QuaesitUM

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QuaesitUM is an annual publication
that provides an academic forum where University of
Memphis undergraduate students can showcase
research from all disciplines.

Editorial Board

To Our Readers

When we began *Quaesitum* ("The Q") five years ago, our vision was to represent the ways that students across disciplines at the University of Memphis exemplify quality research. We sought papers that provided new and innovative approaches to scholarship – new perspectives, new experimental designs, new tested results. As we noted then, the name of the journal, *Quaesitum* (v. to seek or to ask), captures the essence of scholarship – the drive for exploration and the inquisitiveness that fuels academic work. As Zora Neal Hurston put it, "Research is formalized curiosity. It is poking and prying with a purpose."

In this, our fifth volume, we have compiled a collection of papers that represents the high caliber of work that our students produce. Personally, the journey of the past five years has been very fulfilling, as I have witnessed our students growing from being solely 'consumers' of knowledge, to contributors and producers who engage in the scholarly 'conversation' that helps us better understand the world around us. This conversation stretches across disciplines as diverse as Biology, Women's Studies, Linguistics, Biomedical Engineering, Hospitality & Resort Management, Economics, and Civil Engineering, and speaks to an interdisciplinarity that can only make our efforts stronger. As the journal continues to grow, it is our hope to expand the disciplines represented here to showcase the breadth and depth of exceptional scholarship produced by our students across all areas of study.

The past five years would not have been possible without the invaluable contributions of many, many people. First, I would like to offer my sincerest thanks to the Director of the Helen Hardin Honors College, Dr. Melinda Jones and the Technical Editor, Mr. Scott Dutt. Their contributions and hard work have been, and will continue to be, vital to The Q's

success. The three of us would also like to express our appreciation to the Provost, Dr. Karen Weddle-West for continuing the administrative support that makes *Quaesitum* possible.

Mr. Gary Golightly continues to inspire with innovative and energetic cover designs that spark the imagination, and we are grateful for his ongoing support for this project. Dr. Jasbir Dhaliwal once again has provided the financial support that allows us to offer 'best paper' awards – a much appreciated way for us to reward excellence in our authors.

We could not produce this journal without submissions, and we would therefore like to express our appreciation to the faculty sponsors who have invested in their students' work and prepared them to be published authors. The quality of the submissions speaks to their commitment to both our undergraduates and the larger mission of the University to encourage our students to be Dreamers, Thinkers, and Doers.

We are also extremely grateful to our faculty reviewers, who help us maintain the academic rigor that allows us to highlight our students' best work: Dr. Carmen Astorne-Figari, Dr. Shelby Crosby, Dr. Eugene Eckstein, Dr. Donghee Kim, Dr. Joseph Lariscy, Dr. Martin Lipinski, Dr. Keith Martin, Ms. Kendra Murphy, Dr. Jamie Sabel, Mrs. Brannen Varner, and Dr. John Williams.

The students themselves naturally also deserve great praise. Their hard work in both their research projects and in the publication process has, we hope, prepared them to continue their enthusiasm for exploration, whether that occurs in further graduate study or employment 'in the field.' It is our hope that these authors will inspire others to contribute to future issues, and for their commitment, we offer our congratulations and thanks.

Dr. Sage Lambert Graham
Editor-in-Chief

Table of Contents

Engineering Sciences

Life and Health Sciences

Social and Behavioral Sciences

Professional

Publication & Review Process

Kevin N. Patel graduated from the University of Memphis in May of 2018 with a major in Biomedical Engineering and minors in Chemistry and Biology. He graduated *summa cum laude* with Biomedical Engineering Departmental Honors and University Honors with Thesis, and served as Student Marshal for the Herff College of Engineering during commencement. Throughout his time at the University of Memphis, he has been involved in multiple Biomaterials research projects under Dr. Joel Bumgardner and has presented his work at multiple conferences, including the 2018 Society for Biomaterials Conference in Atlanta, Georgia. He will attend medical school at the University of Tennessee Health Science Center beginning fall 2018. He hopes to apply the skills he has gained through experimental research and the Biomedical Engineering curriculum as a practicing physician.

Kevin's paper received a *Quaesitum* outstanding paper award.

Kevin Patel
Evaluation of Two Different Neutralization Methods for Chitosan Coatings

Faculty Sponsor
Dr. Joel Bumgardner

Abstract

Chitosan has been investigated as a coating for musculoskeletal implants due to its osteoconductive and local drug delivery properties. Since chitosan is dissolved in dilute organic acid, the residual acid components must be removed post-coating, which is typically done using alkali and/or ethanol treatments. Neutralization affects coating surface chemistry, adhesion, swelling, and other properties. The aim of this study was to compare the effects of NaOH neutralization versus phosphate buffer neutralization on solution cast coatings on commercially pure titanium. Properties evaluated were contact angle, swelling/drug release, coating adhesion, cell attachment, and cell proliferation. Results show that phosphate buffer-neutralization produces coatings with properties that are more favorable for implant device applications.

Introduction

Chitosan, a versatile biopolymer derived from chitin, has been investigated as a coating for musculoskeletal and dental implants due to its osteoconductive and local drug or growth factor delivery capabilities [1, 2]. To produce chitosan coatings, chitosan is typically dissolved in dilute organic acid, which protonates the amino groups of the molecules. Following substrate coating, the residual acid components must be removed to prevent harmful acidic salts from leaching out [3].

Neutralization of the residual acidic components is typically completed with alkali and/or ethanol treatments. Many different methods of neutralization have been used in the literature; however, the neutralization method can affect coating properties such as surface chemistry, adhesion, swelling, and many others [4-6]. Coating properties that are favorable for musculoskeletal and dental implant devices include good coating adhesion strength to be able to withstand the implantation process and mechanical forces when in use. The coating must also be able to show good cell attachment and growth to promote osseointegration of the implant device. In addition, since chitosan coatings are extensively investigated for delivery of local therapeutic agents, the coatings must also be able to swell and absorb these agents and passively release them over an extended period of time [7-9].

It was previously shown that the adhesion strength of chitosan coatings can be approximately tripled when bonded to cp titanium via silane reactions [10]. This involves bonding chitosan molecules to cp titanium via silane molecules. Consequently, the method used to neutralize the coating must not be detrimental to these silane bonds.

In this study, the most common neutralization method, NaOH, was compared to neutralization using a potassium phosphate buffer, which is a less common method for neutralizing chitosan coatings [7]. Properties evaluated included contact angle, swelling, protein release, coating adhesion, cell attachment, and cell growth. The Saos-2 osteosarcoma cell line (obtained from American Type Culture Collection, Manassas, VA) was used in this investigation, as this is a well characterized human cell line that presents similar proliferation and mineralization to osteoblastic cells [11]. Due to the lack of reliance on extreme pH for neutralization, it was hypothesized that phosphate buffer neutralization would result in coating properties that were more favorable for implant device applications.

4

Methods and Materials

Coating Preparation

Commercially pure (cp) titanium coupons (ASTM F67) were wet sanded and polished with silicon carbide paper up to 1200 grit followed by ultrasonic cleaning in acetone, ethanol, and deionized water for 10 minutes each. Samples were passivated in 30% nitric acid for 30 minutes. Chitosan (95% deacetylated, Heppe Medical, Halle, Germany, molecular weight 300 – 700 kDa) at 2 wt% in 1% acetic acid was bonded to cp titanium samples via silanation reactions. In summary, samples hydrated in deionized water for 24 hours were placed in 95:5 vol% ethanol/water solution acidified with 10 M acetic acid to pH 4.5. Triethoxysilylbutyraldehyde (Gelest, Morrisville, PA) was added such that the final concentration of the silane was 2%. The pH was maintained between 4.5 and 5.5 for 10 minutes with 10 M acetic acid or 1 M NaOH. Samples were washed with ethanol and cured at 110°C for 10 minutes, followed by solution casting with the chitosan solution at 0.5 mL/cm2. Samples were allowed to air dry at room temperature for 6 to 7 days [10]. Dry samples were neutralized in either 0.5 M NaOH or 0.25 M potassium phosphate buffer, pH 7, by submersion for 30 minutes followed by rinsing twice with deionized water.

Evaluation of Physical Properties

Water contact angles were determined using a VCA Optima (AST Products, Inc., Billerica, MA). These measurements were used to evaluate the hydrophilicity of samples (n=6, approximately 1 cm × 1 cm × 0.1 cm).

Swelling studies were performed by measuring the mass of samples (n=6, approximately 1 cm × 1 cm × 0.1 cm) that had been previously desiccated for 24 hours. Samples were submerged in phosphate buffered saline (PBS) for 24 hours. The mass of samples after submersion were determined after gently tapping off excess PBS. Swelling ratios were determined by calculating the ratio of change in mass to dry mass.

Coating adhesion tensile strengths were determined by a method that was previously described in the literature [10]. Three aluminum pins (9.5 mm diameter) were adhered to coated samples (n=5, approximately 2 cm × 5 cm × 0.1 cm) with Loctite 454 gel adhesive. A 5 kg uniform load was applied immediately after bonding surfaces and left for 24 hours at room temperature to ensure an even layer of adhesive. An Instron 4465 (Houston, TX) was used to pull pins at a rate of 10 mm/min. The setup is

shown in Figure 1. Pins glued to bare cp titanium samples were also tested to determine the strength of the adhesive.
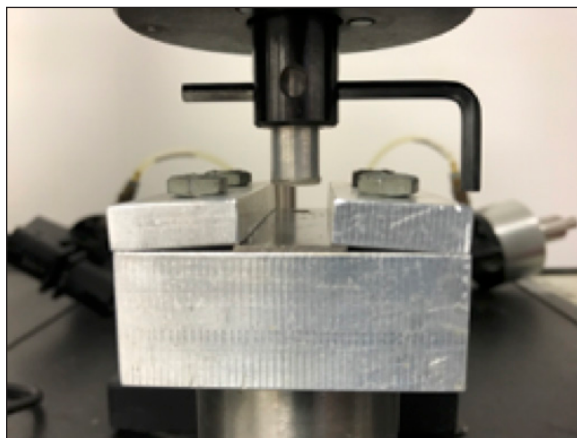

Figure 1. Setup used to measure tensile adhesion strength of coatings

Protein Elution

Samples (n=3, approximately 1 cm × 1 cm × 0.1 cm) were passively loaded with 100 µg chymotrypsin in a buffer solution of 5 mM glutamic acid, 5 mM NaCl, 2.5% glycine, 0.5% sucrose, and 0.01% Tween 80 at pH 4.5. This was done by pipetting the loading solution onto coatings and allowing the solution to swell completely into the coating at 4°C. Chymotrypsin was used since it is an analogue of bone morphogenetic protein-2 (BMP-2), which is a growth factor that has seen many clinical uses in orthopedic and dental applications [12, 13]. Samples were eluted in 1 mL PBS in a 37°C incubator for 6 days. Eluates were collected every 24 hours and replaced with fresh PBS. Protein concentrations of the eluates were determined using the Coomassie Plus protein assay (Thermo Fisher Scientific, Waltham, MA).

Cell Attachment and Proliferation

Cell attachment to coatings was evaluated by seeding circular samples (n=6, approximately 1.56 cm diameter × 0.1 cm) placed at the bottom of a 24-well cell culture plate. Fifty-thousand Saos-2 cells were seeded and after 4 hours, the number of cells remaining in the cell culture medium was determined with the use of a Scepter cell counter (Merck Millipore, Darmstadt, Germany). The number of cells remaining in the medium was

subtracted from the original number of cells seeded to determine the number of cells attached to the coatings. Bare cp titanium samples were used as control. Samples were also fluorescently stained with Alexa Fluor 488 dye (Thermo Fisher Scientific, Waltham, MA) and NucBlue stain (Thermo Fisher Scientific, Waltham, MA) for visualization.

Cell proliferation was evaluated by seeding 10,000 Saos-2 cells on samples (n=4, approximately 1.56 cm diameter × 0.1 cm) at the bottom of a 24 well cell culture plate. Cell number was quantified at days 1, 3, 5, 7, and 9 with the CellTiter-Glo Luminescent Cell Viability Assay (Promega, Fitchburg, WI). All plates were seeded at day 0 and standards curves were produced at days 1, 3, 5, 7, and 9.

Statistical Analyses

Analysis of variance (ANOVA) with Tukey post-hoc tests were used for statistical analysis of contact angle, coating adhesion, protein elution, cell attachment, and cell proliferation data. T-test was used for swelling data. A p-value less than 0.05 was considered significant for all analyses.

Results

Physical Properties

Contact angle, swelling, and coating adhesion data are shown in Table 1. Contact angle data show that coatings neutralized in NaOH were significantly more hydrophilic than bare cp titanium (p=0.029), but no significant difference was determined between the phosphate buffer-neutralized coatings and the other two groups. Swelling ratios showed that coatings neutralized in a phosphate buffer swelled to a greater degree than coatings neutralized in NaOH, and this difference was statistically significant (p=0.0009). Tensile adhesion strength values suggest that phosphate buffer-neutralized coatings were also characterized by a significantly greater adhesion strength than coatings neutralized in NaOH (p=4.3x10-11). Since the adhesion strength of the adhesive on bare cp titanium was significantly greater than the measured strengths of both coatings, it can be assumed that the adhesive did not dissolve through the coatings and adhere to the underlying cp titanium.

Substrate	Contact Angle, n=6 (Degrees)	Swelling Ratio, n=6 (%)	Adhesion Strength, n=5 (MPa)
NaOH neutralized chitosan	75.6 ± 4.4^a	1.2 ± 0.2^a	1.6 ± 0.1^a
Phosphate buffer neutralized chitosan	84.7 ± 14.4^{ab}	1.8 ± 0.1^b	1.8 ± 0.1^b
cp titanium	91.7 ± 7.4^b	N/A	2.5 ± 0.1^c

Table 1. Summary of contact angle, swelling, and adhesion strength data (Superscripts indicate statistical significance, data in each column with similar letter superscripts are statistically similar)

Protein Elution

Figure 2 shows the in vitro release profile from samples passively loaded with 100 µg chymotrypsin. Both coatings resulted in burst protein release; however, coatings neutralized in a phosphate buffer were able to extend protein release until approximately day 6 as compared to the NaOH neutralized coatings which only extended release until day 3. Statistical significance was determined at each time interval. Statistically significant differences in chymotrypsin release between the two coatings were determined for days 2 to 4, during which the amount of chymotrypsin release from the phosphate buffer-neutralized coatings was greater than the NaOH-neutralized coatings ($p < 0.5$). Bare cp titanium samples released almost all loaded protein in the first day as expected.
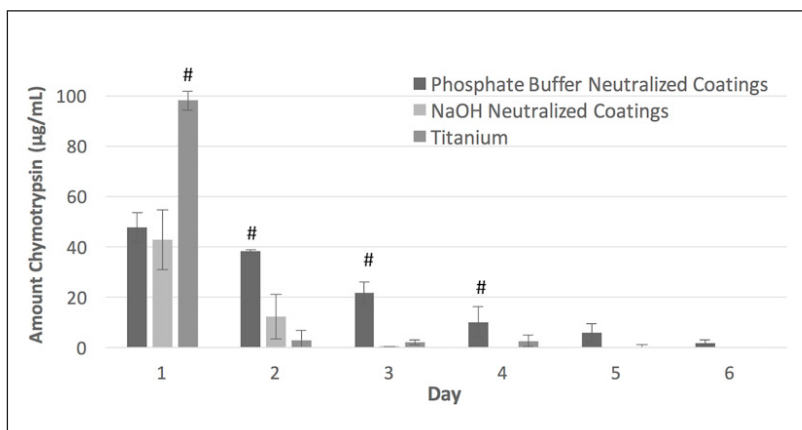

Figure 2. Chymotrypsin elution from samples (# denotes a statistically significant difference from all other groups at that time point), n=3

Cell Attachment and Proliferation

Table 2 shows the number of attached cells 4 hours after seeding samples with 50,000 Saos-2 cells. The data shows that only the number of cells attached to the NaOH-neutralized samples was statistically different (p=0.025). Figure 3 shows the attached cells stained with fluorescent dye. Cells exhibited good spreading for all groups.

