4 and 20 degrees of freedom. The P-value was 0.127, meaning that none of the groups were statistically different from any other group.

**Lab-Distilled Water**

Statistical analysis was performed for the carrying capacities in lab-distilled water. Descriptive statistics yielded the following standard deviations: 0.548 for 0 ppm, 1.140 for 10 ppm, 1.140 for 10-25 ppm, 0.0894 for 50 ppm, and 1.304 for 50-100 ppm. The mean values were as follows: 4.6 fronds for 0 ppm, 5.4 fronds for 10 ppm, 5.4 fronds for 10-25 ppm, 4.4 fronds for 50 ppm, and 7.2 fronds for 50-100 ppm. The homogeneity of variance found a Levene statistic of 0.939 and a P-value of 0.462, meaning the variances were not significantly ($P \geq 0.05$) different from each other. ANOVA yielded an F-value of 5.648 for 4 and 20 degrees of freedom. The P-value was 0.003, meaning at least one group was significantly ($P \leq 0.05$) different from at least one other group. The Tukey test concluded that there were no significant differences between 0 ppm, 10 ppm, 10-25 ppm, and 50 ppm phosphate groups. Only at 50-100 ppm was there a significantly ($P \leq 0.05$) higher carrying capacity compared with 0 ppm.

The statistical analysis was also conducted on r-max values. The descriptive statistics found the following standard deviations: 0.0696 for 0 ppm, 0.0654 for 10 ppm, 0.0423 for 10-25 ppm, 0.0333 for 50 ppm, and 0.0482 for 50-100 ppm. The mean values were as follows: 0.0972 per day for 0 ppm, 0.158 per day for 10 ppm, 0.423 per day for 10-25 ppm, 0.0920 per day for 50 ppm, and 0.222 per day for 50-100 ppm. The

homogeneity of variance had a Levene statistic of 0.472 and a P-value of 0.755, meaning the variances were not significantly ($P \geq 0.05$) different from each other. ANOVA yielded an F-value of 4.905 with 4 and 20 degrees of freedom. The P-value was 0.006 showing that at least one group was significantly ($P \leq 0.05$) different from at least one other group. Lastly, the Tukey test concluded that 50-100 ppm had a significantly ($P \leq 0.05$) higher r-max compared with the 0 ppm. There were no significant differences between any other groups.

**Control Groups of Spring Water, Lab-Distilled Water, and Commercial-Distilled Water**

The control groups of each solvent were analyzed for statistical significance. The control groups had no added phosphate. For spring water, the phosphate concentration was 10 ppm, and lab-distilled water and commercial-distilled water were both 0 ppm. When analyzing the carrying capacities, the descriptive statistics yielded the following standard deviations: spring water was 1.517, lab-distilled water was 0.548, and commercial-distilled water was 1.517. The following were the mean values: spring water was 9.4 fronds, lab-distilled water was 4.6 fronds, and commercial-distilled water was 9.4 fronds. The homogeneity of variance had a Levene statistic of 2.699 and a P-value of 0.108 meaning the variances were not significantly ($P \geq 0.05$) different from each other. ANOVA yielded an F-value of 23.510 for 2 and 12 degrees of freedom, and a P-value was 0.001, meaning at least one group was significantly ($P \leq 0.05$) different from at least one other group. Lastly, the Tukey test showed that lab-distilled water control had a significantly ($P \leq 0.05$) lower carrying capacity compared to spring water and commercial-distilled water controls. The spring water and commercial-distilled water controls did not significantly differ from each other.

The last statistical analysis compared the r-max of the solvent controls. The descriptive statistics found the following standard deviations: spring water was 0.0850, lab-distilled water was 0.0690, and commercial-distilled water was 0.100. The following were the means: spring water was 0.212 per day, lab-distilled water was 0.0972 per day, and commercial-distilled water was 0.234 per day. The homogeneity of variance had a Levene statistic of 0.856 and a P-value of 0.449, meaning the variances were not significantly ($P \geq 0.05$) different from each other. ANOVA yielded an F-value of 3.656 with 4 and 20 degrees of freedom. The P-value was 0.058, meaning that none of the groups were significantly different from any other group.

## V. Discussion

### Methodological Aspects

It is possible that this experiment could contain errors due to the scientific methods used. Inconsistencies arise when working with model organisms in laboratories. Plants are temperamental to growing in non-ideal conditions, and the experimental laboratory did not have controlled air circulation, light, or temperature. Changing conditions in the lab were not optimal for duckweed temperament.

Another possible oversight in the procedure was the number of days allowed for duckweed growth. According to research in the literary overview of the introduction, there is a growth inhibition at high phosphate concentrations (Lasfar et al., 2007). If the experiment continued for longer than 31 days, the inhibition could have occurred.

A limitation of the study was the lack of data on the commercial-distilled water. Representatives at ShopRite would not release their chemical composition of Bowl and Basket distilled water. The absence of nutrient information limits the certainty of conclusions drawn on differences between controls of distilled water.

Errors in measurement could have occurred. Counting large amounts of drops had significant capacity for mistakes. Variation in drop amounts would lead to growth level inconsistencies. A more accurate measurement for counting drops should have been used. There also could have been a greater number of groups per nutrient concentration. Increasing the sample size would create less chance for outliers to skew the data.

### Spring Water

Spring water yielded a statistically significant ($P \leq 0.05$) difference in carrying capacities for the 10 ppm control compared to each of the phosphate treated groups. The control had a carrying capacity of 9.4 fronds, while the treatment groups had 18.2 fronds (10-25 ppm), 17.8 fronds (25 ppm), 17 fronds (50-100 ppm), and 17.2 fronds (> 100 ppm). The treatment groups were not statistically different, but each were approximately double the 10 ppm carrying capacity. This phenomenon follows Liebig's law of the minimum. The law states that adding more of an abundant nutrient does not increase growth. Only adding the limiting nutrient will increase growth (Tang & Riley, 2021). Since phosphate was provided in abundance, it was not the limiting nutrient. Further additions of phosphate did not affect the carrying capacity. These results correlate with past research on the effects of phosphate on intrinsic growth rate. In this study, concentrations of phosphorus higher than 1 ppm did not significantly influence growth (Lasfar et al., 2007). The results in this study had a similar conclusion. It found that only phosphate concentrations less than 10 ppm affected growth. Concentrations greater than 10 ppm had no significant influence. The difference in the concentrations which affected growth can be attributed to

variations in the experimental setup, solvents, length of the experiment, and experimental laboratory conditions.

The r-max showed no significance in the statistical analysis; however, a general trend can be observed. The results showed a maximum with decreasing values on either side. The highest value was at 0.27 per day at 25 ppm, and the lowest values were at 0.13 per day at 10 ppm and 0.16 per day at >100 ppm. This trend follows Shelford's law of tolerance. The law states that growth relies on a variety of complex conditions creating minimum, maximum and a tolerance range for growth. The tolerance range is the area between minimal and maximal values within which species can survive. A Shelford's law curve can be seen in *Figure 12* (Erofeeval, 2021).

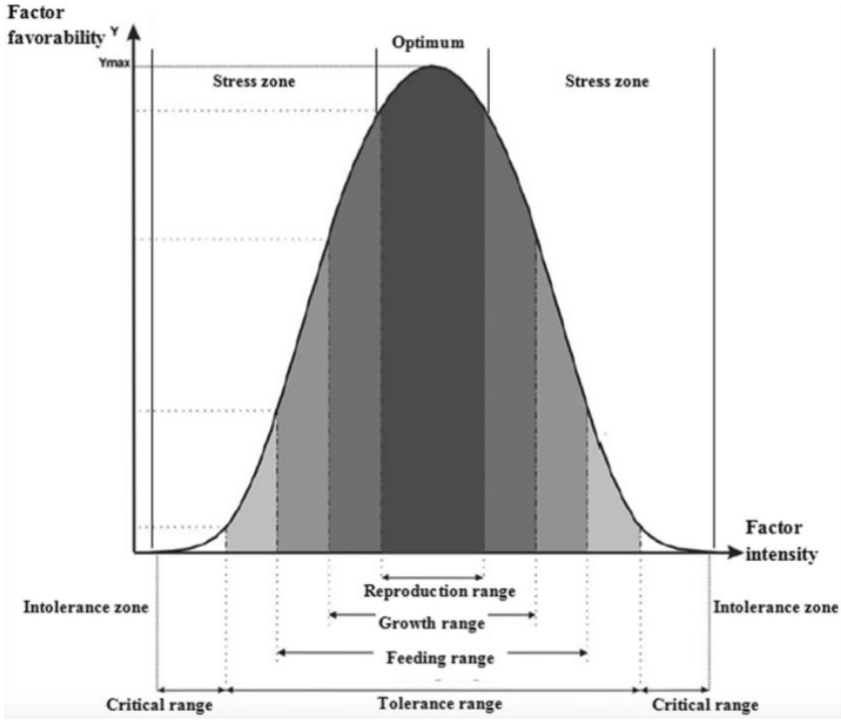


Figure 12. Shelford's law of tolerance curve, showing minimum, maximum and a tolerance range for growth (Erofeeval, 2021).

The r-max at 10 ppm was a minimum value, 25 ppm was the maximum value, and >100 ppm was another minimum value. These values create a tolerance range. Theoretically, when a certain phosphate concentration under 10 ppm and over 100 ppm is added,

duckweed would be unable to survive in the conditions due to being out of the tolerance range. Past studies support the results. In a study on the effects of phosphorus on the growth and root morphology of *A. mono* seedlings, when supplied with optimal phosphorus (8 g plant$^{-1}$), maximum values of the growth parameters were recorded (Razaq et al., 2017). Another study showed that an oversupply of phosphorus, for long periods of time, caused decreases in cellular components (Sivaci et al., 2017). Sufficient phosphate is needed for healthy duckweed, but too much has negative effects. It is important to avoid an oversupply or undersupply of phosphate. These conditions cause low r-max values leading to growth inhibition.

Lab-Distilled Water

Lab-distilled water results showed that 50-100 ppm had a significantly ($P \leq 0.05$) greater carrying capacity and r-max compared to the 0 ppm control group. While there was statistical significance in the data, overall trends are not consistent. The r-max values initially increase, before decreasing, and then increasing again. This does not follow Shelford's law of tolerance as the spring water results did. It is opposite, as it has a minimum value with increasing values on each side. The carrying capacity results also do not follow a trend. The values began by having a slow increase; however, they had a decrease at 50 ppm before increasing again. Adding more of the limiting nutrient should not increase the growth rate. There is also no logical reason for a decrease in growth at 50 ppm. The r-max and carrying capacity results are inconsistent, leading to the hypothesis that there may be something in the lab-distilled water leading to growth inhibition. Comparing the control groups of each solvent provides insight into this hypothesis.

Control Groups of Spring Water, Lab-Distilled Water, and Commercial-Distilled Water

In the control results, lab-distilled water (0 ppm) had a significantly ($P \leq 0.05$) lower carrying capacity compared to spring water (10 ppm) and commercial-distilled water (0 ppm). The spring water and commercial-distilled water controls did not significantly differ from each other. Both distilled water solvents contained 0 ppm phosphate and grew in the same conditions. As distilled water should theoretically lack macronutrients and micronutrients outside of the added phosphate, the carrying capacities are expected to be the same. However, lab-distilled water had significantly less growth compared to commercial-distilled water. The carrying capacity of commercial-distilled water was 9.4 fronds, while lab-distilled water was only 4.6 fronds. The growth was more than halved. There could be two conclusions based on this finding: lab-distilled water is inhibiting growth or commercial-distilled water is promoting growth.

The hypothesis drawn from the data is that lab-distilled water is inhibiting growth. Commercial-distilled water and spring water both had the exact same carrying capacity of 9.4 fronds. Since both carrying capacities were the same, the growth increase cannot be due to micronutrients in spring water. Commercial-distilled water had to go through rigorous testing to be sold as distilled water, so there are most likely no additional nutrients in the water. Another contributor is the appearance of duckweed during the experiment. Duckweed in lab-distilled water tubes fell apart, turned yellow or brown, had a smaller size, and occasionally sank to the bottom of the tube within days of the experiment starting. These characteristics were rarely seen in both spring water and commercial-distilled water. If they were seen, it was within the last days when the carrying capacity had already been reached. The quick degradation in lab-distilled tubes shows that growth inhibition is occurring. A comparison of duckweed on day 10 at 0 ppm between lab-distilled water (left) and commercial-distilled water (right) is shown in *Figure 13*.

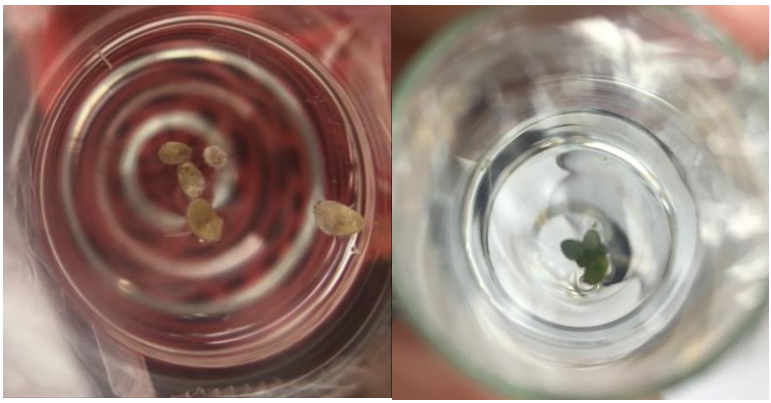

Figure 13. Comparison of experimental duckweed in lab-distilled water (left) and commercial-distilled water (right) both on day 10 at 0 ppn. Lab-distilled water appeared brown and fallen apart, while commercial distilled water was green and together.

The hypothesis is also supported when comparing spring water and lab-distilled water at the same phosphate concentrations. When both solvents were at 10 ppm, spring water had a carrying capacity of 9.4 fronds and lab-distilled water 4.8 fronds. At 10-25 ppm, spring water had a carrying capacity of 18.2 fronds and lab-distilled water 5.6 fronds, and at 50-100 ppm spring water had a carrying capacity of 17 fronds and lab-distilled water 5.6 fronds There are substantial decreases in growth considering each had the same amount of phosphate available. Additionally, when looking at the graphs in *Figure 9* and *10*, the y-

axis goes up to 20 fronds in spring water but only 6 fronds in lab-distilled water. The lines are also consistently increasing in spring water, but sporadic in lab-distilled water. The data suggests that lab-distilled water is inhibiting growth.

The inhibition of growth in lab-distilled water could be due to the distillation system in the laboratory or storage in carboys. After contacting representatives at Fisher Scientific, they could not communicate the exact nutrient concentration after distillation using their system. It depended on resistivity, dissolved ions, volatile organics, bacteria levels, and pH of the added water. There are many factors, meaning the distillation in the laboratory may not be a reliable distilled water source. The storage of distilled water is carboys could potentially leak chemicals. Carboys are soft bottles which hold water under unpredictable laboratory conditions for long periods of time. They contain plasticizers, which are substances added to a polymer solution to promote plasticity and flexibility. Studies have been conducted to examine water contamination from soft bottle materials and plasticizers. The study reported 66 elements contaminating bottled waters. Another study by the University of Copenhagen found more than 400 different substances in water from plastic material, with the toxicity of at least 70% being unknown (Reimann et.al, 2010). The decrease of carrying capacity could be due to toxic chemicals from the plastic in the carboy inhibiting duckweed growth.

Summary

The results of this research show that spring water or commercial-distilled water were better as experimental solvents. Issues arise while using lab-distilled water. This could have been due to the laboratory filtration system or storage of the water in carboys. When duckweed is grown in spring water the carrying capacity follows Liebig's law of the minimum and r-max Shelford's law of tolerance. Future research should focus on the causes behind growth inhibition in lab-distilled water. Additionally, it is important to learn more about duckweed growth for applications such as bioremediation or synthesizing proteins.

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# Section III:
# The Social Sciences

# The Barriers Impeding Women's Existence in the Financial Industry

Mackenzie Vogler (Business Administration)[1]

In today's world, many disciplines are heavily male-dominated. Finance is one of those disciplines with far fewer women being a portion of this industry. With a gap between the two genders, women face social and political barriers from reaching the same dominant presence men have established in this respective field. The childhood, as well as the personality of a woman, will determine what industry she will enter in with societal bias being the root of her decision. If a woman does enter the financial industry successfully, her chances at promotion are hindered greatly as subjective judgments impede a fair evaluation. Men's inherited traits of aggressiveness and fierceness are seen as the reason why the finance world is the relentless way it is, leaving women to be seen as the unfit candidate.

## I. Introduction

With women incurring many disadvantages of the world, there is often a fight for their justice in gaining the same privileges as men. In this paper, I will be analyzing many disadvantages faced by women ultimately leading to their misrepresentation in the finance industry. Over time, women have gained a much stronger existence with their numbers on the upward tick. Though, it is not nearly at the same capacity as men making it hard for women to be taken seriously when they join the office centered off of distinct masculine energy with cursing, screaming, and highly competitive stakes.

To portray this image of misrepresentation, charts, as well as tables, will be implemented to show readers visually and analytically the gap between genders. These data figures will focus on the difference in the amount earned by each gender, the rate at which women hold seats in congress, and the homeownership rate of single women over time. All of these variables will contribute to showing how society has restricted women from being successful. With the numbers of women being low who hold a position in finance, this follows the ideology that they are steered from entering this type of work as well. In young boys and girls, there is a math gender gap that says boys are better at math

[1] Written under the direction of Dr. Shani Carter in partial fulfillment of the Senior Program requirements.

while girls are better at reading. This goes back to gender categorization and judgments of what girls and boys should thrive in, not what they may enjoy learning. Because of this gap, girls will view themselves better linguistically while boys view themselves as more quantitatively driven individuals. Childhood learnings are a key factor in adulthood behavior and how one will pursue themselves later in life.