Substrate	# Cells Attached
NaOH neutralized coatings	$37,000 \pm 3,180$
Phosphate buffer neutralized coatings	$41,800 \pm 3,130$
cp titanium	$43,500 \pm 3,690$

Table 2. Summary of Saos-2 cell attachment data, n=6

| NaOH neutralized coating | Phosphate buffer neutralized coating | cp titanium |
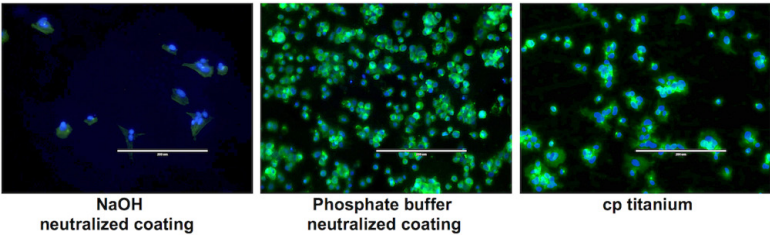
Figure 3. Cell attachment on coatings and cp titanium, 4X magnification

Figure 4 shows the growth of Saos-2 cells on samples. In general, both coatings exhibited similar cell growth during the 9-day period, and both coatings generally showed lower cell count than the cp titanium and cell culture plate controls. No statistically significant difference was determined between the cell count on coatings neutralized in a phosphate buffer and NaOH with the exception of days 1 and 9. Coatings neutralized in a phosphate buffer contained fewer cells than NaOH neutralized coatings at days 1 and 9.
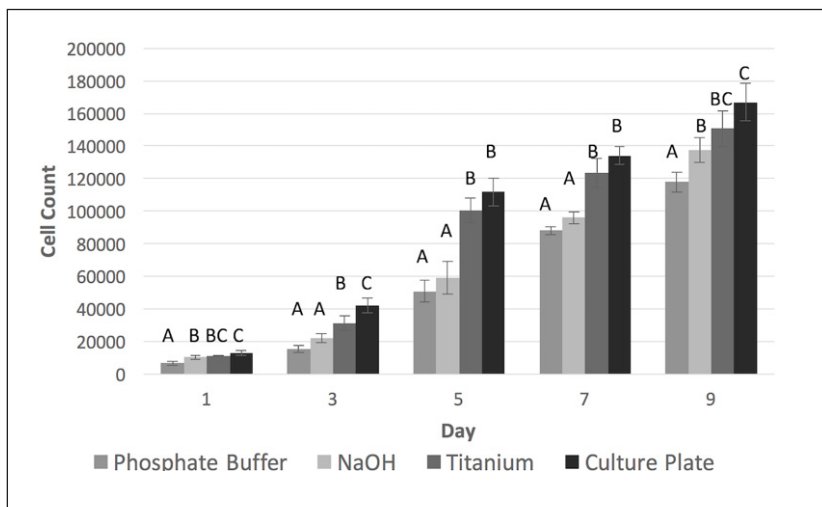
Figure 4. Saos-2 cell growth on samples (letters above data denote statistical significance), n=4

Discussion

The aim of this study was to compare chitosan coatings neutralized in NaOH or a phosphate buffer for use with musculoskeletal or dental implants. Coatings were produced with silane bonding reactions to obtain greater adhesion strength. The coatings produced in this study appeared a slightly yellow-amber color, which is associated with the formation of imine bonds between the silane and chitosan molecules [10].

Physical properties of the resulting coating are of great importance as these will predict the performance of the coating when used with an implant. The important functions required of a musculoskeletal or dental implant coating include good adhesion strength and osteoconductivity. Chitosan coatings have also been extensively investigated as a means for local drug or growth factor delivery, thus these coatings must also exhibit good swelling and elution profile of therapeutic agents.

There was initial hesitancy due to the adhesive used to adhere aluminum pins to coatings possibly dissolving the coating and adhering to the underlying cp titanium instead. However, since the bond strength of the pins glued to bare cp titanium was greater than that of the pins glued to coatings, it can be assumed that the glue did not dissolve through the

coatings. The tensile adhesion strength of the phosphate buffer-neutralized coating was greater than that of the NaOH-neutralized coating by approximately 0.2 MPa. Both of the strength values were similar to the previously reported value [10]. However, as also reported previously, these values are lower than the 6.7 – 26 MPa bond strengths reported for common plasma sprayed hydroxyapatite coating [14]. Thus, further work is needed to increase the overall bond strength of the coating. However, these results suggest that phosphate buffer neutralization produces coatings with greater bond strength. The greater bond strength is speculated to result from the reliance on less extreme pH for neutralization. As explained in the literature, high pH results in bond breaking of the silane-titanium bond [15]. Thus, the NaOH may have disrupted these silane bonds resulting in lower coating adhesion strength.

Water contact angle data are important to predict cell adhesion as more hydrophilic surfaces are better able to support protein adherence, which is the means by which cells adhere to implant surfaces. The data shows that the NaOH neutralized coatings were more hydrophilic than both phosphate buffer neutralized coatings. This suggests that cell adhesion on NaOH-neutralized coatings should be best. However, cell adhesion data contradicts this, which shows that the phosphate buffer-neutralized coatings exhibited more attached cells. This can be rationalized by the fact that NaOH neutralization deprotonates the chitosan amine, while phosphate buffer neutralization is speculated to not cause this to the same extent. Thus, the greater positive charge of the more protonated chitosan coating is able to support greater protein and cell adhesion.

The swelling ratio of phosphate buffer-neutralized coatings was also shown to be greater, which suggested that it would be better for local therapeutic agent delivery by passive loading. This was shown to be the case when samples were passively loaded with chymotrypsin to model the release of BMP-2. The phosphate buffer-neutralized coatings were able to extend the release by at least 3 additional days compared to that of the NaOH neutralized coatings. Again, this can be rationalized by the speculation that phosphate buffer neutralization causes less deprotonation of chitosan amines leading to a greater overall attraction of protein molecules due to molecular charge differences. However, the elution data shows a loss of approximately half the loaded protein in the NaOH group. This may have occurred due to NaOH remaining in the coating following

neutralization and causing pH-dependent protein breakdown. Many osteogenic growth factors require a longer release profile, since osseointegration occurs over a longer time period [16]. The initial burst release shown by these two coatings may reduce the amount of growth factor available at later times to promote osseointegration. However, there is work in the literature pertaining to extending local therapeutic agent delivery by coupling chitosan with other substances [17]. In these cases, the use of phosphate buffer-neutralization may help to extend the release profiles of these agents.

Preliminary bone cell growth data shows that there was little difference between the growth of these cells on coatings treated by the two neutralization methods. Only days 1 and 9 showed a statistically significant difference in which the phosphate buffer-neutralized coatings contained slightly fewer cells. Thus, both neutralization methods maintain the osteoconductivity of the chitosan. Further work must be completed to investigate cell growth over a longer time span, cell differentiation, mineralization, and in vivo implant success need to be completed to supplement these initial cell growth data.

Conclusion

Chitosan coatings have been extensively investigated to take advantage of their osteoconductive and local therapeutic agent delivery properties. Following the coating process, neutralization of acidic components must be completed before in vivo use. The method used to neutralize coatings affects the properties of the resulting coating. The aim of this study was to compare the effects of NaOH-neutralization versus phosphate buffer-neutralization on solution cast coatings on cp titanium. Contact angle, adhesion strength, swelling, protein elution, cell attachment, and cell proliferation data suggest that phosphate buffer-neutralization produces coatings that exhibit better properties for use in musculoskeletal and/or dental implant device applications.

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Tyler Rist completed his Bachelor of Science degree in Biomedical Engineering with minors in Biology and Chemistry. He graduated *summa cum laude* with University Honors with Thesis. Tyler received the Cecil C. Humphreys Presidential Scholarship and the Helen Hardin Honors Non-Resident Honors Student Award. He was also an Emerging Leader Scholar and played on the University of Memphis Men's Soccer Team for 4 years. Tyler is currently a medical student at the University of Tennessee Health Science Center in Memphis and will be pursing a residency position in Otolaryngology after graduating from medical school in May 2019.

This article originated from an Honors thesis project completed by a team of University of Memphis undergraduate students in the departments of Biomedical Engineering (Tyler Rist) and Mechanical Engineering (Cody Bateman, Joel Berreta, John Flores, Jeremy Galloway, and Micah Kassner). Tyler Rist served as the liaison between the project team and the client. He also authored the article presented here with the mentorship of Dr. Joel Bumgardner.

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Lift Walker: Developing an Inexpensive and Lightweight Stand-Assist Device

Faculty Sponsor
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Abstract

The growing senior population (2014 United States Census, 2014) and the documented importance of mobility and transferring in the United States (Desai, Lentzner, & Weeks, 2000) highlight the need for assistive technologies. Specifically, there is a need for inexpensive powered stand-assist technology that can be easily used in a home environment. This project explored the feasibility of developing inexpensive and lightweight powered stand-assist technology by building a device for an elderly man of the Memphis community. The device was less expensive than most commercially available powered devices and weighed approximately 80 pounds (36.3 kg). The device was able to lift the client, but the size and operation of the device made it difficult to use and maneuver in home. Follow-up analysis suggests that with reduction in size/dimensions of the device and improved instructional training for proper use, a less expensive household stand-assist device is possible.

Introduction

Activities of daily living (ADLs) are the "basic tasks of everyday life" (Wiener, Hanley, Clark, & Nostrand, 1990). One of the six main ADLs is transferring, which is defined as moving "in and out of bed independently" and "in and out of chair independently (may or may not be using mechanical supports)" (Katz, Ford, Moskowitz, Jackson, & Jaffe, 1963). Among older adults (70 years of age or older), it was estimated that almost 2.5 million have difficulty transferring (Desai, Lentzner, & Weeks, 2000). This transferring ability and the overall mobility of an individual is often studied in the elderly population due to its close association with a loss of independence (Parker & Thorslund, 2007), increased cost of care (Wiener et al., 1990), increased falls and injuries (Baumgartner, Garry, Romero, Vellas, & Wayne, 1997), and a decline in overall health (Wiener et al., 1990).

An example of a condition that often leads to a loss of mobility and difficulty in performing other ADLs is peripheral neuropathy. According to the National Institutes of Health, approximately 20 million people in the United States of America have peripheral neuropathy. Peripheral neuropathy is caused by damage to the peripheral nervous system. The condition has over 100 different varieties and a wide array of symptoms that include motor nerve damage with associated muscle weakness especially in arms and legs, sensory nerve damage that interferes with the ability to touch or feel pain, and autonomic nerve damage that can disrupt involuntary bodily functions such as sweating or bladder control. The peripheral nervous system can often be damaged by a sudden or prolonged trauma, endocrine conditions such as diabetes, autoimmune diseases such as lupus or rheumatoid arthritis, cancers, benign neurological tumors, certain infections like AIDS or Lyme disease, and toxins from chemicals or alcohol. In many cases, the onset of the condition cannot be determined (Peripheral Neuropathy Fact Sheet, 2015). This loss of sensation and accompanying problems like muscle weakness, especially in lower extremities, can lead to difficultly with transferring and mobility activities such as walking, balancing, and standing up.

Many older adults with such mobility impairments employ assistive devices to aid in daily activities and retain independence. In 2000, it was reported that over 6.8 million people in America used some kind of mobility assistive device (i.e., wheelchair, walker, cane, etc.) and older

adults make up the vast majority of consumers who utilize these assistive devices (Kaye, Kang, & LaPlante, 2000). Furthermore, the elderly population (ages 65+) in the United States will more than double between the years 2015 and 2060 according to 2014 US Census data (2014 United States Census). These data clearly show the growing need for assistive technology to compensate for the rapid aging of the United States' population.

A specific type of assistive device that targets mobility impairments and transferring issues is known as a stand-assist device. This type of device aids a person to move from a sitting or supine position to an upright, standing position and vice versa. These devices help people overcome the large biomechanical stresses on the lower extremities required to move from a sitting to standing position. Individuals who cannot easily make this transition are mobility-impaired because they are often stranded in a sitting position. Currently, there are stand-assist devices on the market. The lift-like devices that are intended for clinical settings are generally too large and heavy-duty for use in a home environment and also can be a serious financial burden to many families. The market price of many of the other powered stand-assist devices that can be independently used without assistance generally cost from $2,500 to upwards of $20,000 US dollars (e.g. Lumex ® Easy Lift Sit-to-Stand Device model LF2020 (market price at $2,660.00 US dollars); the Easy Walking Inc. Adult Up n' Go® device model 100-10-000M (market price at $2,650.00 US dollars); the Joerns-Hoyer ® Ascend Stand Assist Lift (market price at $6,460.10 US dollars); and the more intensive Tek Robotic Mobilization Device ® (market price at $18,000 US dollars). Stand-assist devices that are less expensive than $2,500 often do not provide the power or automation required in many situations.

This study was initiated when an 81-year old man from the Memphis community approached the Biomedical Engineering department at the University of Memphis for help with his mobility and transferring issues. He reported having peripheral neuropathy and intermittent episodes of sensory loss and weakness that would leave his lower extremities unusable. The onset of his condition was unknown. His wife did not have the physical ability to help him, so he was often stranded in his chair or bed. He expressed a desire for a stand-assist device that easily fit in his house while being relatively inexpensive. His concern with the current

technology on the market is that devices are "prohibitively expensive and overly-heavy duty." His primary desire was for a device to help him stand, but also that could be used as a walker around the house. He lived in a one-story house with level floors.

The goal of this project was to design and construct a lightweight and inexpensive stand-assist device for the client who weighted 250 pounds (113.4 kg) and was 70 inches (177.8 cm) tall to use in his home. The following criteria were established to guide the subsequent design and manufacturing process:

The device will:

> • Safely lift a 250-pound (113.4 kg) client from a sitting to standing position.
>
> • Be used independently without any assistance.
>
> • Weigh less than 100 pounds (45.4 kg).
>
> • Cost less than the market price of many of the comparable commercial offerings.
>
> • Be mobile so that it can be used as both a lifting mechanism and a pseudo-walker.

Materials and Methods

Design considerations were based on input from the client, his family, a physical therapist, and review of several different currently available stand-assist devices. The design involved a mechanism for lifting the client from the buttocks and lower back region. This design took into account that the client still had ample upper body strength without any complaints of weakness and avoided issues associated with lifting from the underarm region, which may damage vital neurovascular tissues required for upper extremity functions. The design also included a linear actuator-pulley system to lift or lower the client. The actuator-pulley system was designed to be operated by the user with a simple switch. The frame was designed to be made out of aluminum to provide a lightweight and sturdy structure and to mimic a walker with wheels so that it could be easily maneuvered around the client's house.

The size of the device was determined by measurements made in the client's house along with force and moment calculations that were performed to ensure the safety of the client. Tipping was one of the main

safety concerns with this device. Using the given weight of the client and results from anthropometry studies to obtain average sizes of different body parts, free-body diagrams were developed to determine the optimal height and length of the device to lower the risk of tipping. Finding the optimal dimensions for the device was a process that took into consideration several different characteristics that had to be balanced. If the device was too tall, the moment exerted on the vertical supports became too large. If the device was too short, the lifting mechanism would be pulling the client in a horizontal direction and not lifting in the desired vertical direction. The optimum value for the vertical support columns was determined to be 48.0 inches (121.9 cm) tall. Again, the process of finding the size of the horizontal supports was also a balancing act. If the lower horizontal supports were too long, it would interfere with the mobility of the device. If the lower horizontal supports were too short, the risk for tipping increased. The optimum value for the lower horizontal supports was determined to be 34.7 inches (88.1 cm). This value was increased to 36.0 inches (91.4 cm) for simplicity's sake. Calculations were then performed based on the force assumptions and the optimal size of the device to determine how thick the aluminum bars needed to be to withstand the calculated forces and movements. The best size for the vertical column support bars was determined to be 1.5 inches (3.8 cm) wide and 0.5 inches (1.3 cm) thick. The best size for the lower horizontal supports was determined to be 1.0 inches (2.5 cm) wide and 1.0 inches (2.5 cm) thick.