All of the variables will be examined over some time with respect to women growing to be as well respected as men. The presence of women in finance is crucial to showing that they can do just as much as men, with the same amount of assertiveness as they depict in finance. Each gender has its strengths and with misrepresentation in finance, these will not be successfully executed if there is a gap. Currently, I am a young woman pursuing a career in finance with high hopes that this gap will slowly, and more steadily, become close. It is extremely impactful for me to see women in high-ranked positions within finance knowing that I am capable of reaching the same stature.

## II. Literature Review

### Social Role Theory

Social role theory states that individuals are affected by the stereotypes associated with the role they are influenced to take on by their surrounding environment (Franke et al. 1997). Ethical decisions are made in life and later those decisions may result in events crucial to one's well-being and standard of living. These ethical decisions are said to be affected by the gender of an individual and their biological makeup and can be seen as a part of the social role theory. One's gender will determine what choices they make and how they will progress with their life due to the gender they undertook since birth.

### Gender Differences and Similarities in Social Behavior

Social role theory explains the fact that men and women, throughout life, occupy multiple roles and are ever-changing. In each stage of life, people encounter roles through work, family, and friendships, and other recreational activities (Eagly and Koenig 2014). Although roles ebb and flow through an individual's lifetime, a man's role and woman's role will differ heavily. Women are seen as the more generous and charitable sex having more empathetic habits compared to men who are viewed to be more confident, decisive, and adept (Franke et al. 1997). In the workplace, men and women in the same position will experience what is called *gender-role spillover,* and each will face different expectations due to their gender and cause them to behave differently to meet those (Franke et al. 1997). Because of this "spillover," roles have become clearly defined in

what outsiders see as the generic stereotypes of women and men leaders inside the workplace and what they have to offer when it comes to a position of high rank.

### Societal Stereotypes about Men

Men are expected to be the more dominant and forceful nature within the office (Lombard et al., 2021). Viewed to have the upper hand when it comes to decisions, men make them quicker and more efficient in the workplace. Attributed to their childhood pressures of being the tough one to exhibit little to no emotion, their disposition in the office has remained pushy and unapologetic for a historical number of years.

### Societal Stereotypes about Women

Women have the perceived role of being kind and nurturing in their behavior. (Eagly and Koenig 2014). Women are not viewed as a substantial force in the workplace and are instead viewed to be the weaker link between men and women. If one were to compare the difference between a male leader and a female leader, gender would be the difference at hand and women would be judged on all obligations tied to them throughout each role played in life, not just their presence in the workplace (Eagly and Koenig 2014).

### Social Empowerment

Women do not have as much freedom to speak as they please. (Selzer et al., 2017). They are the gender seen to be either too agreeable or too stubborn to the point where their opinion on a stance is not valued rendering them unfit for a position with seniority (Selzer et al., 2017). With the finance industry being so heavily male-oriented, an environment for women to rise has been so toughly struggled against and has not been able to be sustained (Selzer et al., 2017).

### Lack of Female Role Models in the Industry

Women do not join the financial sector at the same rate as men due to the culture of the industry (Jones and Merritt, 2020). This is only a small percentage of the female population represented in this career path and leaves room for a plethora of women who have not been taken into account during studies of women in this industry. Following suit, women do not major in finance in the same magnitude as men ultimately leading to the low participation rate in the investment services sector and overall finance world (Jones and Merritt, 2020). With an exceedingly low representation of young women pursuing finance in the classroom, few would like to follow where women are not typically venturing, leading to fewer women partaking in this side of the business world.

## High Turnover Rate of Women in C-suite

Not only is there a low percentage of women participating in the financial services industry, but there is also a large portion of women who leave their senior positions (Jones and Merritt, 2020). Their presence is lacking in all aspects with the little promise it will be fruitful in the coming years. It has been found that less than two percent of women make up CIO positions for all firms across the globe. (Jones and Merritt, 2020). There are quite a few factors that contribute to why women leave these c-suite positions and transition into other more, accommodating, careers that may better suit them and their desires in life. The company and/or position may not be structured to her liking leading to discomfort and a lack of confidence. The role has fulfilled her goals and all that she has wished to achieve leading to a lack of desire to stay and continue. Lastly, she has begun to realize there is more to life outside of work and she would like to explore and see what it has to offer. Her high-stress, high-paying job may not be her top priority anymore and each has concluded it is something she must part ways with.

## Women's Shift in Life Roles (e.g., Family)

One of the most important roles some women have is being a mother. Women face a decision in their professional career of when or if they would like to have children. This decision will disrupt the balance they have established in their career and lead to a new lifestyle to pursue. Some women do not want to balance a child and work so they decide to become their own boss and determine how they will provide for themselves (Blair-Loy 1999). Women are expected to mold into a maternal figure as it is a position sought to be filled by societal pressures around them. To fill this role, they must have a well-balanced life between work and their personal life. This desired balance has led women to take on a role as self-reliant entrepreneurs to reach equilibrium in each position she has in life (Blair-Loy 1999).

## Five-Factor Model of Personality

The career path of an individual is related to the traits that the individual shows (Ham et al. 2009 and Larson et al. 2002). The five-factor model of personality distributes an array of personality traits based on five general factors. Those factors are openness, experience, conscientiousness, extraversion, agreeableness, and neuroticism (Sheerin' 2013). The personality traits of women will then in turn take part in why or why not they may choose to enter the financial services industry. These different traits are not the end all or be all to why an individual may choose a career path but a factor that is only a piece to the puzzle as to why they may have chosen a certain career path.

It is said that past the age of thirty the use of personality traits is more consistent and stable while ages below that can be inconsistent and unreliable in nature (McCrae and Costa 2003). Even though this model has some condemnations regarding its validity, it can be viewed as a valuable way to examine why women are lacking in this industry. In addition to why women are lacking in the industry, it can illustrate why young women are not interested in studying finance at the university level. Personality traits are said to be the main cause as men and women may enter a field to practice and are rooted in how they inherited their traits (Sheerin' 2013).

## Gender Identity Growing Up

Growing up, there are rules and standards meant to be followed and as a child, you are going to do as you are told. Expectations from family and later, friends, are sustained by children their entire life into adulthood. This is seen as the root to which paves the way for an adult's behavior and identity later in life (Franke and Spake, 1997). These expectations are also a part of the observed behavior of certain groups and the roles they occupy (Eagly and Koenig, 2014).

## Boys vs. Girls Phenomenon

Whether it is elementary school, middle school, or high school, there are an array of pressures placed on each gender and what kind of behavior they need to replicate. If a child is a girl, it's ok to let out the tears. If a child is a boy, hold back the tears and move on with your day. The types of things they may be active in are also heavily criticized. Little boys should like trucks and wrestling while girls stick to dolls and makeup. Women are to have an abundance of relationships while men are to instill justice in other individuals when the time is right (Franke and Spake, 1997). The stereotypes premeditated for each boy and girl puts pressure on what they must grow up to be.

## Influence of a STEM Parent on Child's Career Choice

The occupation of a child's parent heavily influences the occupation they will choose for themselves later in life. Specifically, female role models in a child's life will heavily determine the route of their professional life. It is more likely that an individual will choose a route in finance if they had a mother or father in a STEM career or finance/economics before they reached the age of 14. (Adams et al. 2018). Most individuals look to their role models or parents for guidance in what they should do for themselves to make money. It has been found that there is a 28.6% increased chance of a

girl becoming a CFA Institute member if raised by a father with a STEM background (Adams et al., 2018)

## Math Gender Gap in Middle School

The math gender gap is the phenomenon between boys and girls at the age of 15 where boys are farther advanced in math-based courses, while girls are not, and girls are farther advanced in reading courses, while boys are not (Breda and Napp, 2019). With women more likely to pursue a career in finance with a father in STEM, comes the idea that the math gender gap in middle school will also affect their career choice (Adams et al., 2018). The gap is traced back to ideas and cultural norms within math development around boys and girls in middle school (Breda and Napp, 2019). If a girl is not pushed to thrive in her math courses and succeed as much as her male counterpart, she will not choose to pursue a career in the STEM field or the finance industry. In addition to the environment and society's influence, students choose a path that they perceive will best fit their strengths (Breda and Napp, 2019). With no one pushing girls to have success on the math side of education, she will deter herself from entering a career that requires math.

## Political Empowerment

In the office setting, there is rank and with a higher rank comes the implied responsibility of leadership. Politically, masculine defaults are heavily prominent causing a systematic disadvantage for women in the political setting (Lombard et al., 2021). The masculine defaults integrated into the U.S foundations of its political system, women are hindered from filling top positions and continue to produce barriers (Lombard et al., 2021).

## Women Perceived as the Weaker Gender

Gender stereotypes within finance have kept women from entering this field. Even if a woman may be a talented individual within her respective field, her lack of confidence will keep her from excelling in it (Gerdman, 2019). With a competitive male counterpart, women render themselves inadequate with no chance of competing with men in a consistent matter. The lack of confidence has caused fewer seats to be filled by women in the C-suite and ultimately male dominance in finance as well as technology (Gerdman, 2019). Women not having confidence in themselves creates a lack of confidence in them by outside viewers.

Companies Afraid of Gender Discrimination

Lawsuits are one of the obstacles that become prominent when a company is incorporated. Of those lawsuits, gender discrimination and a hostile work environment can be one of them with women at the forefront of this issue. 1 in 10 women face gender discrimination at their workplace (Parker, 2018) and are more likely to report gender discrimination (Parker, 2018). From these gender discrimination reports erupt lawsuits which big corporations would like to keep under wraps and not have showcased. It is believed that women are not hired often within the financial services world because of the possibility of a gender discrimination lawsuit that could be filed (Sheerin' 2013).

Outside Pressure Causes Unrealistic Expectations Imposed

Complex judgment by employers on women in the finance world leads to classifying and stereotyping. This judgment is based on grouping women into a category that describes their traits and ultimately results in discrimination. (Bloomfield et al., 2021). Categorizing women into one group and not taking them as individuals, hinders the chances of being promoted and being seen as a fit candidate for the position (Bloomfield et al., 2021). In the finance discipline, women will be seen as stereotypical women and not stereotypical analysts when it is time for evaluation. (Bloomfield et al., 2021). The same judgment is not passed to men as their stereotype of being assertive and competitive in the office is what is sought by evaluators.

Subjective Judgement Rather than Objective Judgement

In the performance evaluation, there are a plethora of judgments that root in being subjective, not objective. Subjective determinants include one's knowledge of the industry, accessibility, and professional integrity that tell you who someone is (Bloomfield et al., 2021). A woman is viewed to be communal and kind in her ways that may deem her unfit as women are not seen to be the success of the finance industry, men are. (Bloomfield et al., 2021). Men's characteristics align with what the finance sector thrives on. Aggressiveness, assertiveness, and dominance. The two different extremes between both genders put women at a disadvantage as they are seen to not have what it takes to thrive in this heavily male-dominated field. (Bloomfield et al., 2021).

## III. Hypothesis

H1: There is a scarce number of women who work in the finance industry due to a lack of political and social empowerment.

## IV. Method

## Subjects

The individuals who are the subject of my research will be women who hold positions in the investment industry and students in college whose ages will range from 18-22.

## Measures

Measures will include an overall examination of the women, as well as men, in the investment industry. The first variable is the number of women in the finance industry, it will be measured through the total number of women with earnings above or below $80,000 in financial operations. To make this data relative to the total amount of professionals in the investment sector, the total number of men with earnings above or below $80,000 will be utilized in addition to the data of women. We will view this through PINC-06. The following variable, social empowerment, will be measured through homeownership rates of single women which were found through the U.S Bureau of Labor Statistics. The final variable, political empowerment, will be measured through the number of women who have had and currently have seats in congress and was examined through data by Rutgers Eagleton Institute of Politics.

Table 1: Components of Study

| Data | Variables | | |
|---|---|---|---|
| | Number of Women | Social Empowerment | Political Empowerment |
| Instrument | PINC-06 | Electronic Survey (STEM) | 2x2 between subject's design scenario |
| Data Source | United States Census Bureau | CFA Institute | American Accounting Association |
| Type of data gathered | Quantitative | Quantitative/Qualitative | Qualitative |
| Types of scores produced | Median Income in $$$ | Mean % of men/women that are CFA member | Persistent/ Non-Persistent |

Adapted from: Rudestam, K.E. & Newton, R.R. (1992). Surviving Your Dissertation. Newbury Park, California: Sage Publications, Inc. page 140.

## Procedure

The business source premier database on Wagner's library website was used. Search terms to locate these articles include women in finance, glass ceiling, gender gap, and women in investments. These searches were completed in September 2021. Each article was selected because it showed the buildup of how women do not participate for a sustained time in the investment world. A few of the articles support the causes of low percentages of women in the finance world while some exhibit the effect on the industry and how men may get away with certain unethical practices.

To analyze the discovered data, line charts will be utilized to describe the relationship between women's empowerment socially and politically and how that will influence their presence in the financial sector. The total number of men and women with an income over or below $80,000 in the financial sector will be evaluated in four different years: 1998; 2000; 2010; and 2020. This variable will take into account the gender with the most earnings. This will be shown through a line graph.

The political empowerment variable will examine the total number of seats in congress that are held by women. Next to the number of seats, time will be compared showing how over time there has been a change in the presence of women. This will be shown through a line graph.

The social empowerment variable considers the homeownership rate of single women. To measure this, time will be used in comparison to show its changes over time. This comparison will be shown through a line graph.

Table 2: Hypothesis, Instruments, and Statistical Analysis

| Hypothesis | Variables | | | Hypotheses & Variable Relationships | Statistical Tests |
|---|---|---|---|---|---|
| | Number of Women | Social Empowerment | Political Empowerment | | |
| There is a scarce number of women who work in the finance industry due to the lack of political and social empowerment. | Number of Women | Social Empowerment | Political Empowerment | LowNOW=LSE+LPE | correlation; regression; line charts |

Adapted from: Rudestam, K.E. & Newton, R.R. (1992). Surviving Your Dissertation. Newbury Park, California: Sage Publications, Inc. page 138.

## V. Results

Variable 1

Over time, women have entered the financial industry more heavily even though they are not seeing a large pay increase like men are.

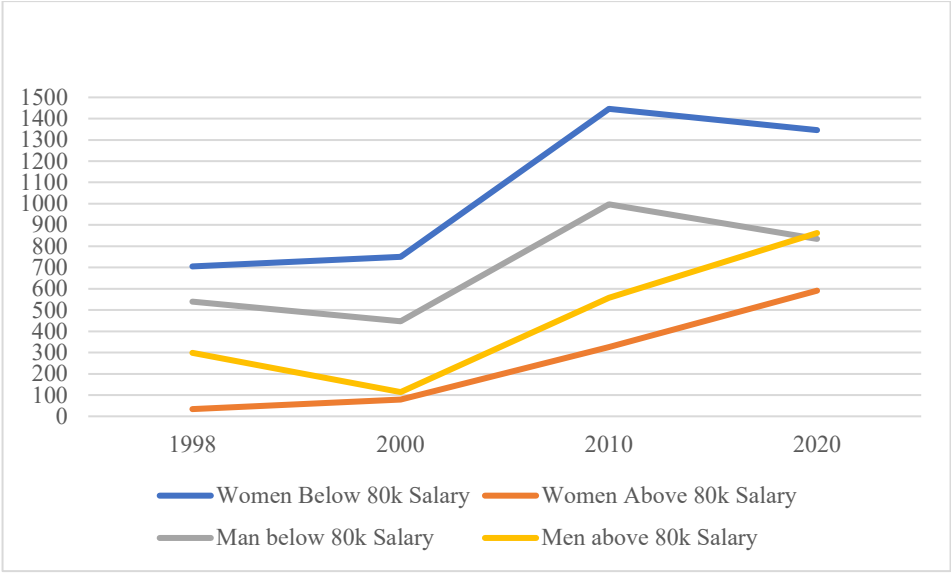


Figure 1: Number of Financial Specialist Men and Women with Earnings Above or Below $80k. Source: United States Census Bureau (2020). PINC-06.

| Table 3: Personal Income of Men and Women in Financial Services Over Time | | | | |
|---|---|---|---|---|
| | **1998** | **2000** | **2010** | **2020** |
| **Women Below 80k Salary** | 705 | 750 | 1446 | 1346 |
| **Women Above 80k Salary** | 34 | 79 | 326 | 591 |
| **Men below 80k Salary** | 539 | 447 | 997 | 835 |
| **Men above 80k Salary** | 299 | 114 | 558 | 862 |

Variable 2

Over the span from 1997-2021, seats held by women in the U.S Congress have improved with more women entering each year.