A local sheet metal worker from Standard Sheet Metal Works, LLC (Memphis, TN) performed much of the aluminum welding for the main structure. The machine shop in the engineering department of the University of Memphis helped perform much of the smaller metal tooling. The initial meeting with the client occurred in December 2013, and the device was completed and delivered in May 2014. Final cost of parts and labor before tax and shipping and handling was $2,054.46 US dollars.

A survey was given to the client in October 2014 to evaluate the usability of the device and client satisfaction. The survey consisted of 16 different questions. The survey was retrieved after 4 months of use by the client. The questions included:

• How often do you use the device?

• Can you successfully use the device independently or do you require assistance?

• Are you able to roll the device around and use it similar to a walker?

• In what situations is the device most helpful? Least helpful?

• Does the device accommodate you in all areas of your house? (i.e. bathroom, bedroom, living room, kitchen, etc.)

• When using the device, do you feel safe and secure? If not, what parts of the device make you feel unsafe?

• Are the frame of the device and the attached parts durable? Does any part of the device feel like it may be breaking?

• When operating the device, do you use every part? (i.e. kneepad, foot steps, handles, harness, lift button, ect.)

• Does the size and shape of the device comfortably accommodate your body? If not, what parts of the device seem to be interfering or causing problems?

• In your personal opinion, what changes would you make to the device to make it most helpful to you?

Results

The constructed and assembled device is shown in Figure 1. The main frame was assembled out of solid bars of aluminum T-6 6061 alloy, and hollow tubes of aluminum T-6 6061 alloy were used to make the extended handlebars (Figure 1C-vii). The overall dimensions of the frame were 53 inches tall, 22 inches wide, and 42 inches long, (134.6 cm tall, 55.9 cm wide, and 106.7 cm long) and the whole device weighed approximately 80 pounds (36.3 kg). These dimensions were specifically crafted based on measurements of his house and safety calculations.

Two 400-pound (1,779.3 Newtons) rated linear actuators (Figure 1B-v) were attached to the either side of the bottom front of the aluminum frame. Both of the actuators were powered by one 12-volt rechargeable battery (Figure 1B-vi) that was mounted at the bottom front of the aluminum frame between the two actuators. Each actuator was attached to coated industrial grade steel wire (Figure 1A-iii) that ran up through the top of the aluminum frame and around a pulley system (Figure 1B-iv). The wires then attached to either side of a lumbar lifting harness with metal quick release clips (Figure 1A-iii). This system made up the lifting mechanism of the device.

A bidirectional switch (Figure 1C-viii) was installed into the right handle bar to control the actuators and lifting mechanism. The bidirection-

al ability of the switch allowed the device to be used to both lift the client from a sitting to a standing position and lower the client in the opposite direction. The actuators only move when the switch is activated, so the movement can be stopped at any time during the lifting or lowering process.
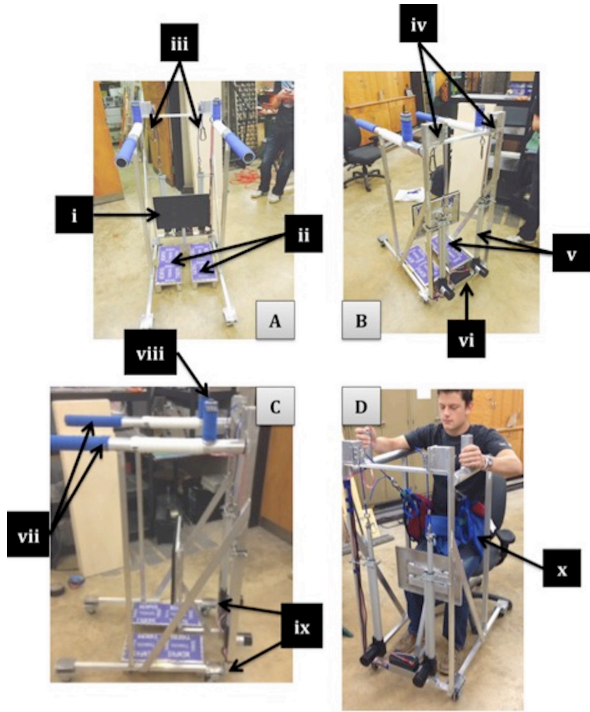
Figure 1. 1A, 1B, 1C, and 1D give an overview of the final design of the lift-walker. 1A, 1B, and 1C highlight different parts of the device without an individual using the device, where 1D shows an example of how the individual is intended to fit in the device. i – Aluminum knee-pad with foam padding on surface; ii – Two steel footpads with grip tape on top; iii – Two easy release clips attached to industrial strength steel wire; iv – Two steel pulleys at top of device. Wire in iii for the lifting mechanism runs over the top of these; v – Two 400-pound (1,779.3 Newton) rated linear actuators (Firgelli Automations™); vi – 12-volt battery (Firgelli Automations™); vii – Hollow aluminum tubing extended handlebars; viii – Bidirectional switch (Firgelli Automations™); xi – Two front wheels with locking mechanisms (Albion Industries™); x – Lumbar Harness (Chattanooga Group™).

A wheel was attached to each bottom corner of the aluminum frame. The two front wheels (Figure 1C-ix) had locking mechanisms that were used to increase stability. The use of the long handlebars (Figure 1C-vii) at the top of the device along with the wheels gave the device the ability to move around on hard surfaces easily and be used as a pseudo-walker.

The harness (Figure 1D-x, and Figure 2) lifting mechanism had the ability to lift the user about 18 inches (45.7 cm) higher than a full sitting position. At that point, the user would be able to use the remaining amount of his leg strength combined with his upper body strength to lift into a full standing position. The aluminum tube handlebars (Figure 1C-vii) were designed to be long so the client could use them to lift up on and also to provide extra stability when trying to transfer from the device to a common walker. The shape of the whole aluminum frame was designed so that it could fit around places in the home where the client would commonly be sitting like a recliner or toilet.

The device was designed so that it could be easily operated without any assistance. Figure 2 gives an overview of the operational movement of the stand-assist device. The instructions for operation of the device were:

1. Pull the device around the structure you are sitting on.
2. Unhook the lumbar harness and secure it around your lower back and gluteus muscles.
3. Attach the two quick-release clips to the lumbar harness.
4. Place your feet and knees against the footpads and kneepads respectively.
5. Once secure, push the switch in the up direction and let the actuators pull the harness upward until it stops.
6. Grip the handlebars and use your upper body strength to fully stand up.
7. Once standing, the device can be used as a walker itself, or a support system to transfer to a typical walker.
8. To sit down, lower back down into a sitting position by reversing these steps.

The user survey was retrieved from the client after 4 months of use. A follow-up visit with the client and examination of responses from the survey revealed that the client had attempted to use the device only

two to three times at most. The survey and follow-up visit revealed that the client had many issues with the design and operation of the device. The major criticisms included:

- The device was considered too big and bulky.
- The harness slid up the client's back when attempting to lift.
- The device did not fit into certain rooms.
- The turning radius prevented turning the device in a hallway.
- Certain pieces such as the footpads and kneepad were not useful.
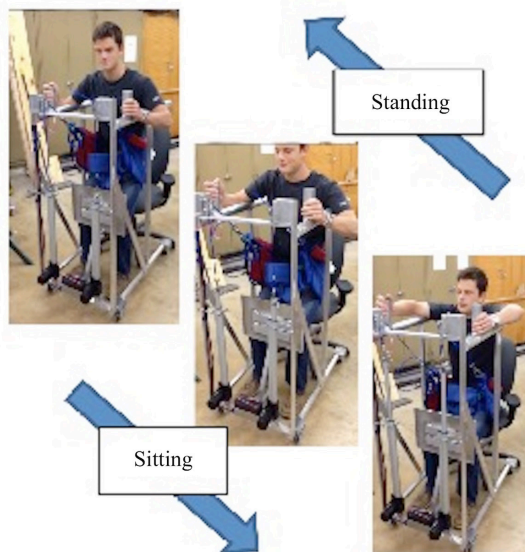
Figure 2. Series of photographs demonstrating how device lifts individual from a seated position to standing and back to siting. The picture on the right shows the individual seated in a chair with the harness secured around the lower back and gluteus region. The picture on the far left shows the position of the user when the device is fully extended in the lifting direction. In all the pictures, it can be seen how the user is using the bidirectional switch with his right hand.

During the follow-up visit, it was discovered that the client had disassembled part of the device. He had used some of the pieces from the device to build an example of some of the changes that he wanted to make. Despite the clear medical consequences that had been explained to him,

the client was still fixated on making a device that would lift him from under the arms.

Discussion

In this project, a powered stand-assist device was custom designed, constructed and evaluated to lift a 250-pound (113.4 kg) client safely from a seated position and vice versa. The device was constructed to also double as a walker with the use of the extended handlebars and four wheels. At only approximately 80-pounds (36.3 kg), the final device was within the 100-pound (45.4 kg) goal that was set. It was considered lightweight because it could be easily controlled and maneuvered by one individual. The dimensions of the device were designed to fit within certain areas of the client's house. The total cost of the device without taxes and shipping was $2054.46 US dollars. The device was less expensive than the market price of most powered devices and more expensive than most general non-powered devices. The device was given as a gift to the client, so no financial burden was put on the client or his family. Results from the user survey, though, yielded several issues for why the device was not well-used by the client.

First, the client complained that the harness did not stay in one spot and slid up the back during lifting operation. This was due to improper placement and use of the harness by the client. The improper placement of the harness was attributed to limited coaching and instruction by the design team when the constructed device was delivered. The device was delivered and demonstrated to the client in one short visit. Unfortunately, observations of the client using the harness were not made and thus any difficulties the client may have had in using the device were not identified. Further, there was no follow-up from the design team, family members or health professionals after delivery. With extended instruction and coaching time by the team members and engagement of family and health professionals, this problem may have been addressed. Additionally, because of the weakness in legs of the client due to his medical condition, correct positioning of the harness may have resulted in an additional challenge in proper use of the harness. This issue will need to be addressed in future re-design and use assessments since this was not assessed in this project.

Next, the client expressed dissatisfaction with the size of the device which limited access and use in some areas in the home. While the device

was designed to operate in spaces initially identified by client, the results of the survey and information provided by client indicated that the client wanted the device to be able to be used more widely in the home. Not having a clear understanding of the client's medical condition, prognosis and how functional needs would vary led to the design being too focused on limited performance criteria. A physical therapist was consulted on the design, but the therapist was not specifically involved in the client's care and living environment. Involving a medical professional who had more direct knowledge of the client's medical condition, prognosis, and living environment would likely be useful in enhancing the design to better meet and anticipate the client's current and future needs, as well as teaching him how to successfully utilize the assistive technology to improve, or maintain his overall functional mobility in his home.

Third, the client did not attempt to use the device more than a few times since it did not perform as he had expected or imagined. Unfortunately, the client did not contact the design team with his issues. Instead, the client attempted to modify the device himself and to have the device lift him from his underarms. The reasons he tried to modify the device this way was due to an incorrect assumption that this would be a better way to lift an individual, that the harness could be more easily adapted to fit and would be easier to put on and take off. The design team explained to him again the dangers of lifting from the arms, and why lifting from the buttocks and lower back region was better. The client did not seem to want to accept this explanation. It is not clear if this was due to some issue with the client's understanding, or unwillingness to listen to the student design team. Again, involvement of a clinician directly involved in client's care may have improved client's willingness to understand that lifting from the underarms was not appropriate.

This device was a first generation design and constructed in a relatively short period of time. There was some degree of over-engineering done on this device to ensure the safety of the device. Areas of improvement that were identified after construction and use of the device by the client include:

- Lowering the extended handlebars six or more inches to better accommodate the arms when sitting.
- Streamlining the frame of the device by:
    - Using smaller gauge and hollow aluminum bars and tubes.

- Making the wheel fittings less bulky so the device could better fit around and under certain chairs.
- Reducing the dimensions, particularly the height and length to reduce overall size and bulk of the device and improve maneuverability.

- Evaluating the size and placement of the harness. A larger harness that covered more area of the back may provide more upper back support making the client easier to lift. This increased support and coverage could possibly reduce the chance that the harness would slip to the wrong area.
- Evaluating how the client would actually put on and take off the harness to ensure ease of use.
- Changing the switch location so that it can be better accessed from any of the many different situations in which the device is designed to be used.
- Involving clinicians with knowledge of client's condition, prognosis and living arrangements to help anticipate how device will be used, and in providing instruction and training on how to use the device.

The device was retrieved from client for re-design and construction. However, follow-up with client's family indicated that the client was no longer in a position to use the device.

Conclusion

A new stand-assist device was designed and constructed for use in a home environment. The device had the capability of lifting a 250-pound (113.4 kg) man from a sitting position without the assistance of other individuals. The final cost of this device was less than the market cost of many comparable powered devices on the market. The device was also lightweight and mobile enough to be easily handled and controlled by one individual. However, the device did not function well for client in his home environment. The main short-comings were the overall dimensions and weight of the device made it too bulky to easily move throughout the home, inability to properly use and wear the harness for correct operation, and lack of-proper instruction and follow-up on device operation. This device should be re-designed to be more lightweight and to have smaller dimensions by using hollow aluminum bars, tubes, and reducing the height of the handle-bars. The harness for lifting the client should also be re-designed for an improved fit, and to make it easier for the client to put on. Additionally,

good instruction, coaching, and follow-up on proper use of device needs to be undertaken. Involvement of a physical or occupational therapist in client evaluation, education, and training with the device would also likely improve future outcomes.

Acknowledgements

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Figure Legends

Figure 1: 1A, 1B, 1C, and 1D give an overview of the final design of the lift-walker. 1A, 1B, and 1C highlight different parts of the device without an individual using the device, where 1D shows an example of how the individual is intended to fit in the device. Each part labeled with a roman numeral is described in detail in the results section of the paper: i - Aluminum kneepad with foam padding on surface; ii – Two steel footpads with grip tape on top; iii – Two easy release clips attached to industrial strength steel wire; iv – Two steel pulleys at top of device. Wire in iii for the lifting mechanism runs over the top of these.; v – Two 400-pound (1,779.3 Newton) rated linear actuators (Firgelli Automations™); vi – 12-volt battery (Firgelli Automations™); vii – Hollow aluminum tubing extended handlebars; viii – Bidirectional switch (Firgelli Automations™); ix – Two front wheels with locking mechanisms (Albion Industries™); x – Lumbar Harness (Chattanooga Group™)

Figure 3: Series of photographs demonstrating how device lifts individual from a seated position to standing and back to siting. The picture on the right shows the individual seated in a chair with the harness secured around the lower back and gluteus region. The picture on the far left shows the position of the user when the device is fully extended in the lifting direction. In all the pictures, it can be seen how the user is using the bidirectional switch with his right hand.

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Andrew Robinson

Job Growth in Freight Operations: The Role of Technology

Faculty Sponsor
Dr. Stephanie Ivey

Abstract

This report reviews the potential change in freight transportation jobs due to technology advances within the United States. Research was conducted by examining multiple scholarly and newspaper articles discussing changes in technology within the freight transportation industry. Through an analysis of Bureau of Labor Statistics Employment Projections, along with the research conducted, a qualitative projection of job growth due to technology was developed.

Introduction

Freight transportation is central to the United States economy. It is important that freight be reliably moved from one point to another. This would not be possible without the men and women in charge of transporting these commodities. For decades, these men and women have worked day and night to ensure that freight is delivered on time. With recent changes in technology, the way freight is shipped has been transformed. With ever-changing technology on the horizon, the future of freight operation jobs is uncertain. Past trends in job growth cannot accurately predict future growth with the possibility of the entire landscape of the industry changing, particularly with the potential disruption due to autonomous and connected vehicles and infrastructure. Instead, employment projections must be analyzed along with predicted changes in the industry to develop an estimate of future growth.

By analyzing employment projections created by the Bureau of Labor Statistics, and breaking these down regionally, a better understanding of employment trends, as well as the impact technology will have on specific regions within the United States, can be obtained. To regionally analyze the data, the United States must first be broken into regions. For this research project, the regional delineations of the National Network for the Transportation Workforce (NNTW) are used. The NNTW breaks the states, the District of Columbia, and Puerto Rico into five regions: Midwest, Northeast, Southeast, Southwest, and West (National Network for the Transportation Workforce 2018) (See Table 1).

By using employment data from the Bureau of Labor Statistics for each state, regional values for freight operations jobs were calculated. From these values, regional projections were made using the same percent change predicted by the Bureau of Labor Statistics employment projections. Although the future regional job growth cannot be expected to be the same across the five regions, applying the percent change predicted by the employment projections allow insight into the effect job growth will have on each region. By breaking the data down regionally, it is possible to see the areas of the country that would be impacted the most by jobs changing with technology.

Midwest	Northeast	Southeast	Southwest	West
Illinois	Conneticut	Alabama	Arizona	Alaska
Indiana	Delaware	Arkansas	California	Hawaii
Iowa	Dist. of Columbia	Florida	Colorado	Idaho
Kansas	Maine	Georgia	Nevada	Montana
Michigan	Maryland	Kentucky	New Mexico	Nebraska
Minnesota	Massachusetts	Louisiana	Oklahoma	N. Dakota
Missouri	New Hampshire	Mississippi	Texas	Oregon
Ohio	New Jearsey	N. Carolina	Utah	S. Dakota
Wisconson	New York	Puerto Rico		Washington
	Pennsylvania	S. Carolina		Wyoming
	Rhode Island	Tennessee		
	Vermont	Virginia		
		W. Virginia		

Table 1. NNTW Regions

Trucking Industry Workforce

The U.S. Department of Transportation predicts a 44% increase in the tonnage of freight shipped by truck by the year 2045 (Bureau of Transportation Statistics 2016). It is reasonable to think that the employment of truck drivers would proportionately increase as well. However, the Bureau of Labor Statistics only predicted a 6.1% increase in the Heavy and Tractor-Trailer Truck Driver employment category through the year 2026 (Bureau of Labor Statistics 2016). Comparing the predicted change in tonnage of freight carried by trucks by 2045 to the employment projections through 2026 reveals an interesting fact. Even if the predicted tonnage increase is

not linear per year, the employment projection appears low, and a significant gap may occur. This is consistent with what many in the transportation industry already know: there is a major driver shortage within the trucking industry. The American Trucking Association (ATA) suggests that the industry is short approximately 48,000 drivers (2017). Several causes have been proposed for this job shortage, but the fact remains that the current trucking workforce is aging and retiring (Mulero 2017a). In order for trucking to continue to be a competitive freight transportation option, the industry must evolve to adapt to the increasing driver shortage.

Before the potential changes in technology can be discussed, the Bureau of Labor Statistics data must first be analyzed regionally to determine where the greatest changes should be expected. The employment projections are shown in Table 2.

# of Employees in 2016 (Thousands)	Projected # of Employees in 2026 (Thousands)	Change in # of Employees (Thousands)	Percent Change
1,871.7	1,985.5	113.8	6.1%

Table 2. Heavy and Tractor-Trailer Truck Driver Employment Projection 2016-2026

Source: BLS Employment Projections
https://data.bls.gov/projections/occupationProj

The category of Heavy and Tractor-Trailer Truck Drivers encompasses the following job titles (Bureau of Labor Statistics 2016):
- Auto Carrier Driver
- Cement Truck Driver
- Concrete Mixer Driver
- Concrete Mixer Truck Driver
- Fuel Truck Driver
- Garbage Truck Driver
- Line Haul Driver
- Logging Truck Driver
- Moving Van Driver

- Over-the-Road Driver

- Semi-Truck Driver

- Tanker Driver

- Tow Truck Operator

Because of the broadness of the categories the Bureau of Labor Statistics places truck drivers in, not all of these jobs would potentially be affected by technology, at least not yet. For jobs such as garbage truck drivers, concrete mixer drivers, and tow truck operators, the threat of technology replacing workers is not immediately looming over the horizon. Instead, the threat is more applicable to long-haul truck driver jobs, though as newer technology becomes a reality, smaller 'across-town' truck driver jobs may eventually be affected. By using specific occupational data from each state and using the percent change in Table 2, regional values for the change in truck driver jobs were calculated. These values are shown in Table 3.

Occupation	Region	# of Employees in 2016 (Thousands)	Projected # of Employees in 2026 (Thousands)	Change in # of Employees (Thousands)
Heavy and Tractor-Trailer Truck Drivers	Midwest	426.5	452.5	26.0
	Northeast	266.8	283.1	16.3
	Southeast	469.5	498.1	28.6
	Southwest	419.3	444.9	25.6
	West	130.6	138.6	8.0

Table 3. Regional Values for Predicted Change in Truck Driver Employment

Source: BLS State Employment Statistics
https://www.bls.gov/oes/current/oessrcst.htm

By graphically analyzing the predicted change in employment from 2016-2026, it becomes possible to see which regions will be affected the most by potential technology changes. From the graph in Figure 1, it is apparent that the largest increase in employment will be seen within the Southwest and the Southeast. From the graph, it appears that the West will see the lowest number of drivers added to the workforce. However, this is due to the fact that there are fewer people employed in freight operations jobs in the West. Since the magnitude of change is directly proportional to

the number of people already employed in the region, it is safe to say that if truck driver jobs change with technology, the Southeast and Southwest regions will be the most dramatically impacted.

Distribution of Change in Heavy and Tractor-Trailer Truck Drivers Jobs Among Regions
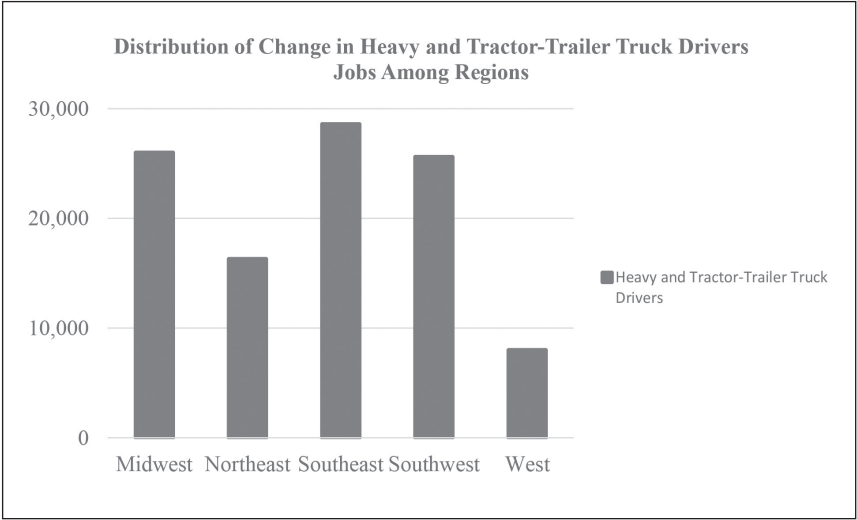
Figure 1. Distribution of Change in Heavy and Tractor-Trailer Truck Driver Jobs Among Regions

With the recent advances in technology, the trucking industry has been experimenting with autonomous (self-driving) trucks (Mulero 2017b). One particular example that is currently being examined is truck platooning, a caravan of several trucks that are autonomously connected to a pilot truck (Sanctis 2017). As of now, every truck includes a driver. However, if this technology is implemented, the next step could be to remove the drivers from the trucks. However, this next step would require a major shift in the public's perception of safety, which is the biggest issue with removing drivers altogether from trucks (Sanctis 2017). Instead, it is predicted that the role of a truck driver will change into a technical role like that of an airline pilot (Sanctis 2017). Future drivers would need to be trained as technicians who could operate and maintain the new technology (Keen 2017). These technicians may also need to perform repairs to the trucks. Thus it is safe to assume that the need for truck drivers will not decrease due to technology in the short term, but rather the required skill-sets for driving candidates will shift to reflect the changing environment.

Autonomous technology may help fill a void that already exists due to an aging workforce and lack of replacements. In fact, it is speculated that the new technology may attract younger people who enjoy today's modern technology (Mulero 2017c). With this knowledge, the projected 6.1% increase in truck driver jobs over the next 9 years may be reasonable, but the job definition of a truck driver will morph into a more of technical role within the cab.

All the speculation regarding the effects of technology on truck driver jobs is dependent on the legality of operating autonomous vehicles among the states. As of 2014, the legality of autonomous vehicle operations was largely up to interpretation since most state laws were not written with these types of vehicles in mind, leaving loopholes in which "autonomous vehicles are probably legal" (Smith 2014). However, the primary legal barriers to automated truck technology, specifically truck platooning, are following-too-close (FTC) laws (Kramer 2017). Many states have laws which set a minimum following distance that must be observed between vehicles, which is often larger than the maximum distance required for a truck platoon to be effective. These laws are in place to allow trailing drivers enough reaction time in the event the vehicles ahead have a sudden issue. However, with truck platooning, all trucks are connected to the same system, allowing each trailing vehicle to stop roughly at the same time as the lead vehicle. Removing operational control from the drivers from the trailing trucks removes the need for extra reaction time. For this reason, many states have been amending their FTC laws to allow a provision for truck platooning, some even encouraging pilot programs for testing on public roads. As of 2017, the following states (outlined in Table 3) have addressed the legality of truck platooning:

State	Provisions Made for Truck Platooning
Arkansas	Platoon testing allowed[a]
California	Platoon testing allowed[b]
Florida	Platoon testing allowed. Pilot program in place[c]
Georgia	Platoons exempt from FTC laws[a]
Michigan	Platooning allowed[d]
Missouri	Pilot testing program vetoed by State Governor[e]

Nevada	Truck Platooning allowed on highways[a]
North Carolina	Exempts platoons from FTC laws as long as approved by state DOT[f]
Oregon	Platoon testing permitted on public roads[g]
South Carolina	Exempts platoons from FTC laws[f]
Tennessee	Platoon testing allowed[h]
Texas	Redefined 'braking system' to allow provision for truck platoons[a]
Utah	Platoon testing allowed. Pilot program in place[c]

Table 4. States Which Have Addressed Truck Platooning

Sources: [a]National Conference of State Legislatures 2018, [b]California Department of Transportation 2017, [c]Kramer 2017, [e]Elfin 2016, [f]Goble 2017, [g]White 2017, [h]Tennessee Department of Transportation 2017

From Table 4, it can be seen that, with the exception of Missouri, states are warming up to the idea of truck platooning. In particular, states within the Southeast region show greater acceptance of truck platooning, while states in the Northeast region have yet to address the issue as of 2017. The Southwest also shows greater acceptance as compared to the West and Midwest regions. With the trend in states authorizing truck platooning, it is reasonable to assume that more states will follow suit within the next few years. Even states such as Missouri, whose Governor originally vetoed a bill allowing for pilot testing due to concerns for safety (Elfin 2016), may eventually legalize platoons as their safe operation is demonstrated.

Rail Industry Workforce

The largest competitor to the trucking industry is the railroad industry, which the Department of Transportation predicts will increase its freight tonnage by 24% by the year 2045 (Bureau of Transportation Statistics 2016). However, the Bureau of Labor Statistics predicted a drop in rail operations jobs by the year 2026. Railroad engineer, conductor, and brakemen/switchmen jobs are predicted to decrease by 2.8%, 2.1%, and 1.6% respectively. These values are shown in Table 5 (Bureau of Labor Statistics 2016).

Occupation	# of Employees in 2016 (Thousands)	Projected # of Employees in 2026 (Thousands)	Change in # of Employees (Thousands)	Percent Change
Locomotive Engineers	38.8	37.7	-1.1	-2.8%
Railroad Conductors and Yardmasters	41.8	41.0	-0.9	-2.1%
Railroad Brake, Signal, and Switch Operators	19.3	19.0	-0.3	-1.6%

Table 5. Railroad Operations Employment Projections 2016-2026

Source: BLS Employment Projections https://data.bls.gov/projections/

The categories of Locomotive Engineers, Railroad Conductors and Yard-masters, and Railroad Brake, Signal, and Switch Operators encompass the following job titles (Bureau of Labor Statistics 2016).

Locomotive Engineers

- Freight Engineer
- Railroad Engineer
- Railway Engineer
- Train Engineer

Railroad Conductors and Yardmasters

- Freight Conductor
- Passenger-Car Conductor
- Train Conductor
- Yard Conductor

Railroad Brake, Signal, and Switch Operators

- Freight Brake Operator
- Locomotive Switch Operator
- Railroad Brake Operator

- Railway Switch Operator
- Switch Coupler
- Train Brake Operator

Breaking the employment projections down regionally reveals the following data (Table 6).

Occupation	Region	# of Employees in 2016 (Thousands)	Projected # of Employees in 2026 (Thousands)	Change in # of Employees (Thousands)
Locomotive Engineers	Midwest	9.4	9.1	-0.3
	Northeast	4.4	4.3	-0.1
	Southeast	6.9	6.7	-0.2
	Southwest	5.9	5.7	-0.2
	West	1.6	1.6	-0.05
Railroad Conductors and Yardmasters	Midwest	7.1	7.0	-0.2
	Northeast	8.5	8.3	-0.2
	Southeast	7.1	7.0	-0.2
	Southwest	6.7	6.6	-0.1
	West	2.7	2.7	-0.1
Railroad Brake, Signal, and Switch Operators	Midwest	3.7	3.6	-0.1
	Northeast	2.1	2.1	-0.03
	Southeast	2.9	2.8	-0.04
	Southwest	3.6	3.6	-0.1
	West	0.9	0.9	-0.01

Table 6. Regional Values for Predicted Change in Railroad Operations Employment 2016-2026

Source: BLS State Employment Statistics
https://www.bls.gov/oes/current/oessrcst.htm

In all three of the railroad operations categories, it was found that the Bureau of Labor Statistics was missing data for numerous states. However, enough data was present to perform an analysis. By graphing the value of the change in employment in Figure 2, the regions which will be affected the most by changing employment can be seen.

From the data available, it appears that the Midwest will see the most impact with changes in locomotive engineers and railroad brake, signal, and switch operators, while the impact of any change in railroad conductors and yardmasters is roughly felt the same across the Northeast, Southeast, and Southwest. Nonetheless, railroad operations jobs are decreasing across the nation.
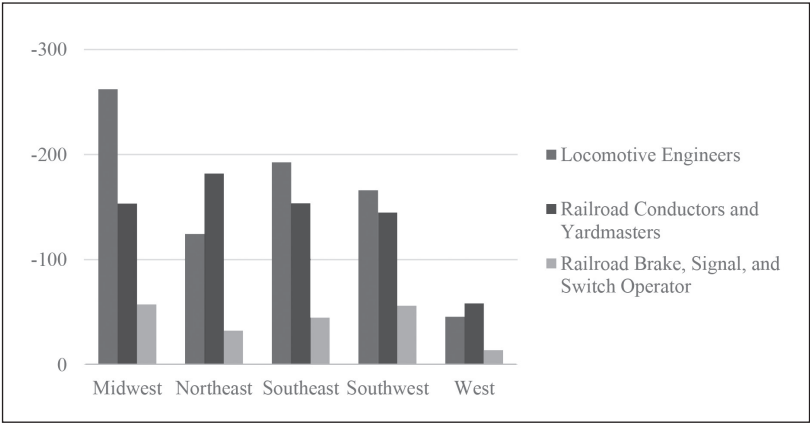

Figure 2. Distribution of Change in Railroad Operations Employment Among Regions

Could this predicted decrease in employment be due to changing technology? With the coming of Positive Train Control (PTC), the path towards automated trains is a little clearer. PTC is a new GPS technology federally mandated for all railroads which monitors the locomotive's performance and track conditions (Bizjak 2017). With PTC, the early steps of automation are there. It would not take much to fully implement automation, or at the very least reduce crews to one person. However, if history is a good prediction, a reduction of train crews will not be well-received. When railroads moved from steam to diesel locomotives, several operations jobs, such as the role of the locomotive fireman to shovel the coal and maintain the steam locomotive, were no longer needed. However, because of labor unions, a fireman was included with each road crew up until the 1980s, when the job was finally dissolved by a presidential mandate (United Press International 1985). Labor unions representing railroad conductors and engineers still have a firm hold on the industry today. It is this hold that has in part allowed the Federal Railroad Administration (FRA) to create a federal mandate which requires two-man crews on every

train (Black 2016). This mandate has created a lot of controversy and leads many in the rail industry to worry about the future competitiveness of the industry with trucks. Because of the power the labor unions hold on the industy, it is unlikely that crew sizes will be reduced due to autonomous technology, even though one person can safely operate and maintain a train today (Black 2016).