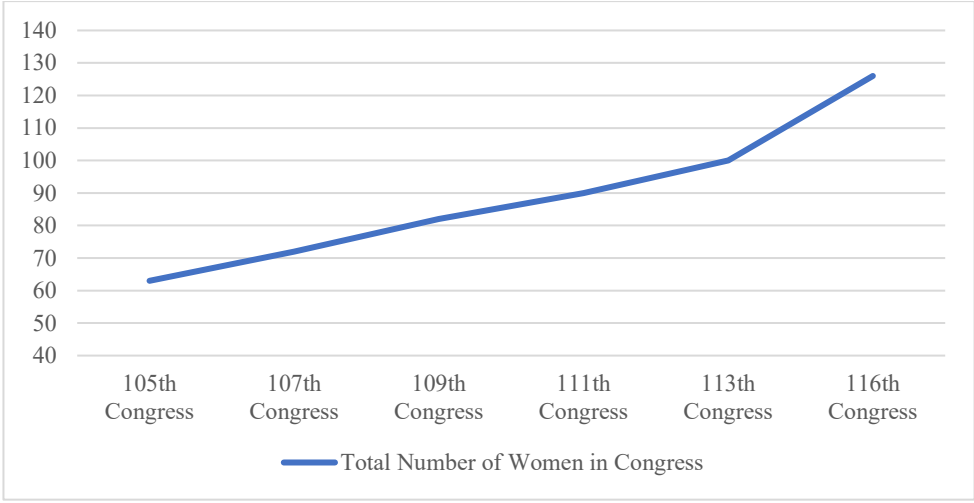


Figure 2: Total Number of Women in Congress

| Table 4: Number of Women in Congress Over Time | |
|---|---|
| **Congress** | **Total Number of Women in Congress** |
| 105th | 63 |
| 107th | 72 |
| 109th | 82 |
| 111th | 90 |
| 113th | 100 |
| 116th | 126 |

Variable 3

From 1988 to 2008, the number of single women who chose to purchase their own home has increased.

| Table 5: Homeownership Rates of Single Women | |
|---|---|
| **Year** | **% of Women Who Own Homes** |
| 1988 | 9.4% |
| 1992 | 17.4% |
| 1996 | 29.4% |
| 2000 | 39.2% |
| 2004 | 49.7% |
| 2008 | 47.3% |

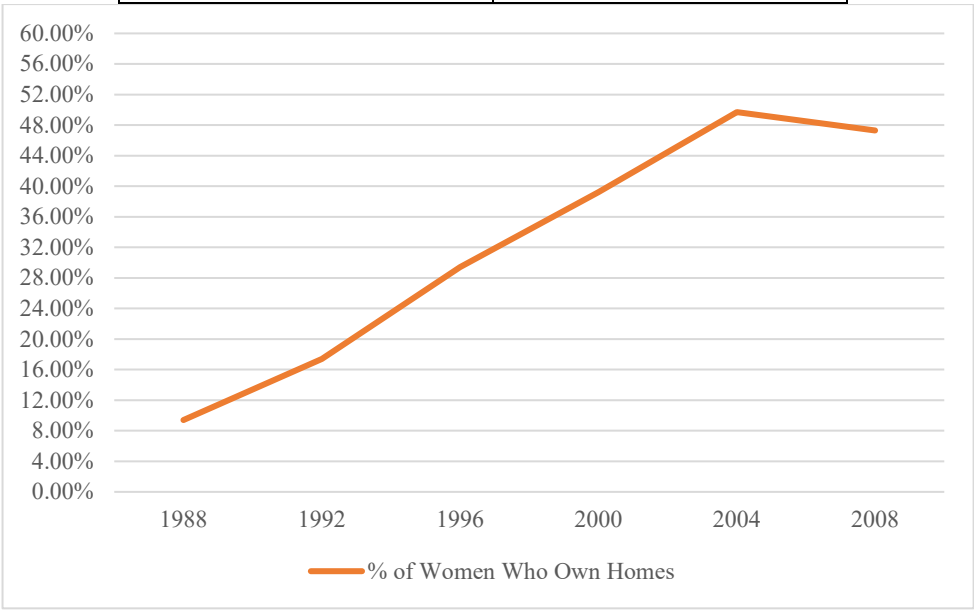


Figure 3: Homeownership Rates of Single Women

## VI. Discussion

In my hypothesis, said social and political factors were analyzed and the different impacts they may have on how women live their lives and the types of roles they may take on. We will examine how a women's salary, a women's role in owning a house, and a women's participation in government are all closely tied when it comes to stepping into these positions and then are soon subdued by their male counterparts.

The first variable of my thesis, the number of women, was evaluated through the difference between the earnings of financial men and women. Table 3 shows the number of men and women by salary below $80,000 or a salary above $80,000 from 1998 to 2020. From the years 1998 to 2000, 113 women earned a salary above $80,000 and 413 men who had earned a salary above $80,000. This supports my hypothesis that there is a scarce number of women present in the finance industry and was heavily outweighed by their male counterparts. Considering the other end of the spectrum, women still outperformed men when earning below an $80,000 dollar salary. 1,455 women received a salary below $80,000 while 986 men received a salary below $80,000. This portion of data exemplifies the less substantial positions women held in the finance sector earning a smaller salary while men dominated in leadership positions, ultimately leading to higher wages. Now, considering the latter half of the data, there were very similar trends in comparison to the years 1998-2000. 2,792 women earned below an $80,000 salary and 1,832 men earned below an $80,000 salary. With 917 women earning above an $80,000 salary and 1,420 men earning above an $80,000 salary, my hypothesis remains consistent proving the idea that women in the finance industry are scarce. For all years, more men than women earn more than $80,000 and more women than men earn less than $80,000. These wage gaps make for a poor incentive to get women into the finance world and work alongside men who are receiving higher pay for the same duties and same roles.

My second variable, political empowerment, considers the number of women who hold seats in Congress. In the fourth table, the number of women in Congress over time is displayed from 1997 and ends in 2021. In that period, there is a clear trend of women becoming a larger and larger portion of Congress and gaining more seats each year. The trend line in figure 1 displays this upward increase of women in Congress gaining a presence. The data was progressing at a steady rate until it hit the 113$^{th}$ congress with a sharp increase in seats, jumping from 100 seats held to 126 seats held. In 1997, there were 63 seats taken by women and in 2021, there are currently 126 seats being filled by women. With Congress having a total body of over 500 individuals, 126 of those being women is still relatively low. With only 126 out of 500 seats being filled

by women today, this supports the idea that women are suppressed to gain dominance in other disciplines outside of finance.

In the fifth table, the social impact on women is exhibited through the number of women that become homeowners on their own. The data looks at homeownership of single women from the years 1988 to 2008. Homeownership rates by single women have sharply increased up until the year 2004 then declines. From 1988 through 2008, it is implied over time women grew to become more motivated to become single homeowners but did not have this motivation to do so in 1988 as single women only owned homes themselves at a rate of 9.4%. Substantial growth has been gained for women but it is not been fully reached with only 47.3% of women owning homes indicating outside pressures deterring them from doing so. If 100% of single women-owned homes in 2008, the social impact would not be a factor upon how single women may choose to live but it is evident with the lacking rate.

## VII. Conclusion

Life for women is not as easily endured as it is for men. A woman faces barriers from the day she is born until the day she dies. Stigmas and categorization are attributed to this hard-fought life and some days make it seem impossible to reach where she would like to go in life. One of the biggest goals in the life of any individual is pursuing a career that they enjoy and for many women that could be the financial industry. However, upon entering the finance world many barriers hinder upward mobility.

To put an end to this seemingly large gender gap, there can be measures taken in childhood and college years to minimize the inequality. The math gender gap will need to be shut as it has a direct effect on whether or not girls choose to chase occupations that involve being highly quantitative. Teachers will need to encourage both boys and girls equally to choose math courses and electives that they enjoy participating in. Emphasizing to young girls that they can complete the same courses their male classmates do will be a key success. Having equal parts participate in math will boost the chances of more girls taking a liking to math and guiding them into fields where math is required. This can be achieved through equal participation requirements in technology clubs and mathletes competitions. Requirements of equal gender representation will emphasize the importance of both genders and not make girls view themselves as outweighed and undervalued. In college, a young women's professional club surrounding finance could be established and become a society of strong women. If a well-renowned finance women's club is founded, women will know they have a space to enter with other individuals just like them. With the different benefits and privileges of this club, women

can realize they are just as valuable to the finance world as men are. These projects will teach girls and women of all ages the importance of their participation in finance. What is learned in younger years will translate into their adulthood and how they choose to live it.

The representation of women in finance can be directed through different initiatives tailored to once they have been working for a financial firm. The business world should put more coverage and applaud more women for completing the impossible. Their work should not go unshown and needs to be highly commended for being just as fierce as their competition. Men. With more women being the point of emphasis, younger girls will be inclined to reach the position they are at one day. Media coverage and the news follows us around everyday so it should be used as an effective way to relay the struggles and successes women in finance have endured. Whether it is being the cover of a financial magazine, being a highlight story on a news channel, or displaying books of female authors at business networking events, it can be done. These plans can be followed by a dedication to hiring just as many women as men in an investment firm. If a firm pursues employees based on their passion and drives them to succeed in finance, there will not be a wide gap left. Women possess the same capabilities as men, and it should be honored through the even distribution in the gender of employees.

With academia continuing to draft literature on the severe imbalance of women in the financial sector it is evident the issue will persist unless the stigma is eradicated around women being seen as unfit to practice finance. My data also solidified the inequality between men and women despite all three of my tables representing their presence growing. Within the earnings achieved by men and women, men outweigh women at every point in time. In terms of seats held in Congress, women only hold about a quarter of the weight. Homeownership rates do not embody dominance and show that there is still more to be accomplished. With all factors considered, it is clear women's presence in the finance industry will need to start way before they reach an interview. Preparing women for the unusually high-strung environment before they step foot in, will set the tone for what it's like securing a job in the finance world. The finance industry can be highly rewarding just as it is challenging. Women deserve to experience the same return on their hard work when it comes to their career. With the stigma being taken out of the equation, women will soon be able to make just as much money as men do. I hope to see the rates today, largely increase by the time I am 10 years into my profession. Knowing I will have strong women working next to me will push me to reach goals and accomplishments I thought I could have never completed. All of the women before me have paved the way and I hope one day, to do the same for younger girls.

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# Influence of Gender Stereotypes on Gender Inequality & Discrimination in the Workplace

Morgan Matrone (Business Administration)[1]

This paper highlights how women face discrimination and stereotypes that in turn impact their interview opportunities, salaries, and levels of leadership. Specifically, the paper discusses the negative impacts of gender bias and stereotypes on women that work for Fortune 500 companies. This paper will highlight forms of gender-based workplace discrimination in the form of the wage gap and unequal promotional opportunities. While exploring theories, such as a practice-based theory of diversity and the glass ceiling. This paper utilizes relevant case studies, filing from the U.S Census Department, U.S. Bureau of Labor Statistics, peer-reviewed sources, and charts of surveys that prove and demonstrate the hypothesized theory.

## I. Introduction

Societal constructs of the male and female genders have influenced the unequal opportunities in the professional workplace for women. While improvements have been made to strive for equality between men and women, the workplace exemplifies the progress that still needs to occur to reach complete gender equality. As diversity, equity, and inclusion are becoming more prominent within Fortune 500 companies' cultures, why are women continuing to experience a wage gap and limited interview as well as promotional opportunities, compared to men?

These are the concepts that I will deep-dive into throughout this paper. I will provide the readers with a more in-depth understanding of some of the hardships women endure within the corporate workforce, specifically among Fortune 500 companies.

In the current paper, I further explore the stereotypes and predisposed gender bias that women encounter from entry-level to senior executive positions within Fortune 500 companies. I focus on how these stereotypes and biases impact women's wages, interview opportunities, and levels of leadership.

I begin this paper with a detailed explanation of gender stereotypes, gender bias, and a practice-based theory of gender. Furthermore, I explain the impact that each one of these

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topics has on women in the workforce, specifically within Fortune 500 companies. I used previously executed studies and surveys to highlight the connection between predisposed gender bias and how women are treated in the workplace through job opportunities, promotions, and pay compared to men. This paper concludes with charts and data tables that express to the audience the unequal interview opportunities, wage gap, level-of-leadership differences, and additional data that helps support the studied hypotheses.

## II. Literature Review

### Ontology

#### Stereotypes

Forms of gender inequalities within a professional environment are based on the foundation of societal stereotypes of each gender. Stereotypes regarding gender are especially influential because gender is an aspect of a person that is readily noticed and remembered (Hentschel Et. al., 2019). A stereotype is a fixed, generalized belief or thought about a person, group of people, or a class of people.

#### Theories behind Social Inequalities

Diversity, inequalities, and exclusions of a specific person or groups of individuals can be viewed as well as analyzed through a vast variety of perspectives that are dependent on numerous factors, such as: who is acknowledging the problem and the circumstances of the situation. After approximately three decades of research, diversity scholars are increasing their search for strategies to theoretically advance and rejuvenate the field (Janssens & Steyaert, 2019). Revisiting diversity research from an ontological perspective means considering how scholars are approaching the nature and basic structure of social life and social phenomena (Janssens & Steyaert, 2019).

The workplace has sometimes been referred to as an inhospitable place for women due to the multiple forms of gender inequalities present (Stamarski & Hing, 2015). Organizations continuously act as a key role in generating and maintaining gender stereotypes through forms of inequality and unfair employment outcomes, regardless of attempted diversity efforts.

A diversity climate is focused on employees' perceptions about the extent to which an organization successfully promotes fairness and the elimination of discrimination, as well as expressing, listening to, actively valuing, and integrating diverse perspectives (Janssens & Steyaert, 2019). Women studying diversity and gender inequality will have a different perception of the problem at hand, compared to men. Therefore, performing a practice-based theory of diversity is the performative nature of these "predictors," which aim to uncover how inclusive human resource departments, company cultures, and diversity

practices coincide to produce an enhanced, equal climate for all employees (Janssens & Steyaert, 2019). The main benefit of executing a practice-based theory of diversity is to eliminate the influence of personal perception and understand the genuine underlying impacts of climate-producing practices.

**Gender Discrepancies**

Gender-based expectations of inferiority insinuate an underperformance on many important tasks, including decision-making and leadership roles. Studies reveal that, when being considered for male-typed (i.e., male-dominated, believed-to-be-for-men) jobs, female candidates are evaluated more negatively and recommended for employment less often by study participants, compared with matched male candidates (Stamarkski & Son Hing, 2015).

Men are characterized as more agentic than women, taking charge and being in control, and women are characterized as more communal than men, being attuned to others and building relationships (Hentschel Et. al., 2019).

The embedding of gender stereotyping from a young age affects the human evaluation of the roles and responsibilities of both men and women. Stereotyping has proven to have stronger implications for women. For instance, women are conditioned since their childhood that unless they demonstrate masculine characteristics, they are less likely to carry out leadership-like roles in organizations and less likely to be successful in work events (Chakraborty & Chatterjee, 2021). However, a meta-analysis of experimental studies reveals that when women act in a stereotypically masculine fashion within leadership positions, they receive lower performance evaluations than matched men (Stamarkski & Son Hing, 2015).

## Workplace Discrimination

**Theory of Gender Inequality**

Gender equality is the concept that all women and men have equal conditions, treatment, and opportunities for realizing their full potential, human rights, and dignity, as well as for contributing to economic, social, cultural, and political developments (UNICEF, 2017). While equality does not signify that women and men are identical in every aspect, the concept conveys that each gender should be offered the same rights, opportunities, along with the responsibilities. Therefore, every individual has the chance to develop their abilities and form decisions without the limitations set by gender stereotypes (UNICEF, 2017). More prominently, gender discrimination is the act of unequal or disadvantageous treatment of an individual or group of persons based on gender, such as sexual harassment.

**Gender Bias**

Gender bias is the tendency to favor one gender over another. By definition, a concept is a form of unconscious bias, also referred to as implicit bias, which occurs when one individual unconsciously attributes certain attitudes and stereotypes to a different person or a group of people (Reiners, 2021). These behaviors impact how individuals understand and interact with each other (Reiners, 2021).

Gender bias is mainly apparent throughout professional settings, such as a corporate work environment. A corporation demonstrates gender bias across various aspects of the operations, including recruiting strategies, decisions of hiring managers, job descriptions, interview questions, career advancements, compensations, mentoring programs, benefits, parental status, and sexual harassment (Reiners, 2021).

Hiring managers act as critical components for the demonstration of gender bias in the workplace during the recruiting process by who is chosen for interviews, the types of interview questions that are asked to candidates, and their overall hiring decisions. Throughout the recruiting process, gender bias is liable, to begin with where and how companies select the potential candidates. For instance, following her college graduation, Erin McKelvey did not receive any responses from employers. However, when she changed her name from Erin (a feminine name) to Mack (a more masculine name) on her resume, she received a 70% response rate (Gaetano, 2016).

Language is known to have gendered associations, such as confidence, decisiveness, strength, and outspokenness, which are found to attract male candidates and deter female candidates from a specific position (Reiners, 2021).

A study performed by the Harvard Library found that when candidates were separately reviewed by individual hiring managers, 51% of managers were influenced by the applicant's gender and selected the under-performing candidate (Bohnet Et al., 2012).

Additionally, during interviews, hiring managers tend to ask more targeted questions about a female candidate's leadership abilities and unconsciously prefer more masculine leadership styles (Reiners, 2021). The entirety of the recruitment process leads to the inevitable continuation of gender bias in the workplace, following hiring the desired candidates.

**Impact on Productivity**

Companies within any industry share a similar goal of maximizing their productivity, remaining competitive, achieving their mission, and earning revenue. Diversity within a firm drives innovation and leads to an increase in the corporation's overall productivity. Specifically, gender diversity among leadership roles has been proven and linked to higher profitability (Bohnet Et al., 2012).

However, gender bias is still a dominant force that limits women from promotional opportunities; therefore, lessening the diversity throughout the numerous levels of positions within a corporation.

One measurement of an organization's productivity is derived from its quarterly, semi-annually, as well as/ or annual performance reviews. In analyzing men's and women's written performance reviews, a study discovered that women were more likely to receive vague feedback that did not offer specific details of what they had done well and what they could do to advance (Mackenzie Et al., 2019). Results have proved that women were more likely to be told, for example, to "do more work in person" with minimal to no explanation regarding how to overcome the issue or the goal of change. This demonstrates performance review bias, which occurs when employers, managers, and colleagues review an employee of one gender differently from another (Reiners, 2021). Generalized evaluations are ambiguous; therefore, bias is more prevalent.