This still does not explain the projected decrease in railroad operations jobs. Instead, this can be explained by a reduction in railroad freight traffic, specifically coal traffic. With the recent push towards cleaner energy, the demand for coal has decreased, which has historically been big business for railroads. Because of a decreased demand, the amount of unit coal trains has also decreased, sidelining both engineers and conductors. In addition, even though the Bureau of Transportation Statistics predicts a rise in freight tonnage, the actual tonnage carried by rail has been decreasing over the past several years (Ashe 2017). This decrease seems to contradict the 24% increase predicted by the Department of Transportation (Bureau of Transportation Statistics 2016). However, the 24% increase is a long-term prediction which may be due to population growth and could potentially be drawn from previous long-term growth. From now until 2045, it is expected that growth will occur within the rail industry, even if it is less than other freight industries (Bureau of Transportation Statistics 2016). Because the projections created by the Bureau of Labor Statistics are through the year 2026, they reflect short-term changes, which show a decrease in rail freight tonnage. With the future demand for coal uncertain, however, along with the decreasing amount of freight carried by rail, it is reasonable to assume that the demand for railroad operations jobs will not increase over the next 9 years.

Warehouse and Distribution Center Workforce

The technology change has perhaps had the greatest impact within warehouses and distribution centers, where robotics and automation are quickly becoming the norm (Bearth 2017). With the popularity of online retailers such as Amazon, distribution centers are popping up and expanding across the country (Baddour 2017). With this boom has also come new automation technology, of which Amazon has been a big promoter (Fletcher 2017). What used to be dozens of people scanning, sorting, picking, packing, and moving materials around a warehouse, is now a series of robots automating almost every step. This automation removes the need

50

for multiple people to touch each item in scanning and sorting, thus reducing the possibility of error. While this does remove a lot of the traditional warehouse roles, most of these jobs have transformed into technical roles assisting and overseeing the automation, as well as more data analysis roles analyzing data collected by robots on the warehouse floor (Chew 2017). These machines are not designed specifically to replace humans, but rather to assist humans in the warehouse sorting process by automating processes, freeing up people to serve in other roles. In some instances, these robots are being used to assist in transporting materials across the warehouse floor as well as picking out the correct materials (Smith 2017).

With a large need for distribution centers and the push for automation, it is difficult to predict how technology will affect job growth. With the need for more warehouses comes the need for more employees to oversee and operate them. However, if these centers become automated, it would not only reduce the number of workers needed to operate such a facility, but also dramatically shift the skillsets required to do so. Thus there seems to be a trade-off with the increase of centers and automation. It is predicted that eventually automation will be implemented in almost every major transportation distribution center, reducing the number of warehouse employees needed to operate such a facility. However, because of the expanse of online retailers such as Amazon, there is an increased need for more distribution centers. Thus it can be predicted that employment in this market will remain fairly steady, with new jobs in new facilities created to replace those taken by automation. The Bureau of Labor Statistics shows a similar prediction, with an 8.5% increase in warehouse supervisors and a 6.7% increase in transportation and distribution managers. However, the Bureau also predicted a 5% increase in stock clerk and order-filler jobs (Bureau of Labor Statistics 2016), which seems high considering the evolving changes in distribution technology. These values are displayed in Table 7.

Occupation	# of Employees in 2016 (Thousands)	Projected # of Employees in 2026 (Thousands)	Change in # of Employees (Thousands)	Percent Change
First-Line Supervisors of Helpers, Laborers, and Material Movers, Hand	184.4	200.1	15.7	8.5%
Transportation, Storage, and Distribution Managers	115.5	123.3	7.7	6.7%
Stock Clerks and Order Fillers	2,008.6	2,109.9	101.3	5.0%

Table 7. Warehouse Operations Employment Projections 2016-2026

Source: BLS Employment Projections https://data.bls.gov/projections/occupation-Proj

The categories of First-Line Supervisors of Helpers, Laborers, and Material Movers, Hand; Transportation, Storage, and Distribution Managers; and Stock Clerks and Order Fillers encompass the following job titles (Bureau of Labor Statistics 2016):

First-Line Supervisors of Helpers, Laborers, and Material Movers, Hand

- Material Handling Crew Supervisor
- Warehouse Supervisor

Transportation, Storage, and Distribution Managers

- Airport Manager
- Cold Storage Supervisor
- Distribution Center Manager
- Logistics Manager
- Logistics Supply Officer

- Marine Oil Terminal Superintendent

- Traffic Safety Administrator

- Transportation Manager

- Warehouse Manager

- Warehouse Operations Manager

Stock Clerks and Order Fillers

- Grocery Stocker

- Inventory Control Clerk

- Inventory Taker

- Night Stocker

- Retail Stocker

- Stockroom Attendant

- Stockroom Clerk

- Store Stocker

- Supply Clerk

- Supply Room Clerk

- Tool Crib Attendant

- Warehouse Clerk

- Warehouse Stocker

Because the categories of Transportation, Storage, and Distribution Managers and Stock Clerks and Order Fillers include a broad range of job titles, not every position covered falls under the category of warehouse worker. However, because it is not possible to separate the data specifically to warehouse job titles, every job title within these categories must be included in the analysis (even though they potentially skew the data as it pertains to freight operations). For instance, because Stock Clerks and Order Fillers is such a large category containing jobs such as Grocery Stocker and Retail Stocker, the employment projection cannot be accurately used to portray changes specific to warehouse workers. This may explain why the predicted 5% increase seemed high. However, because most of the jobs within these categories are similar, potential shifts in technology could bring changes to the whole category. Even though the numbers may be skewed, the data still provides insight into potential changes due to technology.

Breaking the national projection into regional values yields the numbers shown in Table 8.

Occupation	Region	# of Employees in 2016 (Thousands)	Projected # of Employees in 2026 (Thousands)	Change in # of Employees (Thousands)
First-Line Supervisors of Helpers, Laborers, and Material Movers, Hand	Midwest	38.4	41.7	3.3
	Northeast	36.2	39.3	3.1
	Southeast	52.1	56.6	4.4
	Southwest	46.6	50.5	4.0
	West	11.1	12.0	0.9
Transportation, Storage, and Distribution Managers	Midwest	27.8	29.6	1.9
	Northeast	18.8	20.0	1.3
	Southeast	25.4	27.1	1.7
	Southwest	33.7	35.9	2.2
	West	8.4	9.0	0.6
Stock Clerks and Order Fillers	Midwest	429.7	451.3	21.7
	Northeast	422.8	444.1	21.3
	Southeast	528.9	555.5	26.7
	Southwest	542.7	570.1	27.4
	West	109.2	114.7	5.5

Table 8. Regional Values for Predicted Change in Warehouse Operations Employment 2016-2026

Source: BLS State Employment Statistics https://www.bls.gov/oes/current/oessrcst.htm

Graphing the change in warehouse operations jobs yields the following two graphs, shown in Figures 3 and 4.
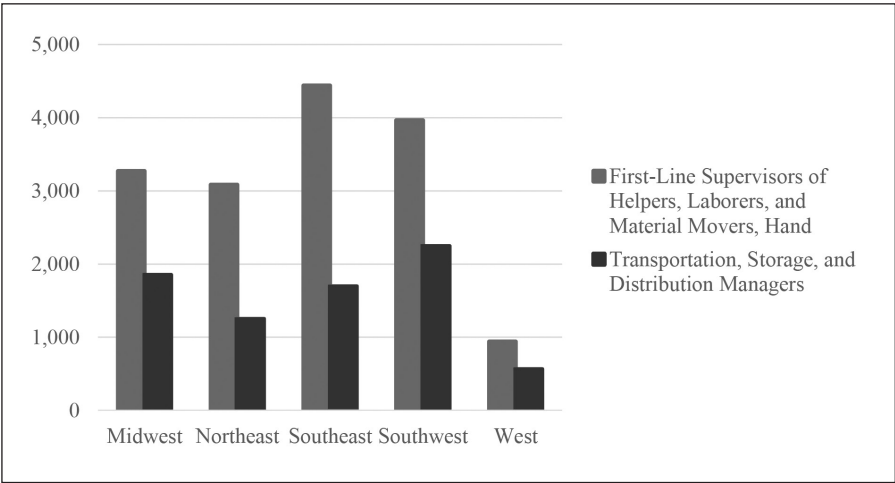
Figure 3. Distribution of Change in Warehouse Operations Employ-ment Among Regions

From Figure 3, it can be seen that changes in supervisor employment will affect the Southeast and Southwest the most, while managerial roles will be most affected in the Southwest region. Due to the large scale of the Stock Clerks and Order Fillers category, this group was graphed separate-ly (Figure 4). As the graph shows, the change is more evenly distributed among all the regions except for the West, with the most impact in the Southeast and Southwest.

Figure 4. Distribution of Change in Stock Clerks and Order Fillers Employment Among Regions

Conclusion

It is difficult to predict the future, but through an analysis of trends and research on upcoming changes, insight can be gained. Through research of the upcoming technological changes, it can be predicted that the freight transportation industry will undergo a major change within the next few decades. With the advent of new autonomous technology, the trucking industry is rapidly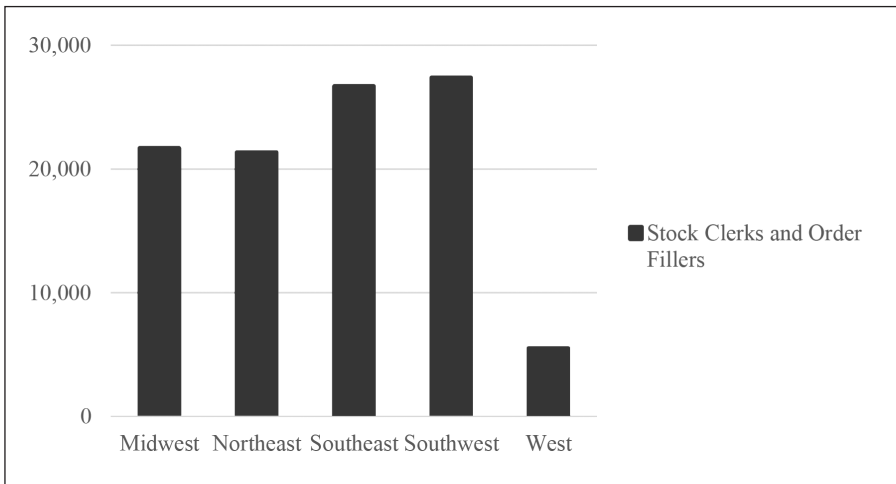 moving towards driverless trucks. With the coming of PTC across all major railroads, autonomous technology may not be far behind; the major hurdle being federal regulations and labor unions. For this reason, it is predicted that railroad operations jobs will not drastically change because of technology. However, the warehouse and distribution area will drastically change within the upcoming years. With the boom in warehouses caused by online retailers and the advent of warehouse robotics self-fulfilling orders, the type of warehouse jobs will shift to technical roles and managerial positions. These few changes only provide a glimpse into the future of freight transportation. With more upcoming technological advances on the way, such as drone delivery (Behrmann 2017), the future looks bright for technical jobs. The advent of drone technology will help create a new career field within the freight transportation industry. Finally, with new logistics and technological software, transportation time is quickly becoming streamlined (Hollingsead 2017), allowing for more

56

freight to be shipped in the same amount of time. By regionally breaking down employment projections, it is possible to see which areas could be most impacted by the coming technological changes. Through this analysis, it was found that the Southwest and Southeast areas of the United States will see the biggest impact in freight operations employment due to technology. Through all the technological advances, one thing is certain: people will still be needed to help efficiently transport freight across the country, although their roles and responsibilities may shift significantly.

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Peyton J. Murin graduated *magna cum laude* with University Honors with Thesis from the University of Memphis Department of Biology in the spring of 2018. For his work in the lab and in the classroom, Peyton has been awarded the Department of Biology Faculty Award and been nominated to the College of Arts and Sciences Dean's Award (honoree TBD). Outside the classroom, Peyton served as a research assistant in the Mckenna Laboratory, a tutor for the Educational Support Program and the Center for Athletic Academic Success, a volunteer soccer coach at Arlington Soccer Association, and a hopsital volunteer at St. Francis-Bartlett. In the coming year, Peyton will be attending medical school where he will continue to pursue his passion for advancing knowledge and helping others.

Peyton Murin

Relationships Among Ovary, Secondary Sex Characteristics, and Embryo Output in the Transparent *Casper* Zebrafish

Faculty Sponsor
Dr. Charles Lessman

Abstract

Casper zebrafish, a mutant zebrafish strain showing both melanocyte and iridophore loss resulting in a body that is largely transparent, provide a unique model organism to gain insight into normal and cancerous cells as well as general zebrafish reproduction (White et al., 2008). Despite this utility, little is known with regard to the factors influencing the level of reproductive activity in these fish. In our experiment, the *Casper* zebrafish were housed as pairs, checked for spawning Monday through Friday, and imaged one-to-two times per week. The images were analyzed in ImageJ; data were analyzed using Excel. The results indicate a statistically significant relationship between average diameter of the ten largest oocytes and the vent area in reproductively active females. At the level of individuals, it was seen that the average oocyte diameter versus time and the vent area versus time graphs tended to mirror one another. This indicates varied reproductive success amongst female *Casper* zebrafish based on measureable characteristics, which may allow for more efficient pairing in future experimentation using zebrafish.

Introduction

The zebrafish is an increasingly important vertebrate model organism, best known for its suitability for reverse and forward genetic procedures, including mutagenesis and morpholino knockdown of gene expression. In addition, zebrafish provide relatively large, translucent oocytes with great frequency in laboratory conditions (26ºC). They have short generational time spans and are especially responsive to a number of insults (mutagens, teratogens, toxins) (Selman et al.,1993).

Despite its utility as a model organism, rather little is known about the basic reproductive biology of zebrafish. While the embryos and larvae are transparent, the wild-type juveniles and adults are not. The internal organs, including the gonads, are obscured in the juvenile and adult by different pigment cells that provide the zebrafish with its name (denoting horizontal dark stripes on a mirror-like iridescent background). Thus, direct visualization of the developing oocytes in the female wild-type fish to assess embryonic development is not possible. In 2008, a new line of mutant zebrafish called *Casper* became available. This double-mutant fish is translucent, allowing direct visualization of the oocytes and their development in vivo. The *Casper* double-mutant is the result of a cross between two pigmentation mutants (White et al., 2008). The *roy* mutant is the result of a spontaneous mutation resulting in a "lack of iridophores, uniformly pigmented eyes, sparse melanocytes, and translucency of the skin" (White et al., 2008). The *nacre* mutant has a mutation in the gene encoding the mitf (Microphthalmia-Associated Transcription Factor) gene resulting in a complete lack of melanocytes (Lister et al., 1999). A cross between *roy* and *nacre* yields *casper* (i.e. roy-/- and nacre-/-) that lacks both functional melanophores and iridiophores (White et al., 2008) and allows visualization of the oocytes in the living animal without dissection.

Oocyte development is characterized by five phases. The first phase is the primary growth phase (pre-follicle). In this phase the oocyte is in a pre-follicle cell-surrounded nest. The oocytes are 7-20uM in diameter. The second phase is called the primary growth phase (follicle phase). The oocytes are in transparent follicles. The vitelline envelope begins to form a unilaminar layer. The oocytes are 20-40uM in size. The third phase is called the cortical alveolus phase. The follicles remain translucent and the cytoplasm takes on a foamy appearance. The vitelline envelope reaches two, then three layers. The oocytes are 140-340uM in size. The fourth

phase is called the maturation phase. The follicle is opaque until after the germinal vessel breakdown. The vitelline envelope begins to thin. The follicles are 690-730uM in size. The final phase is called the egg phase. The follicles are now translucent. The vitelline layer remains tripartite and some pore canals retain oocyte microvilli. The follicles are 730-750uM in size (Selman et al., 1993).

Though little is still known about the reproductive endocrinology of zebrafish, there is information known with regard to the incorporation of vitellogenin into the developing follicles. As with other non-mammalian species, the transfer of vitellogenin from the blood into the vitellogenic ovaries is enhanced by the pituitary gonado tropins. This occurs via extensive stimulation of micropinocytotic activity in the surface region of the oocytes. "Steroids believed to take on this role are Estradiol-17B and 17a, 20B-Dihydroxy-4-pregnen-3-one." (Nagahama & Yamashita, 2008)

Another chemical linked with the maturation of zebrafish oocytes is Activin B. In this study (Pang & Ge, 1999) the Activin B from goldfish created an increase in oocyte maturation when injected into zebrafish. This relationship was further confirmed by the addition of human follistatin abolishing the effect. There are no current studies dealing with the effect of Activin B on the vent or ovipositor area. The present study takes advantage of the transparent nature of adult *Casper* zebrafish to observe the production and diameter of the oocytes, which will then be related to other measureable reproductive factors.

Materials and Methods

Fish

Casper zebrafish (White et al., 2008) were created by mating *nacre* mutants with *roy orbison (roy)* mutants. The *nacre* mutant has a mutation in the gene encoding the *mitfa* gene resulting in a complete lack of melanocytes (Lister et al., 1999). The *roy* mutant is the result of a spontaneous mutation resulting in a "lack of iridophores, uniformly pigmented eyes, sparse melanocytes, and translucency of the skin" (White et al., 2008). The seven female and seven male *Casper* zebrafish were housed, in male-female pairs, in plastic containers (Aquatic Habitats, Inc.) filled with 1 L de-chlorinated water and held in a thermostatically controlled incubator (28°C) with a 14-hr. light: 10-hr. dark photoperiod. All animals in this research were used in accordance with an approved IACUC protocol

(#0714). Fish were fed once daily with a diet of flaked fish food (http://www.aquaticeco.com). The water in the plastic containers was changed daily.

Imaging

The fish were imaged by removing them from their plastic tank via net. The fish were then transferred, along with a small amount of water, to small transparent plastic bags. The bags with the fish were then placed on a microscope with an attached camera. Pictures of both the right and left side of the fish were taken using a Zeiss STEMI stereomicroscope and captured with a 9 Mp Amscope eyepiece camera running Toupview image software.

Checking for Spawning

The fish were checked for spawning every weekday. When embryos were found they were transferred to a 100mm petri dish containing 10ml de-chlorinated water and imaged. The images and the containers were labeled with the box number and the date.

Data Collection

Image analysis and image processing were carried out with lmageJ software (https://imagej.nih.gov/ij/download.html). Images of a stage micrometer, taken at the same resolution, were used to calibrate ImageJ for oocyte diameter and vent (also called the ovipositor or genital tubercle) area measurements. The line measuring tool was dragged across the oocytes and used to determine the diameter. The polygon measuring tool was used to encapsulate the vent, and again using the scale from the 8x micrometer, the vent area was attained. All the measurements were then transferred to an Excel file and sorted by individual and date. The images of the embryo plates were also transferred to ImageJ. Using the counting tool, the number of embryos was ascertained and exported to Excel then sorted by individual and date.

Analysis

Using the data attained from ImageJ, the average oocyte diameter versus time (Figure 1), vent area versus time (Figure 2), and embryo number versus time were graphed for each individual. Using the entirety of the data, the relationship between vent area and average oocyte diameter was graphed (Figure 4). This was then also graphed using only the average of

the ten largest oocytes, and then only the ten largest oocytes in reproductively active animals (i.e. those that spawned). The resolution obtained from images captured at 8x did not allow measurements of follicles <100um.

Results

Vent area and average oocyte diameter of the ten largest follicles positively correlate in reproductively active *Casper* zebrafish.

From the graphs of oocyte diameter vs. time and vent area vs. time in individual fish it could be seen that a correlation between vent area and average oocyte diameter of some degree was present (Figures 1 and 2).
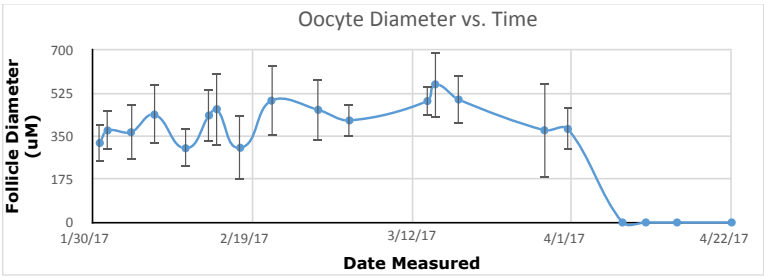
Figure 1. The positive correlation between oocyte diameter in uM and time in the reproductively active females
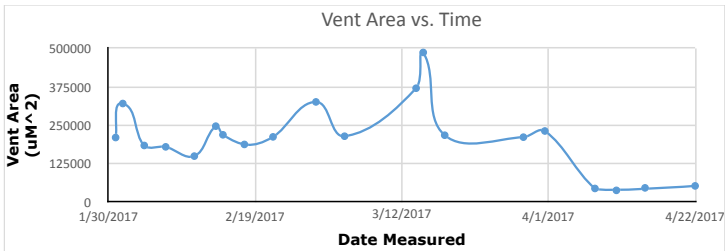
Figure 2. Vent area in uM^2 compared against time for female 11, one of the most representative and reproductively active females

This relationship was also visible, albeit to a lesser degree, when looking at representative images of the fish (Figure 3a and 3b).
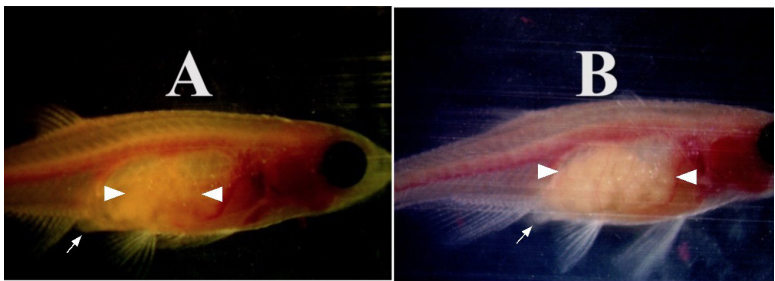
Figures 3A & 3B. The change in vent area and corresponding change in oocyte diameter in female 11 from 03/03/2017 (left) to 03/13/2017 (right)

As a result of these observations the decision was made to compare these two data points (oocyte diameter and vent area) against one another to determine if there was in fact a relationship. The decision to use the ten largest rather than just a straight average was made in order to account for the formation of new oocytes which coincided with the growth of previous oocytes.

Pearson R: 0.516439
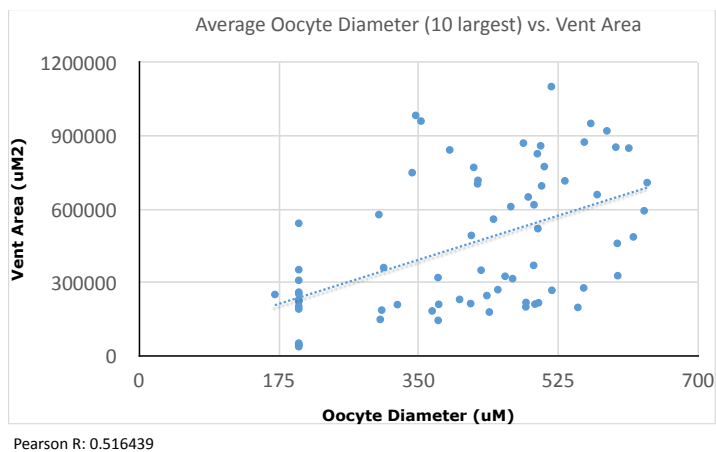
Figure 4. The vent area in uM^2 (y-axis) compared to the average oocyte diameter of the ten largest oocytes in uM (x-axis)

To determine correlation amongst average diameter of the ten largest oocytes and vent area in reproductively active *Casper* zebrafish it was necessary that we determine degree of freedom. We decided to use n=73 (number of data points) rather than n=7 (number of individuals), since the individual data points were distinct measures collected on an individual over time. Thus, using a Pearson R table and taking into account our r of 0.516439 and n of 73, df =N-2=71. For a df of 70, the critical r value is 0.232. Given that our r value is greater than 0.232, since the relationship has a p value less than 0.05 it was concluded to be statistically significant. This led to the decision to compare the two variables against one another as seen in Figure 1. This relationship was also visible by comparing the vent area and oocytes in the images of the fish (Figure 3).

Discussion

The results indicate with a high degree of certainty that there is a biological relationship between the oocyte diameter and the vent area. This significant relationship between oocyte diameter and vent area leaves the door open for further study in a number of ways. First, the frequency of our measurements made it hard to determine the more volatile relationships, such as that between changes in vent area and changes in oocyte diameter. Second, the frequency of our measure impaired our ability to draw conclusions with regards to spawning. More frequent measures would have allowed data on both variables to be observed immediately before and after spawning, something that would be extremely helpful given the quick-changing nature of the variables. Third, further study into potential common causation of this correlation could potentially illuminate the underlying mechanisms involved. Finally, in this study we were limited by the number of reproductively active females. Future studies may benefit from increasing the number of fish, thereby allowing for stronger evidence of correlation between the various reproductive factors. The study by Pang and Ge (1999) brought forward one chemical, Activin B, known to play a role in oocyte maturation. Activin B, a growth factor, is thought to play a mediating role leading to the maturation of the oocytes in zebrafish. Conducting further study to determine if this chemical also plays a role in vent area increase would shed light onto this relationship. Guanesekera et al. (1999) showed that there was a relationship between oocyte diameter, amongst other factors and dietary protein in the fish, Oreochromis niloticus. It is possible that something of this sort could also be implicated in

impacting oocyte growth in *Casper* zebrafish as well.

Acknowledgements

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Aaron's paper received a *Quaesitum* outstanding paper award.

Aaron Persinger

The Effect of Leucine Supplementation on Liver Protein Synthesis
in a Cancer Cachexia Model

Faculty Sponsor
Dr. Melissa Puppa

Abstract

Cancer-induced cachexia plays a major role in the interruption of protein synthesis pathways in both the skeletal muscle and the liver. Diminishing protein synthesis leads to muscle atrophy and loss of quality of life. Branched chain amino acids, specifically leucine, have been shown to increase protein synthesis in both diseased and regular populations. We supplemented leucine into the food of mice to see if leucine could counteract the effect of cachexia. We wanted to see how exactly this happened, so we looked at 6 different proteins run on Western Blots to analyze the protein pathway. Our results seem to suggest that our dose of leucine does not impact liver protein synthesis in a cancer cachexia model. There may be a different pathway the liver uses to promote protein synthesis.

Introduction

Cachexia is a metabolic disease where the patient involuntarily loses body mass that occurs alongside another illness or disease. (Von Haehling & Anker, 2017). Cachexia differs from regular weight loss because in a cachectic model, a disproportionate amount of skeletal muscle atrophies (Evans et al., 2008). Metabolically, cachexia reduces protein synthesis and interferes with the protein messenger chain within the muscle and the liver. In cancer patients, 30% of all deaths can be attributed to cachexia and when patients with cancer die, approximately 50% of them have cachexia present (Von Haehling & Anker, 2010). Cachexia is diagnosed when, alongside skeletal muscle loss, weight loss exceeds 5% in the previous year, abnormalities in the biochemistry of the body are present, and common characteristics of cachexia such as fatigue are found. Cachexia is associated with increased mortality and a very poor quality of life (Von Haehling & Anker, 2010).

Cachexia causes inflammation to spread throughout the entire system (Vaughan, Martin, & Lewandowski, 2013). The protein STAT3, as well as pro-inflammatory cytokines such as IL1 and IL2, are increased. (Morley, Thomas, & Wilson, 2006). These inflammatory markers are associated with an increased metabolism, leading to some of the weight loss associated with cachexia. The presence of these cytokines leads to an increase in the number of adrenal gland hormones in the body. Resting metabolism is increased due to catecholamines circulating, which increases the energy demands of the body. Another cause of low quality of life is a decrease in available energy. One process that causes a decrease in available energy is futile metabolic cycling, during which the tumor gives off lactic acid. The body sends this lactic acid to the liver, where it enters the Cori Cycle. In the Cori Cycle, lactic acid becomes pyruvate, which becomes glucose. The body then sends this glucose circulating throughout the body. Specifically, it goes to the tumor to be converted to lactic acid again. This high energy process may even use the glucose to feed the tumor and help it grow (Morley et al., 2006).

The liver plays an important role in meeting the energy demands of the entire body by regulating both lipid and glucose metabolism. Depending on the energy demands placed on the body, the liver will send different substrates to different areas to meet the imposed demands. Within the liver, a process called deamination occurs. Deamination is the process

by which the body converts amino acids into useable components. The liver is also a location for the Urea cycle. The Urea cycle is the process by which ammonia, which is highly toxic, is removed from the body. The liver regulates lipid and glucose metabolism, supplying energy to the entire body based upon imposed demands. Further, the liver is shown to play a role in the synthesis of protein (Narsale et al., 2015).

In a cachectic model, liver function is diminished. The glycogen stores in the liver and glycolytic enzymes are reduced (Narsale et al., 2015). Due to this decrease in glycolytic enzymes, the body is unable to use glucose as energy and must resort to other sources of fuel. Also, cachectic progression increased PSTAT3 (Narsale et al., 2015). STAT3 progression is significant in that STAT3 interacts with the body-tumor interaction by promoting tumor growth and inhibiting the body's tumor suppressants (Yu, Pardoll, & Jove, 2017). For protein synthesis, cachectic signaling induced PMTOR and suppressed S6 and AKT. Suppressing AKT directly influences protein synthesis because AKT signals to MTOR in the protein synthesis pathway. Impeding that signal directly impedes the protein synthesis process. STAT3 also contributes to cancer cachexia through enhancing tumorigenesis, metastasis and immune suppression, particularly in tumors associated with high prevalence of cachexia (Zimmers, Fischel, & Bonetto, 2016). This means that the tumor is assisted in growing and spreading.

Thus, while we know that cachexia impairs liver function in multiple ways (Narsale et al., 2015) we do not know exactly how the process works. MTOR is the starting point in two protein synthesis complexes. Does cachexia target the liver more than muscles? By what protein pathway does cachexia inhibit protein synthesis? Are there specific proteins in the muscle synthesis process that are more affected or less affected by cachexia? If cachexia increases PSTAT3 and STAT3 levels, does it also alter the way STAT transcribes with the nucleus?

Cachexia has no cure. At its core, cachexia is dangerous because it inhibits protein synthesis and accelerates muscle atrophy. Therefore, we look for a way to promote protein synthesis and inhibit the muscle atrophy process. One way to do this is by supplementing the branch chain amino acid (BCAA) leucine in the diet. Leucine is of vital importance in the process of protein synthesis. (Tamanna & Mahmood, 2014). In fact, leucine is shown to promote protein synthesis in humans and in rats.

Branched chain amino acids play a vital role in the protein synthesis pathway and in protein turnover. They have been shown to promote protein synthesis in humans in skeletal muscle (Shimomura et al., 2017). The three branched chain amino acids are leucine, isoleucine, and valine. They cannot be synthesized in the body, and therefore must be ingested. Branched chain amino acids, unlike other amino acids, do not experience their first catabolic step in the liver. They are unique in the fact that they go through catabolism in the skeletal muscle (Rajendram, Preedy, & Patel, 2015). In fact, the enzyme that begins the process of breaking down BCAA is not present at all in the liver. Interestingly though, the enzyme for the second step is found in high levels in hepatocytes (Rajendram et al., 2015). Therefore, while the liver cannot begin the process of breaking down BCAAs, it can continue the process once it has begun.