As many studies have shown, without structure, people are more likely to rely on gender, race, and other stereotypes when making decisions; rather than, thoughtfully constructing assessments using agreed-upon processes and criteria that are consistently applied across all employees (Castilla, 2008).

Limited feedback depletes an individual's opportunity for growth, as they will not be able to acknowledge their strengths and grow upon their weaknesses. The disparity between promotional opportunities between men and women begins with entry-level roles, where men are 30% more likely than women to be promoted to management roles (Waller, 2016). Though the numbers are growing slowly, women hold less than a quarter of senior leadership positions and less than one-fifth of C-suite roles (Waller, 2016). A solution to this aspect of gender bias, which would also benefit the company by increasing its productivity, is to offer women chances to meet with senior executives daily, attempt challenging projects, and gain exposure to tasks that are not in their day-to-day jobs. Some big businesses have rolled out executive-shadow programs for women, to help give them more access to top leadership and visibility within the company (Waller, 2016). As of June 1, 2019, 33 of the companies on the ranking of highest-grossing firms were led by female CEOs for the first time (Zillman, 2019).

**Workplace Opportunities**

One of the biggest gender gaps is in the area of income. In a study of over 2000 managers, women were compensated less than men were, even after controlling for several human capital factors (Stamarski & Hing, 2015). One-in-four working women (25%) say they have earned less than a man who was doing the same job; one-in-twenty working men (5%) say they have earned less than a female peer (Parker & Funk, 2017).

Additionally, between men and women, the gender pay gap ranges from 3% to 51% and on average sits at 17% (International Labor Organization, 2022).

It is important to consider the two measurements of the gender pay gap: adjusted and unadjusted. The unadjusted gender pay gap solely factors in the average salary of men and women. Whereas, the adjusted gender pay gap takes into account factors, including differences in education, occupations chosen, skills, hours worked, and job experience. With the adjusted gender pay gap, women make about 95 cents to every $1 that men make (Chamberlain Et al., 2017). When considering the gender pay gap, it is critical to account that more women are segregated to lower-level jobs in low-paying industries and are unable to obtain upper-level roles due to biases. These disparities in opportunities prevent women from excelling in their career and inhibits their ability to make the same amount as men (Reiners, 2021). At every stage of their careers, women face barriers that place them at a disadvantage for career opportunities, mentorships, promotions, and pay raises.

There is a clear discrepancy between the promotional opportunities granted to men versus women in the workplace that is expressed through statistical data. In most companies, according to the McKinsey and Lean In study, women, and men are represented roughly equally at the entry-level, and they lobby for promotions at the same rate (Waller, 2016). Women comprise 56.1% of the U.S. civil labor force; however, only 21% have a seat in the C-suite (Reiners, 2022). Women are less likely to obtain those promotions, as they also receive fewer challenging “stretch” assignments, less training, and fewer development opportunities than men. Therefore, it is not surprising that for every 100 men promoted to manager, only 85 women get promoted (Reiners, 2022).

Recognition regarding the minimum number of women in corporate governance appears to be widespread, with several countries having introduced or considering introducing various forms of affirmative action (Labelle Et. al., 2015) As of 2019, just 26.5% of executive/ senior management positions at S&P 500 companies were held by women (Shaw & Milli, 2021). The lack of clear and objective metrics on gender diversity causes organizations to hesitate to increase women’s representation at the highest levels. Only 11% of top earners were women at S&P 500 companies, as were a mere 5.2% of chief executives in these companies (Shaw & Milli, 2021). However, compelling firms to appoint less experienced women in a short time frame to solely demonstrate that the company has a diverse senior management group will lead to fewer women with sufficient senior management-level business experience to sit as directors.

**Human Resource Implementation**

The glass ceiling is a metaphor for the evident, yet intangible hierarchical impediment that prevents women and minorities from achieving elevated professional success

(Reiners, 2021). Multiple factors, which have been discussed, such as psychological implications, gender roles, and bias, along with sexual harassment have contributed to the development of the glass ceiling and common gender discrepancies in the workplace. Exposure to the reality of the metaphorical glass ceiling is the foundation for progress toward gender equality (Reiners, 2022). 60% of male managers state that they are uncomfortable mentoring, socializing, or working one-on-one with female employees (Reiners, 2021). Recognizing the reasons why men are uncomfortable offers the opportunity for transparency in discussions regarding the various forms of gender inequality in the workplace. 36% of men believe it would negatively impact their image if they worked one-on-one, traveled with, or had dinner with female colleagues (Reiner, 2021). Men should be able to treat and work alongside a woman within a professional, business environment without enduring a sense of discomfort. Honest conversations can be complex and uncomfortable. However, when knowledge and resources are shared, it will become a prevalent topic among colleagues that will alter how the individuals view as well as understand the concepts involved (Reiners, 2022).

Since 2002, the Leadership Excellence Acceleration Program, or LEAP, has gathered high-performing women whom managers have identified as promotion-ready (Waller, 2016). The program continues to offer approximately 400 women per year to participate in the 12-month virtual course. The women meet online monthly to hear guest speakers and receive homework and action assignments, such as making on-camera presentations. The goal of the course is that the women are to have expanded their networks and increased their urge to take risks, to earn promotions against male candidates. Netflix has taken the initiative to increase diversity through employment and promotional opportunities. Women now make up 51.7% of Netflix's global workforce expressing a 3% increase in female employment from 2020 (Myers, 2022). Of the 22 leaders across the company's senior leadership team, ten are women, which equals 45% of the team.

Companies need to provide additional training for managers and executives, as these are the individuals that are in regards to the diversity standards and goals the company is striving to achieve. The process starts by assessing how diverse the company is and identifying which demographics are noticeably absent from the corporation (Reiners, 2022). Understanding this information will form a standard for the conditions that a company is currently operating under and will assist in determining the following steps for improving diversity and diminishing the glass ceiling within a company. Blind applications reduce unconscious bias when hiring and promoting employees. (Miller, 2016). Additional efforts, to lessen the magnitude of the inequalities occurring based on gender bias within workplaces, include, conducting blind screenings, implementing bias and stereotype training, setting diversity hiring as well as promoting goals.

## III. Hypotheses

H1: Women are discriminated against more in the workplace than men.

H2: Women receive lower wages than men receive.

H3: Women receive less promotional opportunities than men receive.

## IV. Method

### Subjects

**People**

Women and men that hold entry-level through senior executive positions within the United States that work for Fortune 500 companies, to compare gender bias in the workplace through human resource processes, promotional opportunities, and wage disparities.

**Companies**

Companies that will be examined are corporations that are on the list as Fortune 500 companies.

**Places**

The companies and their employees that are located within the United States of America.

### Measures

**Variable 1: Gender**

This variable acts as the basis for comparing the inequalities, bias, and stereotypes between men and women. This variable affects additional variables such as wages and promotional opportunities.

**Variable 2: Perceptions of Women**

The predisposed perceptions of women influences disparities that women encounter in the workplace, including less interviews, lower wages, and limited promotional opportunities compared to men.

**Variable 3: Wages**

Comparing wages between men and women that hold the same level position within Fortune 500 companies will support the hypothesis that men earn more than women.

**Variable 4: Promotional Opportunities**

The comparison of the rate of promotional opportunities that are offered to men versus women demonstrates the gender bias within the workplace based on gender stereotypes.

## Procedure

**Procedure To Locate Journal Articles and Data**

The data has been collected by using the following database, Business Source Premier, since February of 2022. I filtered my results by peer-reviewed journal articles. While navigating through the Business Source Premier, I utilized the search terms: women, women in business, gender stereotypes, gender inequality, management, promotions, diversity, equity, and inclusion. Additionally, I gathered sources from Google and Google Alerts with similar search terms. The results from Google's search engine that were relevant for my research were the U.S Census Department, U.S Labor Department, Harvard Business Review, Pew Research Center, etc.

From the articles above, I analyzed the relationship between the female and male genders, along with their stereotypical attributes and how each impacts their interviewing processes, salaries, and promotional opportunities.

I have chosen the sources with a ten-year time span, to recognize any improvements in lessening the disparities between how men and women are treated differently in the workforce. The articles that I have chosen are beneficial for comparing the data and viewing the information from different perspectives. Specifically, human resource context, employees, and senior directors within a firm. Additionally, I will be able to gauge the specific connections between gender stereotypes and my chosen variables.

**Statistical Methods to Present and Analyze the Data**

Following a further analysis of the presented data, I will develop tables and line charts that will clearly represent the correlations and regressions among the variables I have chosen.

# V. Results

## Variable 1 & Variable 2: Gender and Discrimination

Table 1 shows eight types of discriminations in the workplace. The table also expresses the percentage of women, compared to men that have experienced each form of workplace discrimination.

Variable 1 & Variable 3: Gender and Women's Wages versus Men's Wages

Table 2 represents, by age, the average weekly earnings of female and male employees that hold a full-time wage or salary position during 2020.

**Table 1: Components of Study**

| Hypothesis | Variables | | | | Hypotheses & Variable Relationships | Statistical Tests |
|---|---|---|---|---|---|---|
| | Gender (G) | Workplace Discrimination (WD) | Wages (W) | Promotional Opportunities (PO) | | |
| H1 | G | WD | | | G=WD | correlation; regression; line charts |
| H2 | G | | W | | G=W | correlation; regression; line charts |
| H3 | G | | | PO | G=PO | correlation; regression; line charts |

Adapted from: Rudestam, K.E. & Newton, R.R. (1992). Surviving Your Dissertation. Newbury Park, California: Sage Publications, Inc. page 138.

**Table 2: Hypothesis, Instruments, and Statistical Analysis**

| Data | Variables | | | |
|---|---|---|---|---|
| | Gender (G) | Workplace Discrimination (WD) | Wages (W) | Promotional Opportunities (PO) |
| Instrument / Survey | Earnings of Age Group | Gender Based Workplace Discrimination | Earnings of Age Group | Who Gets Promoted Survey |
| Author / Publisher | U.S. Bureau of Labor | Pew Research Center | U.S. Bureau of Labor | The Wall Street Journal |
| Type of data | Quantitative | Qualitative | Quantitative | Quantitative |
| Range of scores | Description | Description & Percentage | $USD | Percentage |

Adapted from: Rudestam, K.E. & Newton, R.R. (1992). Surviving Your Dissertation. Newbury Park, California: Sage Publications, Inc. page 140.

Variable 1 & Variable 4: Gender and Women's Promotional Opportunities versus Men's Promotional Opportunities

Table 3 displays five levels of leadership within a corporation. Table 3 shows the percentage of men and women that hold positions within each level of leadership category.

**Table 3: Percentage of Women versus Men that have Experienced Types of Workplace Discrimination**

| Type of Discrimination | Percentage of Women | Percentage of Men |
|---|---|---|
| Earned less than a woman/ man doing the same job | 25% | 5% |
| Were treated as if they are not competent | 23% | 6% |
| Experienced repeated, small slights at work | 16% | 5% |
| Received less support from senior leaders than a woman/ man doing the same job | 15% | 7% |
| Been passed over for the most important assignments | 10% | 5% |
| Felt isolated in the workplace | 9% | 6% |
| Been denied a promotion | 7% | 5% |
| Been turned down for a job | 7% | 4% |

Source: Pew Research Center

**Table 4: Median Weekly Earnings of Women and Men who are Full-time Wage and Salary Workers, by Age, 2020 Annual Averages**

| Age | Median Earnings Women | Median Earnings Men |
|---|---|---|
| 16 to 24 | $ 589 | $ 622 |
| 25 to 34 | $ 852 | $ 952 |
| 35 to 44 | $ 978 | $ 1,205 |
| 45 to 54 | $ 977 | $ 1,260 |
| 55 to 64 | $ 955 | $ 1,228 |
| 65 & Older | $ 897 | $ 1,115 |

Source: Pew Research Center

**Table 5: Percentage of Promotions offered to Women versus Men**

| Level of Leadership | Women | Men |
|---|---|---|
| Entry-Level | 44% | 56% |
| Manager | 41% | 59% |
| Senior Manager/ Director | 32% | 68% |
| VP | 25% | 75% |
| SVP | 30% | 70% |

Source: The Wall Street Journal

## VI. Discussion

H1: Women are discriminated against more in the workplace than men.

The results in Figure 1 indicate that female employees are more likely to experience discrimination in the workplace, compared to male coworkers. While male employees have claimed to encounter discrimination in their workplace, the data clearly displays that for each form of discrimination a higher percentage of women, compared to men have encountered the unequal treatment during their career. Specifically, 23% of female employees compared to 6% of male employees, a 17% difference between genders, have noted to being treated as incompetent.

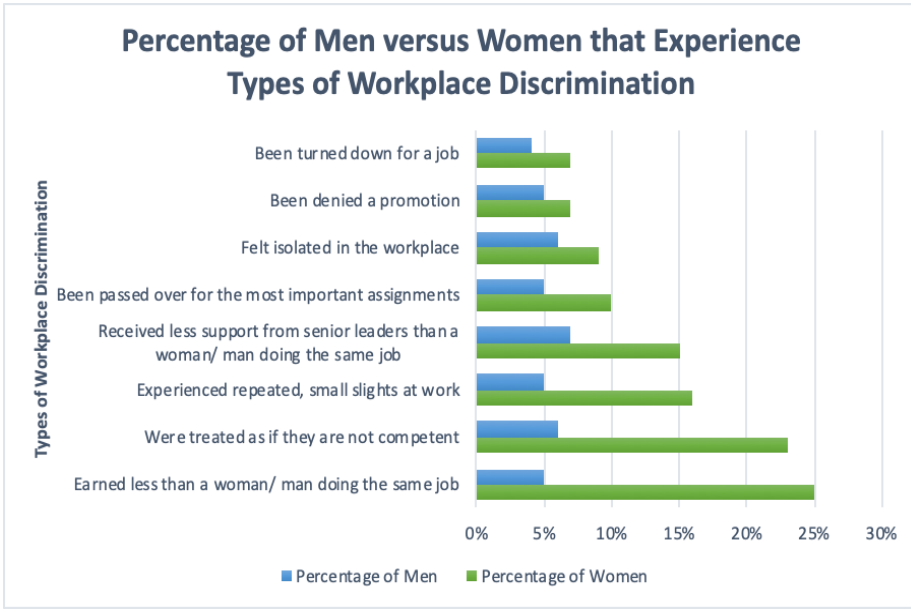


Figure 1: Percentage of Women versus Men that have Experienced Types of Workplace Discrimination (Source: Pew Research Center)

H2: Women Receive Lower Wages than Men Receive.

Figure 2 reveals the data that on average women are not paid equal to men, when comparing full-time salaries. The breakdown of the weekly median pay for both genders demonstrates the consistent wage gap between women and men from ages 24 to 65 and beyond. Men on average earn anywhere from 6% to 23% more than women.

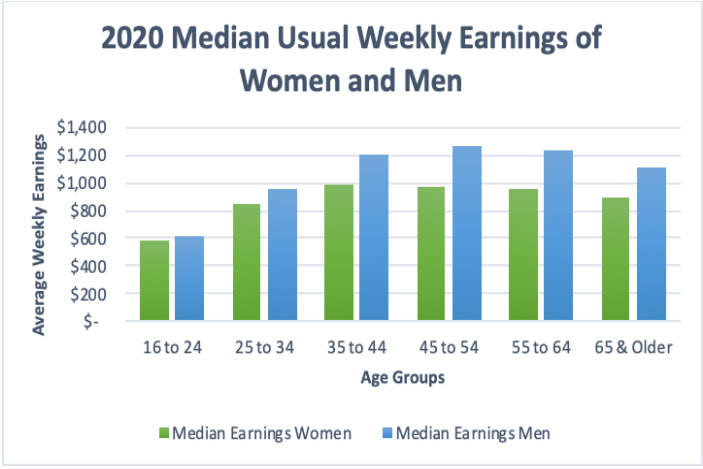


Figure 2: Median Weekly Earnings of Women and Men who are Full-time Wage and Salary Workers, by Age, 2020 Annual Averages (Source: U.S. Bureau of Labor)

H3: Women receive less promotional opportunities than men receive.

Figure 3 represents the unequal opportunity for women to be promoted, compared to men among five levels of leadership. The data expresses that between each level of leadership a higher percentage of men hold each leadership position than women. This gap grows larger as the level of leadership becomes higher, depicting that women are not promoted as much as men within companies.

## VII. Conclusions

General Conclusions

This report has explained the impact of gender stereotypes and gender bias on how women are treated in the workplace compared to men. The research has proposed the idea based on society's stereotypes of women and men, along with the glass ceiling theory, that women are not granted equal opportunities for success in Fortune 500 companies. This study has identified multiple forms of gender discrimination that women encounter in the workplace versus men, including less interview opportunities, minimal potential for a

promotion and rising in their level of leadership, and a wage gap. The human resource department within Fortune 500 companies do not offer women an equal chance when interviewing for a position as well as when competing for a position. Women are paid less than men when holding positions within the same level of leadership in a Fortune 500 company. Therefore, women are not granted equal opportunities to succeed, compared to men in the corporate workplace, due to gender bias that leads to gender discrimination.

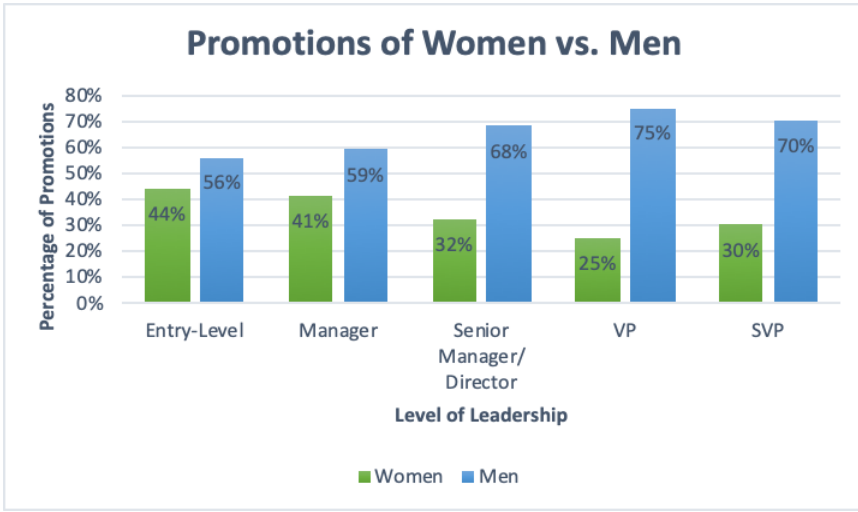


Figure 3: Percentage of Promotions offered to Women versus Men (Source: The Wall Street Journal)

## Implications for Practice

Fortune 500 companies need to be more conscious of how gender stereotypes influence the discrimination that women encounter within the workplace, compared to men. To experience any form of change, the company needs to prioritize implementing diversity, equity, and inclusion (DEI) efforts into their company's culture. As stated within the thesis, the foundation of reducing any form of discrimination begins with the company's human resource department. Recruiters should be more aware of gender bias when recruiting positions, to create an equal opportunity for the job regardless of the candidate's gender. Furthermore, companies should offer mandatory training sessions to increase awareness of the forms of gender discriminations within the workplace and strategies to diminish each type.

Implications for Research

Researchers should analyze various DEI implementation initiatives to determine which strategy is most effective in lessening gender discrimination within the workplace. In recent years, Fortune 500 companies have begun to prioritize diversity, equity, and inclusion; however, there is still evident progress that needs to be made regarding gender bias in the workplace based on the research conducted throughout this paper. Therefore, further analyzing the success rate of multiple Fortune 500 companies' approaches, such as Netflix will be beneficial in promoting and progressing toward complete gender equality. Specifically, by lessening gender discrimination in the aspects of the workplace highlighted within this paper.

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# Section IV:
# Critical Essays

# Increasing Vaccination Rates in the Jerusalem Ultra-Orthodox Community

Kayla Hay (Nursing), Reilly Patterson (Nursing), and Allyssa Turner (Nursing)[1]

In Israel's capital city of Jerusalem exists one of the world's largest populations for those who practice Haredi, or ultra-Orthodox, Judaism. This denomination of the Jewish religion lives in both social and physical separation from the rest of their city, self-isolating themselves in different neighborhoods as they adhere to their own cultural practices. With this insulation the Haredi are left ignorant of and unable to access all of the resources other Jerusalemites enjoy. One of the most prevalent deficits is seen in the immunization rates of the ultra-Orthodox population, leaving this population especially vulnerable to preventable disease outbreaks. The vaccination rates for this group remain lower than the nation and city average, as a result their neighborhoods are more impacted by epidemics (Stein-Zamir, 2019). This leads to the question: how can vaccination rates in this community be increased? Our program, Have Faith in a Safe Community, provides interventions made specifically for this group to take into account what challenges are present in relation to their unique lifestyle. Improvements must be made in communication and trust between the ultra-Orthodox population and healthcare providers. There also needs to be more available resources, especially educational materials on the topic in their preferred language. As religion is at the core of their way of life, any stride in increasing vaccinations must be made in conjunction with ultra, Orthodox religious leaders, communicating with them the importance of disease prevention to then share with the community.

## Community Assessment and Analysis

The ultra-Orthodox are a growing population in the Jerusalem community with a culture that makes it distinctly different from even other Jewish faiths in their strict adherence to religious tradition. The customs of this subgroup are governed by the Halacha, a collection of laws from the Torah that dictates how all aspects of life should be conducted (Gabbay, 2017). In accordance with this scripture, the ultra-Orthodox typically marry at a young age and have large families with an average of 7 children per

[1] Written under the direction of professors Josephine Marcantonio and Tinamarie Petrizzo-Hughes in partial fulfillment of the Senior and Honors Programs requirements.

family, making more than 40% of their population under 14 years old (Stein-Zamir, 2019). This also means rapid growth of this population, in 1996 only 21% of Jerusalemites were ultra-Orthodox, but as of 2019 they had risen to 35% of the population (Choshen, 1998; Stein-Zamir, 2019). Community is integral to this lifestyle as they have frequent large gatherings although they rarely interact with those outside of their neighborhoods, even other Haredi groups. Between their insulation and faith, the ultra-Orthodox tend to disregard the authority of governing bodies, instead referring to rabbis for instruction for matters in and outside of religion (Stein-Zamir, 2008).

This population lives in relative poverty; overcrowded in low-income homes resulting from low participation in the general Jerusalem workforce. Across the various neighborhoods the Haredi inhabit 98% and are in low-ranking socio-economic clusters with 66% of the population classified as low-income households (Korach, 2021). This is reflected in the overall city wealth, as has been noted since the 1990s, causing Jerusalem to have a lower average income than other major cities in Israel (Choshen, 1998). However, a unique feature of the ultra-Orthodox is the gender difference in employment as more women have income earning jobs than men do (Stein-Zamir, 2019).

In addition to being the primary wage earner women are also the child care providers. As executioners of ensuring wellness in large families it is difficult to keep children up to date on necessary check-ups (Stein-Zamir, 2019). Between inconsistent healthcare visits and the insular culture, it can be difficult to get a precise picture of the community's health. As of 2011 only 65% of ultra-Orthodox children ages 0-5 are fully vaccinated, making this population susceptible to preventable epidemics (Muhsen, 2012). This was seen in the 2003 and 2004 measles outbreaks in Haredi neighborhoods, in which 47% of patients were under 5 years old; of those infected 87% in the first wave then 96% in the second wave were under-vaccinated (Stein-Zamir, 2008). While Israel's national immunization rate for measles, mumps, and rubella was 97% in 2018, the ultra-Orthodox in Jerusalem had only a 76% vaccination rate which led to yet another measles outbreak (Stein-Zamir, 2019). Due to the population density, these diseases spread very quickly and affect a large amount of people.

While Israel has a fairly comprehensive healthcare system it is difficult for the ultra-Orthodox to fully benefit from these resources due to their social isolation. In Jerusalem, vaccines are provided for free at maternal child clinics, however these are not in areas convenient to this community (Stein-Zamir, 2019). This makes it difficult for families to make it to appointments, especially when one mother has seven children to coordinate and get care for. While Halacha law dictates the importance of maintaining

health, the Haredi will turn to their rabbis rather than doctors for advice on doing so (Muhsen, 2012). Yet in the modern era the most crucial gap in their resources is internet access. Most ultra-Orthodox do not have a computer or any access to mass media, reliant on print media and talk instead (Shtern, 2021). This leaves the population missing a massive wealth of education making them extremely susceptible to misinformation.

The Haredi face unique challenges related to their cultural lifestyle, the forefront of which is ineffective communication between themselves and Jerusalem at large. This is especially apparent in the dissemination of information regarding the COVID-19 outbreak. Without internet, the ultra-Orthodox missed critical news as the virus became an international concern, despite being such a major part of the population the need for specific measures to communicate this message was an afterthought. Authorities were inefficient in relaying information; coming too late with inadequate resources, thus the community received most of its early knowledge by word of mouth (Schtern, 2021). This issue goes beyond just this pandemic, it is also at the root of vaccination delay; knowledge about the importance of immunization is insufficient. Half of ultra-Orthodox mothers reported having never received information about childhood vaccines, much less the necessary schedule of such (Stein-Zamir, 2017). Haredi take their cues from rabbis, for information to be circulated and headed it must be endorsed by their religious leaders (Muhsen, 2012). As religion is at the core of ultra-Orthodox culture the key to efficient communication with this community is collaboration with the rabbis to work to meet the needs of the people.

## Problem in the Community

The major healthcare problem in this community is vaccine refusal. This is a long-standing challenge that the Jerusalem community faces due to the strict religious beliefs and limited resources accessible to the ultra-Orthodox. In Jerusalem's ultra-Orthodox population religion takes second place to nothing other than the aspect of life. In the United States, a large portion of the population puts religion on the backburner, but religious beliefs in Jerusalem are of the utmost importance to many citizens of the local community. This religious way of thinking relates to every aspect of life in this population, as we see even more clearly now with the current coronavirus pandemic being no exception to them. In the past, this community has been harmed by preventable diseases such as measles, rubella, influenza, among other common diseases (Stein-Zamir, 2008). The ultra-Orthodox community has strict beliefs that impact their way of thinking and everyday lives; they do not participate in taking vaccines to fight off these potentially deadly effects of preventable diseases. This is presenting a major issue for the community

because low vaccination rates continue to ravish the land leaving it with no form of protection (Kasstan, 2021).

In 2018, the measles presented Jerusalem with a very similar problem that the coronavirus currently is in the community. In a statement from the CDC, “once measles is in an under-vaccinated community, it becomes difficult to control the spread of the disease” (Center for Disease Control, 2019). Although a large portion of the Jerusalem community was vaccinated from the measles, most of the local ultra-Orthodox population was not vaccinated due to refusal stemming from religious beliefs so that is where the issue lied. Measles is a disease that is highly contagious whose symptoms can lead to a telltale rash, along with many severe complications, and in the worst of cases death. Like coronavirus, measles leaves people with compromised immune systems at the biggest risk for a more significant reaction to the disease (Center for Disease Control, 2019). The situation with measles that the ultra-Orthodox community went through in 2018, is extraordinarily similar to the situation currently taking place with the pandemic. The challenging part is that the issue with vaccines in Jerusalem is not only due to religion. The ultra-Orthodox are vulnerable to misinformation due to the lack of educational health resources and infiltration of organizations providing inaccurate and misleading information about vaccines, creating a huge disadvantage for the Jerusalem community (Shtern, 2021). It is actions such as these that are making it even more difficult to get this community the protection needed to make sure that future epidemics do not duplicate the situation that occurred with measles. Overall, not being vaccinated, no matter the reason, is presenting a major problem for the people of the Jerusalem community. The fact of the matter is that there is no line of defense for the ultra-Orthodox population, making it that much more difficult to stop an extremely contagious virus. The dilemma of religious belief and education of misinformation is severely putting the Jewish community at a significant health risk.

Today, vaccinations have been a popular topic regarding the national pandemic in Israel. It has been an ongoing battle to encourage people to receive the COVID-19 vaccine in efforts to escape the pandemic. Citizens have very strong beliefs against vaccinations for numerous health or religious reasons, which is creating problems within the community. In comparison to Jerusalem, Israel struggles to get high vaccination rates because of the similar population groups. Specifically in Jerusalem, there are other nationally based issues that have a similar landscape to the issue that is currently ongoing with COVID-19 and vaccination rates in general. In 2018, the United States unveiled an extraordinarily controversial embassy on a very religious land in Jerusalem. The reason

that this action was so controversial nationally was not because of the presence of the United States, but because of the land that the new embassy was sitting on. This religious issue compares to the current situation going on with coronavirus; when it comes to altering religious beliefs in Israel, especially within the ultra-Orthodox population, compromise is extremely hard to come by whether it be holy land or receiving vaccinations (Kasstan, 2021). Although this relates to strongly adhering to religious beliefs, the situation differs because protecting holy land is not putting your personal health at risk, like a vaccine is believed to be.

In the United States, there is a good portion of the population that is fully vaccinated from the coronavirus. But there is still a good portion of the population that is not vaccinated because they are simply uneducated about the vaccine or are fearful of the unknown being injected into their bodies. This global hesitation is because people of Jerusalem and the United States are both unsure what affects the vaccine will have on their health not only in short term aspects, but in long term as well. This vaccine refusal is a common global problem. The difference between the situation in the United States and the situation in Jerusalem is that the United State's main vaccination issue does not stem from religion. On the contrary, in Jerusalem, the main issue when it comes to vaccination is religion. "It is important to differentiate vaccine hesitancy from "vaccine refusal," which is ideological and corrosive." (Trogen, 2021). Along with fear and religious issues, this makes it that much more difficult to protect the ultra-Orthodox population during a pandemic.

Although there are several reasons that the ultra-Orthodox population in Jerusalem is unwilling to receive vaccines, that does not mean that nurses cannot have an impact on changing the tides and hopefully start to change the minds of the citizens towards a vaccinated future. Nurses have a unique opportunity to support vaccinations because they are on the frontlines of these epidemics and have seen the grueling effects that diseases can have on people. First, nurses need to make sure that they are educated about vaccinations so they can spread correct, useful information for how the people of Jerusalem can protect themselves from viruses. Being present and involved is not enough; nurses need to go the extra mile and make sure they have the proper knowledge about vaccinations and the ultra-Orthodox population. It is important that nurses educate themselves on the culture they are working with to have effective communication and avoid cultural bias. Second, not only can nurses educate about vaccinations and their benefits, but they can also help people understand the truly horrifying effects that infectious diseases can have on a person if they were to contract them. It would be more

effective to hear nurses speak about how awful these diseases can truly be, because if you are going to believe someone on the matter, it'd be a nurse. Lastly, if given the opportunity, nurses should advocate for more educational programs about vaccination clinics; learning about vaccines could become mandatory in the schooling system not only in Jerusalem, but all around the world. Therefore, making it that much easier to protect the community from the pandemic. Nurses could go into schools to speak to children and their parents about why vaccines would be in their best interest. Preventable diseases have taken the lives of so many of the Jerusalem community. It is time to make a change and nurses can lead the way.

## Proposed Solution/Program

While there are many challenges that nurses face among getting communities vaccinated, there are also many solutions to this problem. Our proposal is to increase the vaccination rates among the ultra-Orthodox Jewish population in Jerusalem. To do this we have created a program that encompasses specific, attainable, and measurable goals that will help to increase the vaccination rates. This program is called: Have Faith in a Safe Community. This program will target ultra-Orthodox Jewish communities who do not get vaccinations for themselves, or for their children. The health goal is for more ultra-Orthodox Jewish people to be vaccinated. We can achieve this through respectful and culturally sensitive avenues. The main goal of this program is to increase awareness of the risks that come with not getting vaccinated, and to educate on the safety and benefits of vaccinations. Awareness and education are essential to increasing vaccine rates among the ultra-Orthodox Jewish population.

One of the most important parts of our program is finding and building trust. If the community does not trust us, then the information will not be received. You cannot build trust, if you do not respect their culture and religion. Culture is a huge driving force in the outcome of vaccine rates. This is why it is so important to acknowledge diversities and respect the ultra-Orthodox Jewish religion, so that we can create breakthroughs in education and health care. Leininger's Culture Care Theory is the influential framework for our proposal, stating that, "nurses cannot separate worldviews, social structure factors, and cultural beliefs or practices (lay/folk/generic and professional) from health, wellness, illness, or care when working with cultures because these factors are closely linked and interrelated" (McFarland, 2018, p.541). This theory will guide us to create and implement solutions that accommodate the ultra-Orthodox religion. We will stress the importance of respecting and understanding the ultra-Orthodox Jewish culture, while navigating ways to implement education and support towards vaccines.

Leininger reminds us that, “the central purpose of the theory is to discover and explain diverse and universal culturally based care factors influencing the health, well-being, illness, or death of individuals or groups. The purpose and goal of the theory is to use research findings to provide culturally congruent, safe, and meaningful care to clients of diverse or similar cultures" (Leininger, 2002, p.189). Our proposal encompasses culturally based care through the use of our program, that focuses on providing simple, yet effective solutions to the lack of vaccinations while still using solutions congruent and sensitive to the ultra-Orthodox Jewish population. By using Leininger’s theory, we are confident we will be able to provide solutions in our program that respect the Jewish culture, while also providing the education and care needed to keep these communities safe.

Have Faith in a Safe Community has innovative activities that will set nurses and the community of Jerusalem up for success. The three program activities are (1) involving healthcare providers, (2) creating signage, and (3) educating the rabbis of the community on the safety and health benefits of vaccinations. The activities in this program will help to achieve the goal of increasing vaccination rates among the ultra-Orthodox.

Our program will be effective in educating this population through interpersonal communication and direct information. We will aim to involve healthcare providers in our effort to inform the community about the importance of vaccinations, since they have already built a strong rapport with the Jewish community. Through healthcare providers, like pediatricians, we will be able to provide accurate information in a more trusted and effective way. (Tokish, 2020)

Pediatricians are essential to spreading responsible and trusted information to the ultra-Orthodox families, especially they are more likely to educate parents on the importance of vaccinating their children. Healthcare providers will be vital in spreading knowledge and awareness to the ultra-Orthodox population, and we nurses must be sure to maintain interpersonal communication in order to ensure that the information is being received.

An important element of this program is signage and pamphlets. This is a time-effective way to spread information to a large number of people (Maynard, 1999). By posting signs and handing out pamphlets, we will be able to reach and educate more people. Yiddish is the primary language of the ultra-Orthodox, so it is essential that any signage and pamphlets are written in their language (Stein-Zamir, 2008). It is important that these handouts and signs are translated to Yiddish. We will do this for two reasons.

The first is that translating to Yiddish will help the culture receive information better, and the second is to show that we are respecting their culture by using their language. This will also help us to build a rapport with the ultra-Orthodox. The more the community sees that we respect their religion, the more they will be willing to listen to what we have to say. Signage is also an important way to combat the ultra-Orthodox population's lack of internet use (Shtern, 2021).