In a disease state, some research shows that high levels of leucine can inhibit protein degradation in both the muscle and the liver (Tamanna & Mahmood, 2014). Knowing that cachexia inhibits protein synthesis and also knowing that supplemental leucine can facilitate protein synthesis and inhibit protein degradation, we wanted to know if leucine can diminish or even counteract the effects of cachexia on protein synthesis. There is some proof to back up these thoughts. In a study with mice with the tumor MAC16, researchers supplemented leucine and valine and found an increase in protein synthesis and a decrease in protein degradation (Eley, Russell, & Tisdale, 2017). Further encouraging the support of leucine as compared to other BCAAs, Anthony et al. (2017) found that leucine was unique in its ability to promote protein synthesis in rats, increasing it by as much as 65%. Due to this, we decided to supplement leucine in our mice to see how it affects the protein synthesis in the liver.

Methods

Mice

All use of animals was approved by the University of Memphis Institutional Animal Care and Use Committee. Twenty male mice, approximately 7 weeks old, were purchased from ENVIGO and were housed in the University of Memphis animal facility. Their room was climate-controlled and on a 12-hour day, 12-hour night cycle. After two weeks of adjusting to their facility, they were placed in four separate groups of five. During this adjustment period, all mice had the same diet. After their adjustment peri-

od, the mice were given one of two injections. The control groups (Chow1 and Leu1) were given a PBS injection, while the cancer groups (Llc1 and Llc+Leu1) received an injection of 1x 106Lewis Lung Carcinoma (LLC) cells suspended in PBS. After injection, the separate groups began receiving their special diets. Groups 1 and 3 received a regular (Chow) diet. Groups 2 and 4 received a Leucine supplemented (Leu) diet.

Over the course of 28 days, the mice were monitored and checked daily. Their food intake and body weight were measured every 48 hours. If the mice were not eating, had a movement pattern that was severely impacted, had a tumor greater than 2.5 cm in diameter, were unresponsive to our actions, lost more than 20% of their body weight since the last check, or otherwise seemed to be severely deteriorating, they were immediately euthanized. Mice were fasted for 5 hours prior to euthanasia. Thirty minutes before the collection and removal of tissues, the mice were injected with 0.04 µM/g BW of puromycin for use in protein synthesis measurement assays. Isoflurane was used to anesthetize the mice before euthanasia. The tissues were subsequently harvested and frozen in liquid nitrogen for temporary storage. Then, they were played in a negative 80 degree centigrade freezer for long-term storage and use.

Western Blots

A portion of the liver was homogenized on ice with Meuller Buffer that contained protease and phosphatase inhibitors. These samples were placed in the centrifuge for 10 minutes at 10,000g. Then, the supernatant was removed and placed in a new tube. A Bradford assay was used to quantify the protein in each sample. Afterwards, the samples were diluted to 5ug/ul with diluent buffer and 5X Lane Marking Reducing Sample Buffer and were heated at 95°C for 5 minutes. The samples were then loaded into a Western Blot apparatus where they ran through sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) on a 4-15% gradient gel and subsequently transferred onto a PVDF membrane. Afterwards, the transfer was checked with Ponceau stain. After removal of the Ponceau stain, membranes were blocked in 5% Milk in Tris-buffered saline 0.1% Tween 20 (TBST), then placed in their primary antibody overnight (Puromycin 12D10, Millipore; PGC1α 3G6, Cell Signaling Technology; 4EBP1; AMPK D5A2; PAMPK T172; MTOR 7C10, PMTOR D9C7; STAT3, D3Z2G; PSTAT3 T705). The next day, they were washed three times for five minutes each in TBST. Then, they were placed into the

appropriate animal-based secondary for 2 hours. After washing again in TBST, the blots were photographed using a chemiluminescent agent and imaged using a Fotodyne® 60-7020 bench top imager. The bands were then quantified using ImageJ software.

Protein synthesis was quantified with a western blot adaptation of the SUrface SEnsing of Translation (SUnSET) technique (Schmidt, Clavarino, Ceppi, & Pierre, 2009). The puromycin injection prior to euthanasia allows for a quantification of overall protein synthesis.

The blots were stained with Ponceau in order to have a means of normalizing and controlling for any loading variances. Two blots were generated for each protein. All data were averaged across both blots and centered around 1.

Statistical Analysis

All statistical analyses were conducted using GraphPad Prism 7® software. All data are presented as means + Standard Error of Mean (SEM). All graphs are based on IOD (Integrated Optical Density). Statistical significance was set at $\alpha = 0.05$. Western blot data were analyzed via two-way analysis of variance (ANOVA).

Results

To understand how liver protein synthesis is altered by leucine and cancer, we measured several markers of protein synthesis. MTOR activation through phosphorylation was unaltered by the presence of cancer. Leucine by itself did not change MTOR phosphorylation; however when both leucine and cancer were present, MTOR phosphorylation was decreased (Figure 1A). Next, we measured puromycin incorporation to get a more direct measure of protein synthesis. Neither cancer nor leucine had an effect on puromycin incorporation in liver protein synthesis (Figure 1B). P4EBP1 is a marker for protein synthesis translation. In both cases, cancer trended to decrease P4EBP1 phosphorylation (p=.07) while leucine by itself had no impact (Figure 1C). These data suggest that in our model of the early stage of cancer, there is no alteration in the liver protein synthesis.

Figure 1. Markers of Protein Synthesis
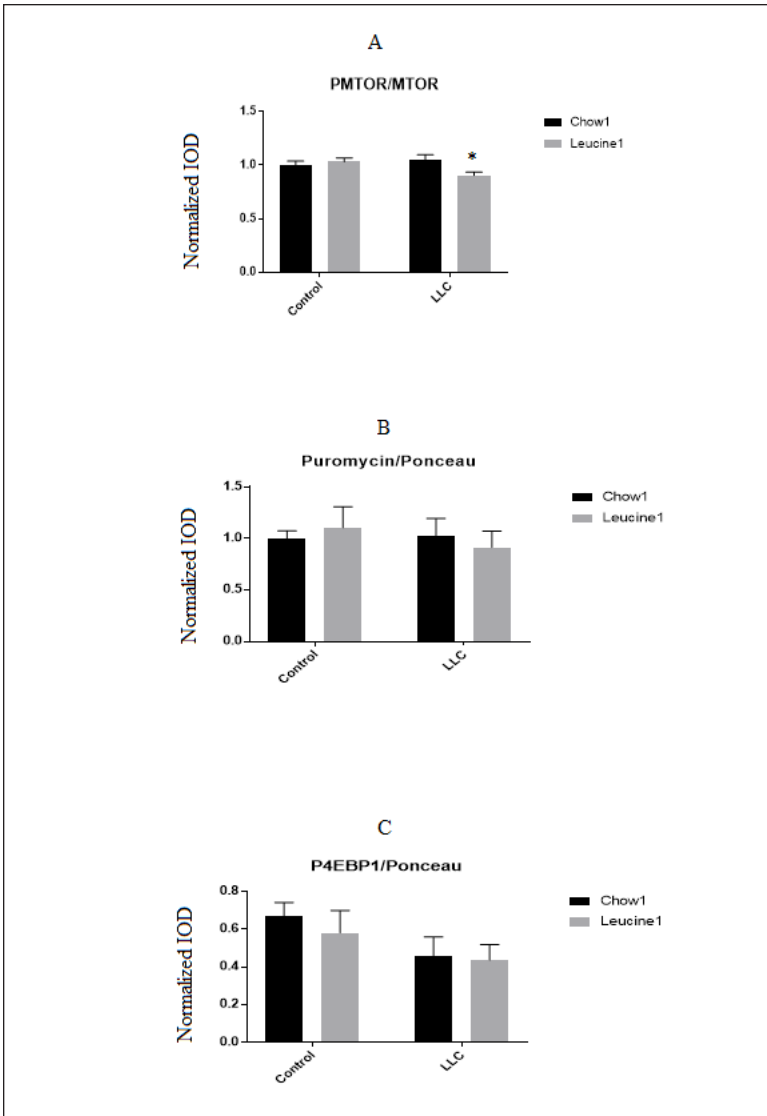
A) The ratio of pMTOR and total mTOR was taken from western blot analysis. B) Incorporation of puromycin into liver was measured by western blot analysis C) Phosphorylation of 4EBP1 was measured by western blot analysis. Data were normalized to total protein quantified by Ponceau stain. All data are presented as mean ± SEM.
* Represents a difference from all other groups p<0.05.

Next we looked at STAT3 activation as a marker of inflammation. With cancer, STAT3 levels were decreased. Supplementing leucine had no effect on STAT3 phosphorylation. When both cancer and leucine were present, STAT3 levels were diminished. This indicates that there was not significant inflammation in the liver of the mice with cancer (Figure 2).
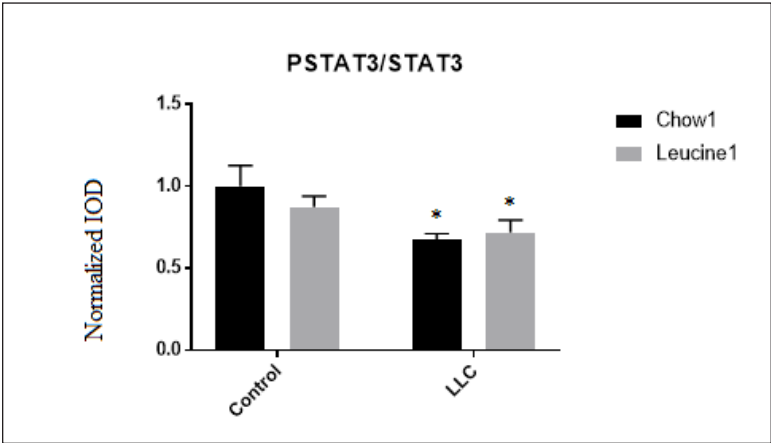
Figure 2. PSTAT3/STAT3

The ratio of PSTAT3 to STAT3 was taken from western blot analysis. Data were normalized to total protein quantified by Ponceau stain. All data are presented as mean ± SEM.
*Represents a difference from all other groups $p < 0.05$.

AMPK negatively regulates protein synthesis and is a potent sensor of energy levels. In the group with cancer, AMPK levels were increased. The group receiving just leucine did not have altered AMPK levels, and the group with both cancer and leucine had increased AMPK phosphorylation (Figure 3). Because protein synthesis was not decreased by the increase in AMPK, AMPK may be acting in an alternative manner.

Finally, we looked at PGC1, a known marker for mitochondrial biogenesis. PGC1 alpha can be regulated by AMPK. With cancer, PGC1 levels were unaffected. Adding leucine into the diet also did not alter PGC1 levels. With both cancer and leucine, PGC1 levels were not changed (Figure 4). This tells us that our cachexia progression and leucine dosage may not have been high enough to alter mitochondrial biogenesis in the liver; however, more research needs to be done to confirm if dosage was the issue.
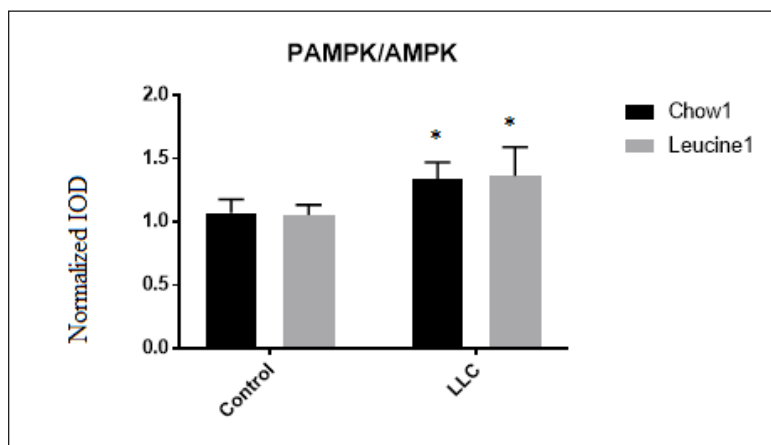
Figure 3. PAMPK/AMPK

The ratio of PAMPK to total AMPK was taken from western blot analysis. All data are presented as mean ± SEM.
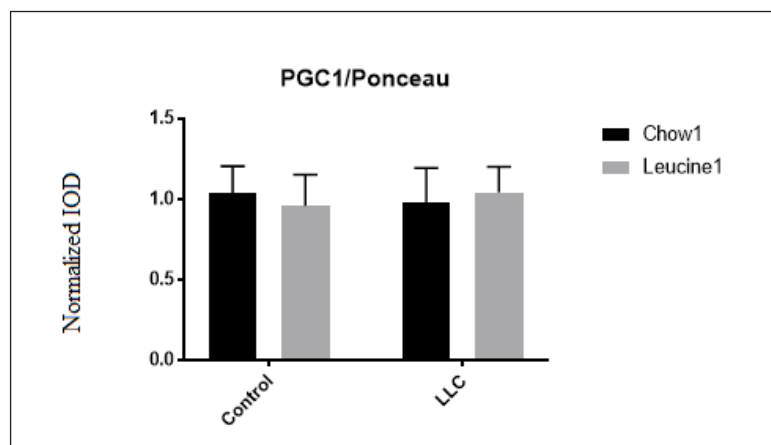*Represents a difference from all other groups p<0.05.

Figure 4. PGC1/Ponceau

Phosphorylation of PGC1 was measured by western blot analysis. Data were normalized to total protein quantified by Ponceau stain. All data are presented as mean ± SEM.
*Represents a difference from all other groups p<0.05.

Discussion

Cancer cachexia causes a decreased quality of life in part due to the negative impact on protein synthesis. Leucine has been shown to increase protein synthesis, therefore, we wanted to see if supplementing leucine in a cancer cachexia model could diminish or even counteract the negative impact of cancer cachexia on liver protein synthesis. After supplementing leucine in our mice, we expected to see a decreased effect of cachexia on liver protein synthesis as compared to the mice without supplemental leucine. STAT3 and P4EBP1 were both decreased in the cancer groups and were unaffected by leucine. AMPK was increased when cancer was present. When both cancer and leucine were present, we found PMTOR to be decreased; however, there was no effect with cancer or leucine alone. Additionally, there were no changes in puromycin incorporation suggesting that there was no change in protein synthesis in the liver.

Even though the mice had tumors, the actual cachexia had not progressed beyond the early stages. There are 3 stages of cachexia: pre-cachectic, cachectic, and refractory cachectic (Penet & Bhujwalla, 2015). If we had allowed the cachexia to progress further and supplemented leucine longer, we would have expected to see changes in inflammation and protein synthesis. For example, one study found that STAT3 phosphorylation in the liver increased with the progression of cachexia (Narsale et al., 2015). Further, they also found that AKT and S6 phosphorylation were both decreased as cachexia progressed (Narsale et al., 2015). Overall, there tends to be a decrease in protein synthesis as the cachexia progresses (White et al., 2011). This suggests that if our mice had progressed further, we may have seen more pronounced effects of leucine.

Leucine upregulates MTOR signaling in many healthy and diseased conditions (Du, Shen, Zhu, & Ford, 2007). Further, chronic leucine supplementation in rats has been found to increase protein synthesis rates in adipose tissue, skeletal muscle and the liver (Lynch, Hutson, Patson, Vaval, & Vary, 2002). Cachexia suppresses MTOR activity and downstream signaling (White et. al, 2011). It has been found that during the initial stages of cachexia, phosphorylation of 4EBP1 is reduced in skeletal muscle (White et al., 2011). Leucine supplementation has been found to increase 4EBP1 phosphorylation through MTOR signaling (Millward, 2012). In our study, we found decreased 4EBP1, which further supports that our leucine dose was not high enough to elicit a response. In skeletal

muscle, AMPK has been shown to increase as cachexia progresses (White et al., 2011). Further, any stress that depletes ATP will lead to the activation of AMPK (Viollet et al., 2006). In cancer, increased glycolysis and lactate production leads to less available ATP (Solaini, Sgarbi, & Baracca, 2011). Therefore, we can expect to find increased AMPK in our cancer groups. In our study, we found increased AMPK phosphorylation. AMPK negatively impacts protein synthesis; therefore, we expected total protein synthesis to be decreased as a result of increased AMPK. However, by measuring puromycin, we found no changes to overall protein synthesis even though we expected decreased protein synthesis because of increased AMPK activation. This suggests that although AMPK is activated in the liver, liver protein synthesis is not suppressed through AMPK. One potential explanation for this is that PGC1 is activated by AMPK to increase mitochondrial biogenesis, therefore, we would expect increased AMPK to impact our levels of PGC1. However, we found no changes in PGC1alpha levels. Previous studies in muscle have shown a decrease in PGC1alpha with the progression of cachexia. It is possible that the increase in AMPK acts to preserve PGC1alpha levels and maintain mitochondrial function. Further research needs to be done to confirm this.