Educating the rabbis on the importance of vaccines will play a big role in spreading information. The population puts a lot of their faith and trust in the rabbis, so if they encourage the use of vaccines, then the ultra-Orthodox are more likely to get immunized. It is important to teach the effectiveness of vaccines and the safety of them. A lot of the unwillingness to vaccinate is due to fears that vaccines are not safe. Our goal is to educate the rabbis on the safety of vaccines and the risks of not being vaccinated. This way, the rabbis will be able to spread awareness and information, which will be much better received among the community (Stein-Zamir, 2008). As mentioned previously, the Haredi will turn to their rabbis rather than doctors for advice on doing so (Muhsen, 2012).

By combining these activities, this program has the potential to be very successful. The most essential part of this program is to make sure to provide congruent care that is both informative and culturally sensitive. The information will better educate the community so that they will be more apt to getting vaccinated. This would not be possible without the respect and acknowledgement of their cultural differences. By respecting their religion, we are gaining their trust and building a rapport. This is crucial to meeting our health goal: increasing the number of vaccinated Haredi in Jerusalem.

We have provided learning objectives for our program to help guide our implementation of the activities, and to better measure the effectiveness. The first learning objective is that the community will understand what a vaccine is and how it works. This can be measured through a survey or questionnaire. It is essential that we get the information out to soon-to-be and new parents. The more educated parents are on what the vaccine is, and how it works, the more likely they will be to trust the vaccine and be less concerned with the safety (Muhsen, 2012). This can be attained through educational pamphlets given out at hospitals and places of worship. It is also important to encourage pediatricians and other healthcare professionals to educate their patients on the safety of vaccines. Secondly, the community will be well informed on the importance of childhood vaccines, and the effects of disease on the community. This will be measured by the increasing rates of vaccines. It will be attained through the use of rabbis and

pediatricians. The more aware the community is about the risk factors of not getting vaccinated, the more likely they are to be vaccinated. This is because people want to protect their loved ones and the community. This will ensure that more children will be vaccinated due to the increase in education to parents. Lastly, the community will feel that their culture is being respected, while understanding the need to vaccinate their children in order to protect their entire community. This is essential to the success of our program. We will make sure to survey how the community feels about our activities and if they are culturally appropriate. A way to do this is to also ask the Rabbi's how to be culturally sensitive. This way we are meeting the needs of the community by providing harmonious care of both culture and science.

## Conclusion

The goal of Have Faith in a Safe Community is to marry the significance of science with the importance of culture. By educating the ultra-Orthodox Jewish population in Jerusalem, we will be able to better protect this community from preventable diseases and viruses. The drive to protect your loved ones and community is what will bring about change. It is clear that the community of Jerusalem has had a long standing problem involving low vaccination rates, which has led to the prevalence of many preventable diseases. With the new COVID pandemic, the need for vaccines is of utmost importance. We hope that our program will help to bring safety to the community and protect the lives of its citizens.

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# The Creation of a Monster: An Analysis of Emotional Perception in Pre-Modern Literature

Kevin Roach (Biopsychology and English)[1]

The complex set of feelings and affects that we call emotions have thrived alongside humans for many years. We express this complexity in a plethora of art forms through which we attempt to encapsulate what we feel. However, in earlier time periods, emotions are depicted as externalized and out of one's control, leading to personifications of emotions. In the Medieval period these are often allegorical, named for what they are ("Happiness", "Anger", "Despair"). With that, there are frequent embodiments, like Cupid, the god of Love, who are used to provide explanatory content for emotional states: Cupid shoots his arrows, and love happens. Within such pre-modern depictions, emotions are a part of an external system, intertwining physical and mental health, leaving little room for an individual to stop and understand how they feel. More modernly, emotions are perceived as a separation of mind and psyche, allowing an individual to truly step back and conceptualize their feelings. That being said, when contrasting pre-modern perceptions of emotions, externalizing and personifying made the emotions more malleable, allowing them to be understood by the audience. However, this was at the cost of one's own emotional perception, leaving them unaware of how to *internalize* and *feel* the emotions being invoked. This paper analyzes the emotional perception through pre-modern literature, and how these emotions are exhibited through characters within stories. From magical green knights to emotions personified, the emotional perception of the premodern world was drastically clouded by these mythical tales and battles, rather than allowing an individual to conceptualize and feel their emotions.

In the early 1400's, stories of pious and honorable knights battling vicious monsters, or mythical creatures, were very popular, allowing individuals to conceptualize epic quests and battles. However, underneath the religious fervor and honor, emotion is disguised as a character, monster, or higher power. Albrecht Classen states that "In recent theoretical discussions monsters have been identified as markers of alterity and otherness." (522) In Medieval literature, monsters serve more purpose than an obstacle in an adventure; they become a manifestation of "otherness". Classen goes on to explain

[1] Written under the direction of Dr. Emily Barth for EN211: *British Literature Survey*.

that monsters or mythical creatures serve as "A representation of the alien other within the self, although it operates on the outside" (523). With this alienation and othering of the self, monsters serve as an externalization, or manifestation, of the "alien other" which, according to Classen, is the "force the protagonist [uses,] … to come to terms with the beast in the own person in order to extricate the self from the beastly nature (sin/ evil/etc.) in all of us"(523). The alien other that Classen highlights is what the protagonist must fight, not the monster itself. It is not a great leap to suggest that the monster might be a manifestation of the conflicting emotions an individual feels. As the protagonist projects their negative emotion, which has been difficult to internally assimilate, resulting with the noble knight, or hero, slaying the beast, signifying their victory not only in the story's plot, but of their alien self. In their essence, monsters and mythical creatures in early literature serve as an externalization of emotions, which can be seen in early literature like *Sir Gawain and the Green Knight*, and *The Faerie Queene.*

In *Sir Gawain and the Green Knight,* readers enter an extravagant hall, where Christmas Eve and the New Year are being celebrated. This celebration includes noble knights, honorable ladies, and other great people; King Arthur is also in the mix. As their party continues, the Green Knight enters with a demanding presence, so bold that all are in awe of his terrifying stature. He intrigues the knights and ladies as he fills the space in the hall:

> "For scarce was the noise not a while ceased, and the first course in the court duly served, there hales in at the hall door a dreadful man, the most in the world's mould of measure high, from the nape to the waist so swart and so thick, and his loins and his limbs so long and so great half giant on earth I think now that he was." (Gawain 17)

The Green Knight, with his incredible height and build, is seen as "dreadful." Continuing to emphasize his size, the author establishes that the onlookers see the Green Knight as inhuman, calling him "half giant." This statement expresses that the Green Knight is a creature, not belonging in the hall with the men and women, but rather than scaring them; the Green Knight leaves his audience in awe. The anonymous writer tells the reader that "All studied that steed, and stalked him near, with all the wonder of the world at what he might do. For marvels had they seen but such never before; and so, of phantom and fairie the folk there it deemed." (Gawain 22). In likening him to these other creatures, the attendees encounter the Green Knight as an other: they first conflate the intimidating figure with his horse (as they study "that steed" but wonder "what he might do," the pronoun leaping forward to refer to the Green Knight). Having dehumanized him,

bestialized him, the knights and ladies then label The Green Knight as a mythical creature, that of "Phantom and fairie the folk" (Gawain 22). However, the Green Knight is clearly not an animal; nor does he embody evil or evil manifestation of the self. Rather, he acts as a judge of character. Upon walking in, the Green Knight questions:

> " 'What, is this Arthur's house,' quoth the horseman then,'that all the rumour runs of, through realms so many? Where now your superiority and your conquests , your grinding down and your anger, your great words? Now is the revel and the renown of the Round Table overthrown with the word of a wanderer's speech, for all duck down in dread without dint of a blow!'" (Gawain 25)

With this statement, the Green Knight questions the validity and truth of the Lords and Knight, causing them to be angered and upset. He infuriates them to protect their honor, so much so that the protagonist Gawain proves his boldness and beheads the Green Knight. Gawain's action is in many ways ignited by emotions: the game that the Green Knight proposes to the court entails a blow for a blow, whatever done to him, is repeated to the contender a year later; there is no requirement that this blow be fatal. Gawain's drastic and dramatic strike occurs in response to the Green Knight's suggestion that the court cowers in fear, causing Gawain to think he can simply kill the thing that disturbs them, in other words, their alien selves or consciousness that questions the validity of their honor and virtue. That being said, the Green Knight serves a greater representation of self and consciousness. The extent of the Green Knight's power is further established with the phrase, "That all the rumour runs of, through realms so many,", suggesting the Green Knight is able to see all in not just one place, but is able to observe and critique through many areas and realms, similar to a higher power, or one's own consciousness. A year later, as Gawain journeys toward the Green Knight, he first finds his way to an enchanted castle in the woods, where he meets a Lord and Lady who offer him many material objects that test his piety and honor.

In the house of Lord and Lady Bertilak, Gawain is presented with another sort of game. He is, Lord Bertilak tells him, quite close to the chapel where he will meet with the Green Knight. He should rest in the castle for some time. While Gawain is there, Lord Bertilak will go hunting every day, and will give Gawain whatever he catches; in return, Gawain will give Bertilak whatever he might obtain in the house during the day. Lady Bertilak immediately begins an attempt at seducing Gawain. The first day, she appears in his bedroom. Gawain resists her advances, leaving with only one kiss - which he gives to Lord Bertilak. The "game" proceeds like this until the last day, when it becomes clear

that Gawain will not be won over by the Lady. She offers him something else instead: an enchanted green sash that will preserve his life. Gawain ties this sash around his waist and conceals it from Bertilak. Gawain ultimately is exposed: he does not have any of the honorable qualities that he is supposed to have as a knight. To further demonstrate this, at the end of the story, as Gawain kneels before the Green Knight and flinches, afraid of his own impending beheading, the Green Knight again questions the honor and value of Gawain, and knights in general. The Green Knight states:

> " 'You are not Gawain,' quoth the man, 'held so great, that was never afraid of the host by hill or by vale, for now you flinch for fear ere you feel harm. Such cowardice of that knight have I never heard." (Gawain 91)

After seeing Gawain shrink in fear, the Green Knight holds him accountable and asks Gawain why he has so much fear if stories claim he is bold and brave. After all, Gawain knew exactly what punishment he would be given, having initially struck the Green Knight himself (this was the game). The Green Knights' interactions and boldness, not only with Gawain, but with the other knights, serves to show the Green Knight as a critical voice that holds others accountable to their piety and honor. Within the Medieval world there was a wide acceptance of externalized and outside forces that played a key role in everyday life. After discussing the role of magic in *Sir Gawain and the Green Knight*, Kimberley Burton states, "The Medieval mind accepted that unseen forces were constantly present and governed by some set of principles— whether or not mankind fully understood or experienced their parameters" (7). Within medieval writing, having an overseeing powerful character is common. That being said, the Green Knight's presence and purpose can also be interpreted as Gawain's conscience, his own anxiety over his morals and actions.

Gawain loses himself when he expresses fear and hesitation as the Green Knight prepares to cut off his head: "You are not Gawain," the Green Knight tells him. The lie and fear tied up in the green sash, and the visible fear in Gawain's face, become a commentary on identity, on what makes a knight a knight. Although he survives, Gawain carries his guilt back to the court, effectively returning to the beginning of the poem, suggesting that all knights share in his dishonor and lack of piety. Unable to kill his fear, Gawain fails to embody the ideal, chivalric image of knighthood; at the same time, he becomes a more human character for his faults.

Throughout this story, it is clear that the emotional worry and guilt were not conceptualized as abstractions within Gawain, but rather, externalized as the Green Knight. In imaginative literature, the complex emotions that challenge an individual, like

Gawain, tend to be separated from the protagonist through literary techniques such as personification. This is all in hopes of expressing a dramatic dilemma, exhibiting the relationship between emotions and oneself. Mary Flannery explains that "personification represents emotions as something brought into being by the body as well as the mind," and "by giving emotions a face, personification participates in and furthers embodied emotional practice" (2-3). This expresses the product of complex emotions in literature and an individual's means of expressing said emotions, as well as how these emotions are often projected via personification. Through personifying Gawain's guilt, the Green Knight manifests as a judge, collecting and holding Gawain's worries and guilts as one figure. As Monique Scheer explains, "we *have* emotions and we *manifest* emotions" (195). Scheer's statement expresses how normal it is for one to project their own emotions, in order to see and grapple with them as much as possible, from a first-person perspective. Through this projection and externalization in premodern literature, one's selfhood consists of the mind and body, which are held together in a relationship where one exists because of the other, again, creating dramatic dilemmas for the reader's enjoyment. However, even as the audience reads the struggle as a confrontation between two characters, the text also manifests an engagement between a protagonist and their guilts and worries. For the sake of character and ego, Gawain's guilt and consciousness are extended into the Green Knight, so that he can attempt to reclaim those aspects of himself through battle. As time goes on, more manifestations and external projections of internal emotional conflicts can be seen in early modern works like Edmund Spenser's *The Faerie Queene*, where readers see embodiments of both positive attributes and negative emotions.

In *The Faerie Queene*, *Book I Canto I,* readers are following the pious and noble Redcrosse Knight, the embodiment and protector of all things holy, who is tested through his battles with monstrous creatures. Early in the story, Redcrosse comes upon a monster named Errour, a nocturnal snake-like monster, who vomits pages of paper, and has offspring that feed off of her. Errour, in this story, is the manifestation and embodiment of error. The Redcrosse Knight's meeting with this particular monster comes after several missteps of his own: Redcrosse and his companions enter the Wandering Wood during a sudden rainstorm to seek shelter, and do not seem to notice that the foliage is so thick it "heavens light did hide" (I.i.7). They are "with pleasure forward led," and quickly become distracted; "Led with delight, they thus beguile the way" (I.i.8, 9). By the time the travelers - Redcrosse, Una, and a dwarf - are thoroughly lost and about to stumble into Errour's den, Una gives a belated warning: "Oft fire is without smoke, / And perill

without show: therefore your hardy stroke/ Sir knight with-hold, till further trial made" (I.i.12). The Redcrosse Knight, though, is young, and eager for adventure. He rushes in:

> But full of fire and greedy hardiment,
> The youthfull knight could not for ought be staide,
> But forth vnto the darksome hole he went,
> And looked in: his glistring armor made
> A litle glooming light, much like a shade,
> By which he saw the vgly monster plaine,
> Halfe like a serpent horribly displaide,
> But th'other halfe did womans shape retaine,
> Most lothsom, filthie, foule, and full of vile disdaine. (I.i.14)

Errour's purpose is to represent the human action and emotion of error, and what it can do to people. Errour's activity and Redcrosse's struggles show an individual's battle with committing error, and how dangerous it is. During their battle, as Redcrosse is caught in Errour's tail, the narrator comments, "God helpe the man so wrapt in *Errours* endlesse traine" (I.i.18). This statement is a direct message to readers, informing them not to succumb to error, even as the poem further manifests error as the allegorical Errour. As the fight progresses, and Redcrosse is winning, Redcrosse strangles the monster, and she ends up spewing out papers and books (I.i.20). This serves as political commentary at the time, pushing Errour's meaning further. Errour and Redcrosse's fight ultimately becomes a religious battle between faith and error, emphasizing how difficult the battle is. Thomas Dughi states that "The narrative thus clearly establishes the futility of trying to overcome Errour (to achieve saving faith) through even the most strenuous effort of human will" (26). This interaction and battle are performances of faith. The embodiment of not only error, but faith, shows how still, in the late sixteenth century, individuals are expressing their emotions and morals through personifications and projections, rather than writing about internal experiences of personal emotional encounters; people are still externalizing their feelings. This, in part, has to do with the extent to which emotions are understood to be bodily experiences, which is described by Gail Kern Paster, but perhaps there is real psychological utility to externalizing emotions and turning them into monsters or foes to be conquered (Paster 4-7). These negative emotions are often shown as being slain or conquered, in part due to the religious or social stigma of the time period. Externalizing and embodying emotions in order to battle them allows the protagonists of these stories to conceptualize the emotion in a very tangible way.

With this tangibility, readers encounter a tale of a brave protagonist in an epic battle against a monstrous other, while simultaneously an emotional struggle takes place. What an individual sees as a monster exhibits their psyche, due to our projection of what we feel, as seen in the stories above. The word monster has been established to articulate something scary, foreign, or even familiar to an individual, creating some sort of discomfort. However, in Latin, the word "monstrum" is given the definition "unnatural thing or event regarded as omen, sign or portent." Further tracing the etymology reveals that the word monster derives from the word "mŏnĕor," defined as "to warn" (Olivetti). It is clear that the monsters we create are meant to be warnings or omens from our psyches, which must be understood and seen; in other words, our emotions are asking to be seen and understood for what they are. Rather than being masked behind a vile creature in an obscure forest, or a Green Knight, for the sake of control, our emotions stand alone and demand us to look at them.

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# The 'Classy' Way to a Man's Heart

Maïa Vitoratos (Health Sciences)[1]

Advertisement, in general, represents a complex and constant conversation about race, class, gender, and modernity. Specifically, food advertisements can be used to understand how Americans view gender roles within society. Food advertisements date as far back as the 1880s and have become an excellent tool for analyzing the past.[2] Taking a feminist approach that considers the imagery and text that particular advertisements present, this paper will attempt to unravel the gendered messages that food advertisements relayed to the American population during the 1950s. This paper aims to analyze the following statement: food advertisements in the 1950s in America promoted gendered societal conditions and aspirations that still carry influential meaning in American food advertisements today.

Before diving into detail about how food advertisements reduce women, it is important to understand the evolution of food advertisements. In her book "*The Food Industry: Lifeline of America,"* Lilian E. Edds summarizes the evolution of food and beverage advertising into three categories: fragmentation, unification, and segmentation.[3] Fragmentation refers to a period before 1880 where food supplies were almost exclusively local.[4] Packaged food and beverage goods often could not survive long-term transport or storage, so most brands, no matter how large, were limited to a small regional market. Advertising, if done at all, was done through one-off painted murals in visible public spaces or through locally circulated publications like gazettes.[5] Following industrial advancements, packaged food businesses boomed. Products like canned foods were becoming mass manufactured then safely distributed across the country. Edds suggests that the ability to share the same products without regard for region defines the beginning of the unification period.[6] Figure 1 below is a Campbells soup advertisement

[1] Written under the direction of Dr. Alison Smith for HI345: *Global Food History*.
[2] Hampe, Edward C., Merle Wittenberg, and Lillian Edds. Book. In *The Food Industry: Lifeline of America*, 54. Cornell University, 1980.
[3] Edds, "In *The Food Industry: Lifeline of America,"* 12.
[4] Edds, "In *The Food Industry: Lifeline of America,"* 68.
[5] Cummings, Richard O., and Edward C. Hampe. *Agricultural History* 40, no. 3 (1966): 229–30.
[6] Cummings, Richard O., and Edward C. Hampe. "*Agricultural History* 40, no. 3," 229.

for vegetable soup published in 1920.[7] The advertisement is clearly showing the ingredients within the can of soup. The price of the soup is written on the advertisement, as well as a description of the nutritional value of the soup.


*Image 1: Campbells Soup Advertisement for Vegetable Soup, 1920.* [8]

The Campbell's soup advertisement is pretty simple, with larger drawings and minimal writing. There are lots of colors, and consumers are drawn to the product's image. However, during the 1950s, major brands such as Heinz, Pillsbury, and Campbell's Soup rode to prominence during what Edd's calls the unification period.[9] Brand iconography like the calligraphic Morton Salt's umbrella girl was born around this time. The period that will be analyzed in detail in this paper will be the period of time that Edds refers to as the segmentation period. This marked the realization that competing products had to differentiate themselves by appealing to different market segments with different values.[10] The so-called segmentation period began around 1950, with the rise of large advertisement agencies.[11]

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[7] Campbell's Soup. "Campbell's Condensed Vegetable Soup," 1920.
[8] Campbell's Soup. "Campbell's Condensed Vegetable Soup," 1920.
[9] Cummings, Richard O., and Edward C. Hampe. "*Agricultural History* 40, no. 3," 229.
[10] Edds, "In *The Food Industry: Lifeline of America,"* 89.
[11] Cummings, Richard O., and Edward C. Hampe. "*Agricultural History* 40, no. 3," 229.

The 1950s represented a significant transition period for the American food system as it moved from local food to industrialized food. As industrialization spread throughout the country, so did the desire for modernity. “The 1950s was a time of great innovation in food products. It was a decade driven by the demand for convenience, and many of the modern products we use today are food innovations of the 1950s.”[12] This concept is evident looking at food advertisements of the time. As the food industry changed, the definition and use of “food” began to change; this new understanding of “food” needed to be explained to Americans. This resulted in the creation of a civilization that placed meaning in seemingly modern food. “During the 1950s, middle-class Americans were exemplary of a civilized people who recognize canned foods as a better, more nutritious, more modern option.”[13] Preparing food became advertised as both inconvenient and time-consuming. Efficiency was seen as a modern concept, and industrialized food was efficient.

Modern, progressive food became scientifically produced. Similarly, Americans were in a period of time where they were promoting “modern” women to purchase scientifically approved and manufactured products. “Modern science had ushered in an era of homemaking where commercially canned foods could be trusted matter-of-factly.” [14] Advertisements were filled with wording and imagery to persuade consumers of modernity and progression. The advertisements did not necessarily highlight the product but the lifestyle the product could offer.

Food advertising attempted to persuade Americans that progress was possible when turning to food products. For instance, progress was applied to a pineapple by transforming it into something better. Image 2 is an advertisement made in 1953 promoting canned Dole's Pineapple.[15] "Advertising also stimulated the popular conviction that what was new was desirable."[16] By sprucing up the idea of a pineapple, consumers were amazed; they wanted to try this new fruit, although it was very similar to a simple pineapple. This canned pineapple was revolutionary and seemed to be better than regular

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[12] “Food Innovations of the 1950's: Gunther Toody's.” Gunther Toody's | An American Classic, April 12, 2014. https://gunthertoodys.com/food-innovations-1950s/.
[13] Whitfield, Kristi Renee. “Canning Foods and Selling Modernity: The Canned Food Industry and Consumer Culture, 1898-1945.” LSU Digital-commons, 2012. 121.
[14] Whitfield, Kristi Renee. “Canning Foods and Selling Modernity: The Canned Food Industry and Consumer Culture, 1898-1945.”157.
[15] Dole. “Hawaiian Sliced Pineapple,” 1953.
[16] Marchand, Roland. “Advertising the American Dream: Making Way for Modernity, 1920- 1940.” Berkeley, CA: University of California Press. (1985) 9.

fruit. The advertisement that Dole created sold a Hawaiian dream. In the example below, Dole allowed Americans to eat 'Hawaiian Pineapple' anywhere in America, how modern. There is a photograph of children playing in the ocean waves on a sunny day. This advertisement does not just sell canned pineapple; it sells the Hawaiian dream.

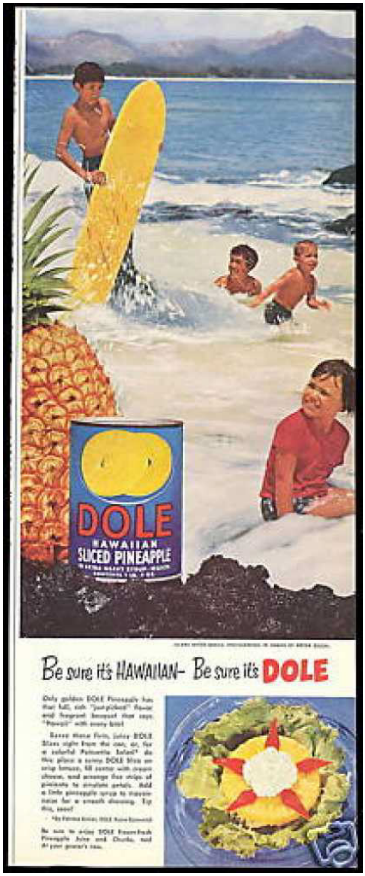


*Image 2: Dole's Advertisement for Hawaiian Sliced Pineapple,1953.*[17]

Advertisements similar to Dole's ad became more popular within the 1950s. The number of industrialized food companies rose after World War II, and consumers of

[17] Dole. "Hawaiian Sliced Pineapple," 1953.

advertisements were bombarded with different types of products constantly.[18] One of the main targets of most of the food advertisements was women.[19]

In an article titled, "A Postmodern Feminist Analysis of Food Advertisements from Women's Magazines during the 1950s, 1960s," Alysha Bergeson discusses that "Food advertisements do not simply sell food; they sell ideas, beliefs, and definitions about women and gender." [20] What Bergeson is trying to explain is that food advertisements were selling a product and attempting to sell Americans a specific lifestyle. Mainly the lifestyle in which the stay-at-home mother cooks and cleans all day, and their product helps her. During the 1950s and 1960s, food advertisements were heavily targeted at women. They attempted to manipulate women and American society into believing that women could not cook, should not cook, and that it would never be perfect if they did cook. Advertisements targeted women by attempting to degrade their abilities to please their husbands, nourish their families, and maintain good health.

> "Advertisements also attacked a woman's ability to create good, wholesome food for their families in the rushed, modern society they lived in. Advertisements reduced a woman's worth to whether the peas came out just as juicy as the canned version, her marital status and ability to keep her husband happy, and whether she had embraced her fate of motherhood yet." [21]

Bergeson says it excellently, women could do nothing perfectly. Food advertisements were trying to promote their product as helpful when they were trying to quash women's true abilities. As previously stated, food advertisements during the 1950s promoted a lifestyle to many Americans. "Many scholarly articles that focus on food advertisements analyze their effects on children- how children are impacted by how food industries

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[18] Story, Mary, and Simone French. "Food Advertising and Marketing Directed at Children and Adolescents in the US." The international journal of behavioral nutrition and physical activity. BioMed Central, February 10, 2004. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC416565/.

[19] Story, Mary, and Simone French. "Food Advertising and Marketing Directed at Children and Adolescents in the US." The international journal of behavioral nutrition and physical activity. BioMed Central, February 10, 2004. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC416565/.

[20] Bergeson, Alysha. "*Advertised identity: A postmodern feminist analysis of food advertisements from women's magazines during the 1950s, 1960s, and 2000s*." ScholarWorks. (1970, January 1). 1.

[21] Bergeson, Alysha. "*Advertised identity: A postmodern feminist analysis of food advertisements from women's magazines during the 1950s, 1960s, and 2000s*." 4.

attempt to create lifetime consumers out of children. By introducing brand names, slogans, and mascots to children, food companies hope to generate loyalty to and preference for their food products that will last throughout their lives."[22] Food advertisements heavily influenced children; however, these food advertisements had even more meaning to a woman.

> "Women needed a champion. Here were millions of them staying at home alone, doing a job with children, cooking, cleaning on minimal budgets- the whole depressing mess of it. They needed someone to remind them they had value. Betty Crocker became a figure of dignity who treated homemakers with respect."[23]

Laura Shapiro thoroughly analyzes the relationship between women and food during the time period of the 1950s-1960s, also writing on the influence that food advertisements had on this relationship. The particular passage above is quoted from her article titled, "And here she is...your Betty Crocker". Shapiro explains that Betty Crocker was represented to women as a hero. She was supposed to be the relatable woman that could save meals. However, the article goes into detail about how she was not the homemaker saver that she was claimed to be. Betty Crocker was created in 1921; the name and face of Betty Crocker has appeared in American grocery store aisles, pantries, and cookbooks for over 90 years.[24] "The Betty Crocker formed bonds between customers and brands at a time when convenience cuisine was at its infancy but primed to grow quickly."[25]

Betty Crocker tried to convince women that cooking was not only a task that women oversaw but a task that showed their value as a woman. A combination of fantasy and reality, Betty Crocker was an instructor of modern cuisine who offered tips, recipes, and packaged products to assist homemakers in achieving success in the kitchen. "Betty

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[22] Bergeson, Alysha. "*Advertised identity: A postmodern feminist analysis of food advertisements from women's magazines during the 1950s, 1960s, and 2000s*." 16.
[23] Shapiro, Laura. "And here she is ... your Betty Crocker!" *The American Scholar*, *73*(2), (2004). 88.
[24] Contois, Emily. "Curating the History of American Convenience Cuisine." Emily Contois, July 11, 2017. https://emilycontois.com/2012/10/04/curating-the-history-of-american-convenience-cuisine/.
[25] Contois, Emily. "Curating the History of American Convenience Cuisine." Emily Contois, July 11, 2017. https://emilycontois.com/2012/10/04/curating-the-history-of-american-convenience-cuisine/.

Crocker imparted advice in a way that values a housewife's efforts, respected her intellect, and instilled confidence."[26] This message that not only Betty Crocker but other food advertisements of this time period displayed is put into question when reviewing Katherine Parkin's work. Her book, "Food is Love"[27] details how food advertisements force women into the kitchen. They promote cooking as a female task. She questions the advertisements' messages stating that making food for a family shows motherly love.[28] Instead, Parkin's refers to cooking as unfairly forced work upon women. Food advertisements promote the concept that the purpose of a woman is to show love through cooking and buying whatever product the specific ad offers. The following advertisement below was an advertisement for Reddi-Wip in 1950 demonstrating this exact concept.[29]


*Image 3: Reddi-wip Advertisement, 1950.*[30]

[26] Contois, Emily. "Curating the History of American Convenience Cuisine." Emily Contois, July 11, 2017. https://emilycontois.com/2012/10/04/curating-the-history-of-american-convenience-cuisine/.
[27] Parkins, Katherine. "Food Is Love: Food Advertising and Gender Roles in Modern America." Pennsylvania: University of Pennsylvania Press, 2006. 54.
[28] Parkins, Katherine. "Food Is Love: Food Advertising and Gender Roles in Modern America." 33.
[29] Reddi-wip. "How To Hold a Husband," 1950.
[30] Reddi-wip. "How To Hold a Husband," 1950.

Messages such as the above, "How to Hold A Husband," were prominently displayed in food advertisements in the 1950s. Women's societal purpose was to find a husband and then keep their husband by pleasing him. Food advertisements attempted to make women feel like taking care of their husbands was not an easy task. Reddi-Wip advertises a simple solution to creating a happy husband by buying their product.

The woman in the advertisement is drawn as short, with both her hair and makeup done. She is holding a cup of Reddi-Wip while receiving a kiss from her husband. The writing under the advertisement says, "your dessert magic secret that helps to hold a husband." [31] This advertisement promotes the sexist stereotype that a woman's most essential and often only purpose was to find a man to marry. The advertisement in image 3 suggests that the man in the picture is kissing her because he enjoys the Reddi-Wip. Not only is Reddi-Wip trying to show married women that their product will make their husbands happy, but it is also showing unmarried women that they do not match what society expects of them if they are single.

During the 1950s, women were not only being told through advertisements that they needed to be married but that they needed to be the perfect mother. “Mothers in advertising from the 20s through the 80s were shown as taking pride in the way they were bringing up their children.”[32] The advertisements in the 1950s placed mothers in a world of expectations. “Mothers in advertising in the 20s and the 50s were depicted as being knowledgeable about the care they offered their children; the brand being advertised playing a supportive role.”[33] The expectations a mother should meet that were set up by advertisements are followed by a guarantee that claims that their product will help women live up to gendered societal requirements. The trendy message of being a perfect mother can be seen in the Campbell’s Soup advertisement published in 1953.[34]

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[31] Reddi-wip. “How To Hold A Husband,” 1950.

[32] Commuri, Suraj, Ahmet Ekici, and Patricia Kennedy. “>Historical Review of Advertising Targeting Mothers: Content Analysis under Sociological Imagination of Ads in 1920s, 1950s, and 1980s: ACR.” ACR North American Advances, January 1, 1970. https://www.acrwebsite.org/volumes/8572/volumes/v29/NA-29.

[33] Commuri, Suraj, Ahmet Ekici, and Patricia Kennedy. “>Historical Review of Advertising Targeting Mothers: Content Analysis under Sociological Imagination of Ads in 1920s, 1950s, and 1980s: ACR.”

[34] Campbell's Soup. “Soup for Lunch,” 1953.

The advertisement shown in image 4 by Campbells Soup in the 1950s explains that their canned soup will help a mother make her family happy. The picture shows a woman grocery shopping with presumably her young daughter. Both are smiling with a grocery cart full of Campbell's Soup. The young woman is dressed in what seems to be business casual clothing, with her hair and makeup both entirely done—a switch from Campbell's advertising in the 1920s, which primarily focused on the soup product.

Campbell's is advertising to mothers that Campbell's Soup will help feed a family and maintain the image of a perfect mother.

> "In developing consumer culture which began to grow during and after the industrial revolution, women were identified as the primary consumers of household goods and services. Homemakers have been the target of Campbell's Red & White advertising since its inception, and this focus is reflected both in the content and the placement of the advertising."[35]


*Image 4: Campbell's Soup, 1953.*[36]

[35] Smithsonian Institution. "The Campbell Soup Advertising Collection: Collection." SOVA, 2015. https://sova.si.edu/record/NMAH.AC.0367.
[36] Campbell's Soup. "Soup for Lunch," 1953.

Campbells Soup and other brands during this time period saw women as primary consumers of home products. Not only did these brands target female consumers, but they conformed to a gendered society and presented that expectation to women. They always expected women to look 'presentable.' This is relevant in the Reddi Wip and Campbell's soup advertisement and a prominent depiction of women during the 1950s. "The advertisements of the 1950s tended to direct all products associated with behavior through advertisements."[37]

During the 1950s, food advertisements sent varying messages to women. Another statement that came along with the concept of convenience foods was that women could not cook anything that would taste as good as the scientifically created food. This concept angered many women who enjoyed cooking. The advertisement below was published in 1950. It is a Pillsbury cake mix advertisement emphasizing the idea that this cake could be made quickly and taste amazing.[38] The advertisement tried to persuade bakers that this cake mix would save time and taste better than a homemade cake.


*Image 5: Pillsbury Advertisement, 1950.*[39]

[37] Kennedy, Kimi. "Women in Advertising." Omeka RSS, 2014. https://americancentury.omeka.wlu.edu/ exhibits/show/reinforcement-of-gender-roles-/advertising-in-the-1950s/leisure-advertisements.

[38] Pillsbury Cake Mixes. "Why Not You?" 1950.

[39] Pillsbury Cake Mixes. "Why Not You?" 1950.

Cakes communicate potent symbolic meaning by expressing love, requiring effort and skill, and demonstrating feminine mastery. A challenge for many homemakers to execute, cake mixes prove a prime example of early convenience food. As this advertisement shows, a woman's baking ability was also read as subtext for her ability to please her man and fulfill her feminine duties inside the kitchen and out. Women of the time struggled with advertisements like the Pillsbury advertisement (image 5) because most did not want to be removed from the kitchen. "This advertisement approach did not thrill housewives, as cake mixes effectively engineered out the culinary labor that women felt was their moral, social, and emotional responsibility."[40] There seemed to be a stigma of laziness around using a box cake mix. In fact, "Ernest Dichter posited the "egg theory"- that allowing women to add eggs to the mix would ensure that they felt they had more fully fulfilled their cooking responsibilities." [41] Some women were more than happy to just add eggs to a cake mix; in fact, women decided to profit from this new wave of commercial food by trying to change the narrative of the situation.

Poppy Cannon, the author of "The Can-Opener Cookbook,"[42] published in 1952, created an entire cookbook based on convenience foods. Instead of guilting women and making them feel lazy for using convenience foods, she encouraged them and provided recipes that would incorporate the canned food. Cannon wanted to change the narrative that using convenience food was a "...badge of shame, a hallmark of the lazy lady and the careless wife,"[43] by advertising her book to modern women. Some women loved this idea and were also in favor of using convenience foods to simplify their lives.

Following the same notion of choosing precooked food for a family, the ad below was one of several advertisements run by Bakers of America. It explained that purchased bread was the best bread, with the slogan "Eat more BREAD… your best food buy."[44]

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[40] Contois, Emily. "Curating the History of American Convenience Cuisine." Emily Contois, July 11, 2017. https://emilycontois.com/2012/10/04/curating-the-history-of-american-convenience-cuisine/.
[41] Contois, Emily. "Curating the History of American Convenience Cuisine." Emily Contois, July 11, 2017. https://emilycontois.com/2012/10/04/curating-the-history-of-american-convenience-cuisine/.
[42] Cannon, Poppy. "The Can-Openers Cookbook." New York: Thomas Y. Crowell Company,1952.
[43] Cannon, Poppy. "The Can-Openers Cookbook." New York: Thomas Y. Crowell Company,1952. I.
[44] Bakers of America. "The World's Busiest Engine Run Best on BREAD." 1966.

The advertisement (image 6) shows pictures of a small child playing, presumably playing thanks to the Bakers of American bread he was eating. The ad suggests simple ingredients and promises a healthy product. This advertisement and many others yet again tell women what to do. Bakers of America and Pillsbury tell women to buy their products and discourage them from making their own by pressuring them into believing that a mother's job is to serve their family the best possible product. "With a closer look, one can see that many cookbooks directly contradicted their own message about a woman's role. Both advertising and cookbooks in the 1950s recognized that cooking was a boring and unpleasant task that women were held up to."[45] Of the several other advertising messages women were served, this one chooses to tell women that they do not need to cook, even if it is recognized as an assigned duty.


*Image 6: Bakers of America Advertisement, 1956.*[46]

What advertisements were being targeted toward men during this time period? Image 7 is one of the few advertisements from the 1950s with a man at the front and center. Obviously, it is not a man in the kitchen. Instead, it is Harland Sanders with a tray

[45] Neuhaus, Jassamyn. "Gender and 1950s." Cook Booking, 1999. http://hdmzweb.hu.mtu.edu/cookingbooks/?page_id=871.
[46] Bakers of America. "The World's Busiest Engine Run Best on BREAD." 1966.

of fast food.[47] The below advertisement is not of a young man with large muscles and a full head of hair catching attention for his looks, but an older man in a suit selling chicken.

Kentucky Fried Chicken's message above indicates that women who do not want to cook should buy their chicken. With a male figure front and center, this advertisement can be interpreted in numerous ways. In the advertisement, the man, Harland Sanders, is dressed in a suit, looking very professional with a tray of prepared chicken. He seems happy to be saving a potential wife with the burden of cooking. The advertisement can be perceived as the notion that a solution to a woman's problems is a

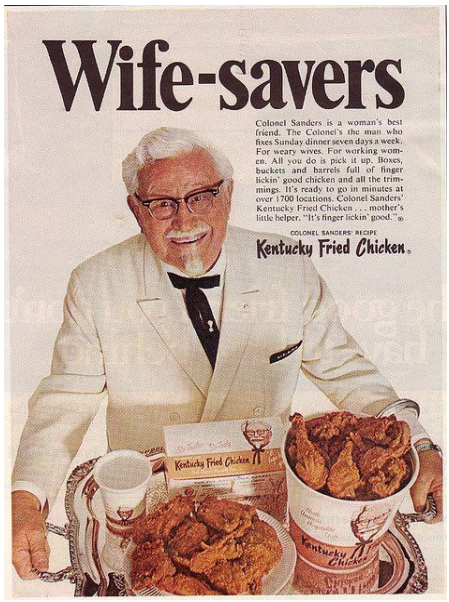


*Image 7: Kentucky Fried Chicken Advertisement, 1954.*[48]

man. Not only is this advertisement continuing to suggest that it is a woman's job to cook but implying that it is not a man's job to cook. It does not advertise a man cooking, but that a man can buy premade food. The article "Exploring Gender Roles in Vintage Advertising"[49] discusses the strict gender roles that advertisements feed to audiences.

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[47] *Kentucky Fried Chicken*. "Wife-savers." (1954).
[48] *Kentucky Fried Chicken*. "Wife-savers." (1954).
[49] Bondfield, May. "*Exploring gender roles in vintage advertising*." NFSA. (2020, August 6)

> "The other noteworthy similarity among ads was gender stereotyping. In the 1950s, gender roles were very clearly defined. The men went into the world to make a living and were either sought-after, eligible bachelors or they were the family breadwinner and head of the household. Women filled the roles of housewife, mother and homemaker, or they were single but always on the lookout for a good husband."[50] (Bondfield, 1)

Bondfield explains that men were always in charge. They were never advertised a specific product, but a particular type of woman, girlfriend, or wife was constantly advertised to male consumers.

Is earning the key to a man's heart achieved by cooking? After analyzing many food advertisements, it would seem as though this statement could be regarded as correct. Food advertisements in the 1950-1960s targeted women and attempted to tell them who they could be, should be, and who they needed to be within society. Advertisements for simple food products showed more than just the product, but a fairytale lifestyle attached to the price tag. Advertising will always manipulate gender stereotypes if it sells a product. Food advertisements still harbor American gendered societal requirements and desires and still carry a heavy, influential gendered anchor established around the 1950s.

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# The Renaissance, the Vatican, and the Music of Palestrina

Bridget Quinn (Vocal Performance)[1]

The Renaissance was a period of change, or rebirth, beginning in the 1300s and ending in the 1600s. It affected the political, economic, social, and cultural systems that existed at the time in Europe. Many saw the Middle Ages, from which they were emerging, as a period of disorder. There was a desire to return to a time of great thinking and learning that had existed in ancient Greece and Rome. This movement was especially focused on the way in which people viewed themselves and their world, with less focus on the afterlife and more focus on the here and now. There was greater emphasis on what each individual was capable of and what skills and talents one could possess. Even today, we classify someone as being a Renaissance man (or woman) if they are talented or skilled in a variety of areas.

The beginning of the Renaissance was focused in Italy and it spread north to the rest of Europe by the time it reached its peak in 1500. As this time period saw a renewed interest in ancient Rome and its culture, it is not surprising this would have been the birthplace of the Renaissance. Italy had been the center of the Roman Empire and although it had fallen in the fifth century, A.D. remnants of its heyday remained and could be seen and learned from. Examples include the Forum, the Colosseum, and the Pantheon which are still standing and provide an insight into the past. Italy's cities had fared well during the Middle Ages, maintaining many aspects of the glory of Rome. Genoa, Florence, Milan, Venice, Rome, and Naples were all thriving manufacturing and trade centers. There was a wealthy and politically powerful merchant population that held sway over their cities, with the Medicis emerging as one of the most powerful family dynasties of the time. It was these patrons' interests and money that steered the Renaissance's beginnings and financed it as it grew.

Equally important was the role of the Vatican and the Pope. Following the fall of the Roman Empire, the Church emerged, over the course of a thousand years, as a powerful and long-lasting organization that came to be in control of many aspects of daily life. As such, they dictated how the *curia* - a term originally denoting certain divisions of Romans but now representative of any Roamn citizen - thought and saw the

[1] Written under the direction of Dr. Thomas Juneau. This paper was inspired by the author's recent trip to Rome with the Wagner College Choir.

world. Throughout the Middle Ages, the goal of universities was to emphasize and reinforce classic ideas and thinking. However, as the 1300s progressed, there was a shift in thinking with the emergence of the humanist movement. This movement appeared at the time of the Renaissance and believed that education should stimulate an individual's creative powers. It moved away from religious studies and towards more worldly topics. Humanists looked to the scholarly texts of Greece and Rome and focused on the topics of grammar, rhetoric, history, and poetry. They believed that they could synthesize the knowledge of these texts with their own experiences. This shift had far reaching implications and brought about changes in all aspects of life, including art and music.

It was during this shifting of artistic forms that change came about in both the visual and musical arts. Music was an important part of life for the *curia* and the religious and artistic communities during the Renaissance, with the most important music being composed for the church. This music was polyphonic; it had two or more melody lines, with each line having equal importance to the piece. The madrigal, motet, and the mass of the Renaissance were all examples of this style of composition. The motet was the leading religious song style of the Renaissance, sung by four or five voice parts. This would have continued as the major form of religious music, but the church was faced with a threat to their power that caused them to reassess all aspects of worship.

The Reformation saw the unity of the Catholic Church tested and questioned by those that thought the Church corrupt and in need of restructure. What emerged was a different view of Christian faith, called Protestantism, led by Martin Luther. One component of the Reformation was the shift in sacred music towards simpler hymns called chorales than the complex polyphony of the Catholic Church. These were often sung in German, instead of Latin, and would be sung by the entire congregation as opposed to a select few.

The Reformation brought about a reaction on the part of the Catholic Church, called the Counter-Reformation, to affirm the beliefs and practices of the Church. Pope Marcellus II, who succeeded Pope Julius III in 1555, was a member of the Council of Trent which convened in an effort to address all the challenges the Reformation posed. The Council of Trent made a number of recommendations, including a leaning towards sombre but dignified sacred music and clearly understood and heard words.[2] They did not want as great an emphasis on secular music that was being used in the services nor did

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[2] Arkenberg, Rebecca. "Music in the Renaissance." In *Heilbrunn Timeline of Art History*. New York: The Metropolitan Museum of Art, 2000–. http://www.metmuseum.org/toah/hd/renm/hd_renm.htm (October 2002)

they want the text to be neglected. The Council put forth a statement, in Canon 8, detailing what liturgical music should be. It states that:

> "Everything should be regulated so that the Masses, whether they be celebrated with the plain voice or in song, with everything clearly and quickly executed, may reach the ears of the hearers and quietly penetrate their hearts…In those Masses where measured music and organ are micustomary, nothing profane should be intermingled, but only hymns and divine praises. If something from the divine service is sung with the organ while the service proceeds, let if first be recited in a simple, clear voice…"[3]

This led to an effort to move away from the polyphonic style that had existed in sacred music for centuries. It was felt that the text - the very conveyance of the Lord's message - was not being understood by the *curia* and, therefore, the message was lost. In an effort to bring about a change from polyphony and towards a clearer sound, Giovanni Pierluigi da Palestrina (1525 - 1594) was asked to compose music in this new style.

Palestrina, *maestro di cappella* at the Cappella Giulia at Saint Peter's in Rome, was the iconic High Renaissance composer of Counter-Reformation sacred music, which featured clear lines, a variety of textures, and a musically expressive reverence for its sacred texts.[4] He was appointed by Pope Julius III, who had previously been the bishop of Palestrina from whence Palestrina came and took his name. By 1550, he had established himself as a reliable and talented composer of liturgical music. He did not step away from the polyphony of the past but made it smoother and clearer in a more expressive way, to be more in line with the sacred texts on which it was based. He worked to maintain the pageantry and awe of the polyphonic music that the church had used for some time, thus maintaining the impact these works would have on the public. His strong grasp of how to balance clarity of lyric with lavish vocal sounds led to this being termed the "Palestrina Style" or late Renaissance polyphony. His work became the representative example of the *stile antico*, or ancient style, of music that was the standard in church music of the time.

Palestrina was a prolific and well published composer. His 104 masses, hundreds of motets, and various other religious music were disseminated all over Europe. His work shows that he thought it was important to have "a close relationship between

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[3] Cianfano, Julianna. "Music in the Counter Reformation." Blogs.shu.edu. Accessed June 7, 2022. http://blogs.shu.edu/ecww/project/music-in-the-counter-reformation/.

[4] Arkenberg, Rebecca. "Music in the Renaissance."

text and music, and a texture that is thin enough for the words to be heard."[5] He is credited with bringing independent, interlocking melody lines to his compositions, known as counterpoint. He, along with Gregorio Allegri (1582 - 1652), Paolo Bellasio (1554 - 1594), and a few other Italian composers working for the church became known as the Roman School. They garnered a reputation for bringing about a consistent style of music for liturgies, one that was strongly influenced by the Franco-Netherlandish school of music. With Rome maintaining its role as a cultural center all through the previous centuries, it is understandable that composers of this style would have passed through and, therefore, influenced the music of Roman composers. The two most influential Netherlandish composers, Guillaume Du Fay and Josquin des Prez, both spent time in Rome and it was during their time there that Palestrina was emerging as a musician on note.

Palestrina's most well-known work is his *Missa Papae Marcelli* (Pope Marcellus Mass), believed to have been composed in 1562. It is a head-motif, or cyclic, mass with a recurring melody (known as cantus firmus). This work is written as a six-voice mass, with a *Kyrie, Gloria, Credo, Sanctus/Benedictus*, and a two-part *Agnus Dei* (with the second one being designated *Agnus II* and having a seventh voice added). There are parts for soprano, alto, tenor (in two parts), baritone, and bass. The work was composed to allow the words to be understood as the voices move, for the most part, in a stepwise fashion. Palestrina used a more homophonic approach for sections with longer texts, such as the *Sanctus* and *Agnus Dei* movements. For the *Gloria* and *Credo*, with shorter texts, polyphony was used. This was in response to Pope Marcellus' desire to have the words of the works clearer to the audience. Palestrina tends to use imitative polyphony in this work, thus allowing the listener to hear the words sung by one voice before the additional sections are added in intertwining patterns.

This mass was one of only six masses Palestrina composed that was not based on any previously created motets, madrigals, or other work, although some have argued that there is some similarity to a popular medieval song entitled *L'homme armé*. The *Kyrie, Sanctus*, and *Agnus Dei* all include individual vocal lines that rise and fall on their own yet blend with other voice lines. In the *Kyrie*, for example, each voice begins with a repeated, held note followed by an upward leap and then descending steps, yet none of

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[5] Jessie Ann Owens, "Giovanni Pierluigi da Palestrina," in *Composers at Work: The Craft of Musical Composition 1450-1600* (New York: Oxford University Press, 1997), https://ezproxy.wagner.edu:2991/eds/ebookviewer/ebook?sid=5ea293db-a530-4329-ba1d- f02896d187ba%40redis&ppid=pp_291&vid=0&format=EB.

the six parts rhythmically or thematically copies any other part. With the *Benedictus*, there is a shift; only sopranos, altos, and tenors perform this section, so it comes off as more delicate than the other sections, creating a bridge to the next section. In recognition of what Pope Marcellus wanted - music that is easier to understand - the *Gloria* and *Credo* each possess techniques Palestrina often used, making sections of voices counterpoint each other. The use of harmony and rhythm in this work foreshadowed the music of the Baroque period, with a movement away from modal harmonies to tonal harmonies. It was well received by the Church and was sung at the Papal Coronation Masses for hundreds of years, with the last being the 1963 coronation of Pope Paul VI; the cessation of its performance coincides with Vatican II and its efforts to bring the Catholic Church into the 20th century by moving away from works in Latin.

Although much of Palestrina's musical career centered around Liturgical Mass composition, he did compose other types of works as well, most especially motets and madrigals. One of these motets, *Alma Redemptoris Mater*, was sung by Wagner's Choir on our recent Italy tour. This motet is traditionally sung at Advent and Christmastime as it tells of the Blessed Mother, Mary. It has a peaceful, hushed feeling to it, which is appropriate to the time of the liturgical calendar. It is a cappella and the structure of the piece is based on the Gregorian chant form, with the tenors (or basses) singing the opening word ("Alma") and the choir answering back ("Redemptoris Mater"). There is a small use of melisma for the sopranos and altos on the word "Mater", drawing the listener's attention. Palestrina uses a bit of word painting at points in this work; an example is heard on the words "succurre cadenti" (help the fallen ones), where there is a decent of notes while the following word "surgere" (rise) has the parts jumping up in note, in some cases as much as an octave. This shows how Palestrina linked his music to the words, with movements and combinations created to emphasize the key moments in the story. To sum up Palestrina's style and intentions, we can turn to his own words, found in the preface to his 1567 *Second Book of Masses*: "I have considered it my task, in accordance with the views of most serious and most religious-minded men, to bend all my knowledge, effort, and industry towards that which is the holiest and most divine of all things in the Christian religion – that is, to adorn the holy sacrifice of the Mass in a new manner."[6]

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[6] Bertoglio, Chiara. 2017. *Reforming Music: Music and the Religious Reformations of the Sixteenth Century*. Berlin: De Gruyter. https://ezproxy.wagner.edu:2462/login.aspx?direct=true&db=nlebk&AN=1477516&site=eds-live, 429.

The Renaissance brought about changes in the way people saw themselves and looked at the world around them. This shift in thinking affected all aspects of life, not the least of which was the music that was being composed. Combined with this shift in thinking about the arts was a re-evaluation of the tenets of Catholicism, leading to the Reformation and Counter- Reformation which in turn led to a change in Liturgical music. As a result of this time of re-assessment, Renaissance church music possessed three new elements: polyphonic, rather than simply monodic style; more tonal music; and a simplicity of polyphony which allowed the text, once again, to be discernable by the congregation.

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