Our dose of leucine for this study had no impact on liver protein synthesis, regardless of the presence of cancer. These findings suggest that the liver may possess an alternate pathway it can activate to maintain protein synthesis and liver function. Another possibility is that liver protein synthesis is maintained as a side effect of maintaining other liver functions. The liver, amongst other roles, metabolizes fats, proteins, and carbohydrates. It also serves as a storage location for glycogen. In cancer, glycogen stores are of importance because of the increased energy demands on the body. Therefore, the body may attempt to preserve the liver to preserve this energy supply. Thus, as a coincidence, the protein synthesis pathway may be preserved.

For this study, we can go back and look at other proteins such as AKT or P70S6K. AKT is known to signal to mTOR to increase protein synthesis. P70S6K is known to be downstream from mTOR and regulate ribosomal biogenesis. By looking at these two proteins we can get more of a view on what is happening on both sides of mTOR. Knowledge of how other proteins are affected by our conditions may help us discern other possible pathways. Further, because we have saved tissues and muscles

from this study, we can look at a systemic view of the interaction. In future studies, we can supplement more leucine than we did in this study. Our results show that our level of leucine supplementation was not enough to elicit the expected response, therefore, altering the dose may yield different results. Another possible modification would be to allow the cachexia to progress further as our actual cachectic progression was low. By allowing cachectic progression, STAT3 should increase, allowing us to match the results found in other studies. Either one of these modifications could be made and follow similar methods and procedures to the ones we followed.

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Anna's paper received a *Quaesitum* outstanding paper award.

Anna Church

An Analysis of Breastfeeding Initiation Trends of Shelby County, TN Women from 2007 to 2015

Faculty Sponsor
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Abstract

Breastfeeding is a prominent public health issue, and if guidelines were followed, the United States could save billions of dollars and hundreds of lives. The ability to do this starts with initiation. This study uses data from the Shelby County Health Department, located in Memphis, TN, to study breastfeeding initiation trends and the relationships between initiation, race, and age of the mother (n=74,496). These data span nine years (2007-2015) and were cross-tabulated to identify significant differences in initiation distribution by the racial and age group make-up of the mothers. There is a positive trend in the percentage of mothers initiating breastfeeding over time among all racial and age groups, but disparities within both variables persist. This study finds significant relationships between the variables and can be used to inform future research and community intervention.

Introduction

Breastfeeding is a prominent public health issue and one of increasing importance in Shelby County, TN, where infant deaths remain higher and breastfeeding rates remain lower than national averages. This area has historically fared poorly with various issues of health, particularly with the persistence of racial health disparities. Breastfeeding has been shown to have a positive impact on health in later life. At the national level, populations have become healthier over the years, but the racial disparity between non-Hispanic whites and blacks has continued to persist. When the Centers for Disease Control and Prevention evaluated all states against the Healthy People 2010 objectives, it was discovered that most states were not meeting the targets of any breastfeeding objectives for any racial or ethnic group; therefore, Shelby County and Tennessee as a whole are not alone in this struggle (Centers for Disease Control and Prevention 2010).

The data used in this study defined breastfeeding initiation as infants being breastfed directly after birth. While this measure is not able to indicate longevity of breastfeeding, if a woman does not get off to a successful start with breastfeeding while still in the hospital, surrounded by healthcare professionals, then it is very unlikely that she will continue to breastfeed upon her return home. If 90% of U.S. families were able to comply with medical recommendations to breastfeed exclusively for six months, the country would save $13 billion per year and prevent an excess of 911 deaths, nearly all of which would be in infants (Bartick and Reinhold 2010). Those six months of breastfeeding all begin with initiation.

There is a large amount of literature on the health benefits of breastfeeding for mothers and infants, as well as analyses of how national or workplace policies can affect breastfeeding rates. Macro-level analyses are necessary for various reasons, but they can cover up trends at the micro-level (for the purposes of this study defined as local- or county-level). A "one size fits all" approach is not always appropriate for health interventions, as every community has impeding structures, cultural variations, and ranging demographics. Micro-level analyses of breastfeeding women have not been disseminated in the same manner as macro-level ones. The current study aims to address this gap. It will supplement previous research in two important ways: (1) by focusing on initiation only rather than longevity of breastfeeding or reasons for early cessation, and (2) by focusing on the demographics of those women who chose to initiate rather than those

who did not.

This study uses data from the Shelby County Health Department to analyze the racial make-up of the sample, while considering respective age groups. The data spans from 2007 until the most recently available year at the time of analysis: 2015. Through this research, I strive to answer the question: How do race and age affect the likelihood of a woman initiating breastfeeding in Shelby County? Conclusions will be drawn about breast-feeding initiation trends over time and how those trends have been influenced by age and race as well. Other objectives of this study are to identify any race and/or age-based initiation disparities in the data and to potentially provide a tool that can identify target populations for future community intervention.

Literature Review

Health Benefits of Breastfeeding

The health benefits of breastfeeding are a common subject in the literature, and it is generally agreed upon that breastfeeding practices are an important subject for study. Across the world, breastfeeding saves the lives of infants, such as reducing their disease burden and providing protection from infections (Oddy 2001). Sudden Infant Death Syndrome (SIDS) is the leading cause of infant death from one- to six-months-olds in the developed world (Bernshaw 2016). There have been many theories introduced and proposed to explain SIDS deaths, with some related to adverse circumstances surrounding either the infant or the mother. Others suggest that a thiamine deficiency or a hormonal/biochemical imbalance in the infant is the ultimate cause (Bernshaw 2016). Breastfeeding is one method to prevent these imbalances, as previous research has shown that SIDS occurs significantly less frequently in breastfed infants. The health benefits of breastfeeding do not only extend to the infant, but the mother as well. These benefits include lactation amenorrhea, postpartum weight loss, and protection against ovarian and breast cancer (Leung and Sauve 2005). Lactation amenorrhea refers to a delay in the return of a menstrual cycle for breastfeeding women. This natural form of birth control assists with child spacing, which allows the mother sufficient time to rest from her most recent pregnancy and to be healthier if she wishes to get pregnant again (Leung and Sauve 2005).

Determinants to Successful Breastfeeding

Current World Health Organization (WHO) guidance recommends exclusive breastfeeding until the infant is six months old, followed by the intake of breast milk up until two years old at least (Callaghan and Lazard 2012). Knowing all of the above benefits and the recommendations by world-renowned health organizations, just over half (55.3%) of U.S. mothers, according to the National Immunization Survey, were breastfeeding their infants at 6 months of age (Centers for Disease Control and Prevention 2017). An even smaller percentage (25.5%) were exclusively breastfeeding their infants at 6 months, the actual recommendation of the WHO (Centers for Disease Control and Prevention 2017). Previous literature has cited multiple reasons for the low numbers of women following breastfeeding guidelines. Ogbuanu et. al. (2011) found that women often cited work-related barriers to prolonged breastfeeding, such as a lack of supportive work environments which included the provision of lactation facilities and paid maternity leave. Brown et. al. (2014) found that one of the most common responses among women they surveyed who discontinued breastfeeding was a concern about milk supply and their ability to sufficiently feed their infants. Another factor of great significance was the fear of breastfeeding in public. This fear could be due to many things, including a fear of experiencing negative reactions (Roche, Owen, & Fung 2015), perceptions of social approval (Lippitt et. al. 2014), and embarrassing themselves and/or others (Acker 2009). Considering that infants need to eat every 2-3 hours, the chance that a woman may need to breastfeed her infant while out in the public sphere is quite high. All of the above barriers and fears may cause women to forgo breastfeeding altogether, much less follow the recommended duration guidelines.

Race and Age Disparities

National estimates from across the United States indicate substantial racial/ethnic differences in breastfeeding. A Morbidity and Mortality Report from the Centers for Disease Control and Prevention found that non-Hispanic blacks had lower rates of breastfeeding than non-Hispanic whites in all but two states (2010). Over the past few decades, national estimates of breastfeeding initiation have consistently increased, but the racial and ethnic differences remain substantial (Centers for Disease Control and Prevention 2010). The difference in breastfeeding initiation rates between non-Hispanic blacks and whites in 1990 was 35%, and the

difference found in the report from 2003-2006 showed that this difference had dropped to 20% nationally. However, in thirteen states (including Tennessee), this difference remained higher than 20%. Overall, Hispanics have slightly higher initiation rates than non-Hispanic whites, but this did vary by state. The relationship between time spent in the United States and breastfeeding initiation shows that those Hispanic women who had lived in the U.S. longer were less likely to initiate breastfeeding (Centers for Disease Control and Prevention 2010). These persistent racial disparities are common across many other health outcomes.

There also remain consistent disparities in the initiation of breastfeeding across age groups. Younger maternal age, lower income, lower education, and single marital status are all factors associated with not breastfeeding (Centers for Disease Control and Prevention 2010). All of these factors are characteristics more often found among younger mothers, which helps explain why this age group has lower rates of breastfeeding on average. Older women may have slightly higher than average breastfeeding initiation rates due to taking the time to establish a strong financial situation, which may give them the privilege of taking extended time off from work (Batzdorff 2002).

Description of Place

Tennessee's Breastfeeding Report Card, issued by the Centers for Disease Control, provides a clear picture of how the state measures up to the nation on various breastfeeding benchmarks. The rates of Tennessee infants (1) ever breastfed, (2) breastfeeding at 6 months, and (3) breastfeeding at 12 months are all lower than national averages (National Center for Chronic Disease Prevention and Health Promotion 2014). One contributing factor may be lack of professional lactation support which has been proven to help mothers initiate and continue breastfeeding. The most recent Report Card shows that Tennessee, one of eleven states, has a limited availability of this professional support with fewer than three certified lactation consultants per 1,000 live births (2014).

Hospital support can also be a factor in increasing rates of breastfeeding. The Baby-Friendly Hospital Initiative is a World Health Organization and UNICEF joint project that has a goal of increasing breastfeeding initiation and duration rates by developing specific protocols disseminated to all staff members to promote breastfeeding while in the hospital after birth (Hawkins et al. 2015). These hospitals have been prov-

en to reduce disparities in breastfeeding initiation by improving the rates of initiation for lower-income, lower-educated minority women (Hawkins et al. 2015). On average, 7.79% of live births occur at hospitals given a Baby-Friendly endorsement by the CDC, but in Tennessee only 0.13% of births occur in these hospitals (National Center for Chronic Disease Prevention and Health Promotion 2014). This can be attributed to the lack of hospitals with a Baby-Friendly certification as there are only two in the entire state, neither of which are within 200 miles from Shelby County. Many hospitals can promote breastfeeding initiation without being official Baby-Friendly designated hospitals, but without the protocols that this designation mandates, there is the potential that new staff or management could negatively influence the pro-breastfeeding culture in these institutions.

The heightened focus in this study on one singular county is necessary for various reasons. In the year 2005, Shelby County had the highest infant mortality rate in the entire United States, and by 2014 it still had the highest rate in the state of Tennessee (Quander 2014). Infant mortality rates and breastfeeding rates often go hand-in-hand. Shelby County is 52.1% black or African-American according to the 2010 Census, with the city of Memphis having one of the largest African-American populations of all U.S. metropolitan areas (Shelby County Tennessee 2010). Along with identifying breastfeeding initiation trends, stratified by race and age cohort of the mother, this study will also provide implications for further study on topics in the field of maternal and child health, such as infant mortality.

Methods

The data used for this study was provided by the Shelby County Health Department's Office of Epidemiology in aggregated form, which did not require IRB approval. The source of the original, person-level data is the Tennessee Department of Health Office of Policy, Planning and Assessment Division of Health Statistics, specifically drawn from Birth and Death Certificate Files for Shelby County residents. This sample is representative of Shelby County residents who have given birth to live infants spanning the years 2007 to 2015. The total size of the sample is 74,496 residents. This aggregated data set only includes those respondents that initiated breastfeeding. Due to missing values in the original source of the data (meaning those birth certificates which did not have any indication of

breastfeeding initiation shown) the percentages of those respondents that chose not to initiate breastfeeding cannot be determined with certainty.

There are two independent variables for this study: 1) race, and 2) age of the mother. The frequency of these variables was determined from self-identification of race and legal age as presented on birth certificate data from the Tennessee Department of Health. The categories for race include non-Hispanic white, non-Hispanic black, and Hispanic. An 'Other' category was included in the original data, but excluded from analysis due its very small values. The categories for the independent variable of age include 15-19 years old, 20-34 years old, and 35+ years old. The dependent variable for the analysis is the breastfeeding initiation indicator. The value for this variable was determined when in the hospital after birth, women were asked by a healthcare worker, "Is Infant Being Breastfed?" If the answer was 'Yes', then that would be marked appropriately on the birth certificate by the health care worker. 'No' answers were not included in the data set due to the aforementioned missing values.

Due to the lack in variation of the dependent variable (all 'Yes' answers), cross-tabulation analysis was performed using both independent variables in order to reveal disproportionate percentages of breastfeeding initiation between and within racial and age groups. This breakdown indicates how many members of each racial and/or age group in the sample initiated breastfeeding while also indicating the percentage of each age group that belonged to a certain racial group. The cross-tabulation analysis was performed on the first year and last year of the data set, 2007 and 2015 respectively, in order to determine if and how the variables changed over that timeframe.

Results

For all racial groups, the percentage of women initiating breastfeeding increased overall from 2007 to 2015 with some downward fluctuations from year-to-year. In Figure 1, non-Hispanic black women saw a substantial increase in the percent initiating breastfeeding (39.4% to 61.5%). Non-Hispanic whites and Hispanics did not see this large an increase, which is in part due to their higher beginning initiation percentages. There is not as much room for improvement when starting from an initiation percentage of over seventy. Non-Hispanic black women do continue to have lower rates of initiation than other racial groups despite their group's substan-

tial improvement. The Shelby County total, which represents the average for the county, is lower than both white and Hispanic, but higher than the black totals. All groups' initiation percentages steadily rose from 2007 to 2012, but since then have leveled off and been fairly constant, with white women's initiation percentage slightly decreasing over the past two years. The data displayed in Figure 1 indicate that the race of a woman does affect her likelihood to initiate breastfeeding.

Figure 1. Breastfeeding Initiation by Race, Shelby County, 2007-2015

Data Source: Shelby County Health Department (SCHD), Office of Epidemiology and Infectious Diseases, prepared 3/20/17 from Birth and Death Certificate Files for Shelby County Residents, 2007- 2015, Tennessee Department of Health, Office of Policy, Planning and Assessment, Division of Health Statistics.

The data in Figure 2 also show an overall increase in breastfeeding initiation across all age groups. As with the racial groups in Figure 1, the initiation percentages for each age group have also leveled off for the past three years after consistent increase. The Shelby County total, or average, is even with the 20- to 34-year-old group, which is also the age group containing the largest number of women. The 15- to 19-year-old group has the lowest rates of initiation, but has come within 10 percent of the Shel-

by County average and has seen the most drastic improvement over the 9-year timeframe. There was a slight decrease in initiation in 2015, so it will be important to see how the numbers change in the coming years. The 35+ year-old group has the highest rates of initiation, but the gap between this group and the 20- to 34-year-old group has decreased. A relationship between breastfeeding initiation and age is illustrated here: the higher the age of a woman, the more likely she is to initiate; whereas, the lower the age of a woman, the less likely she is to initiate. This makes it clear that age of a woman does affect her likelihood to initiate breastfeeding.
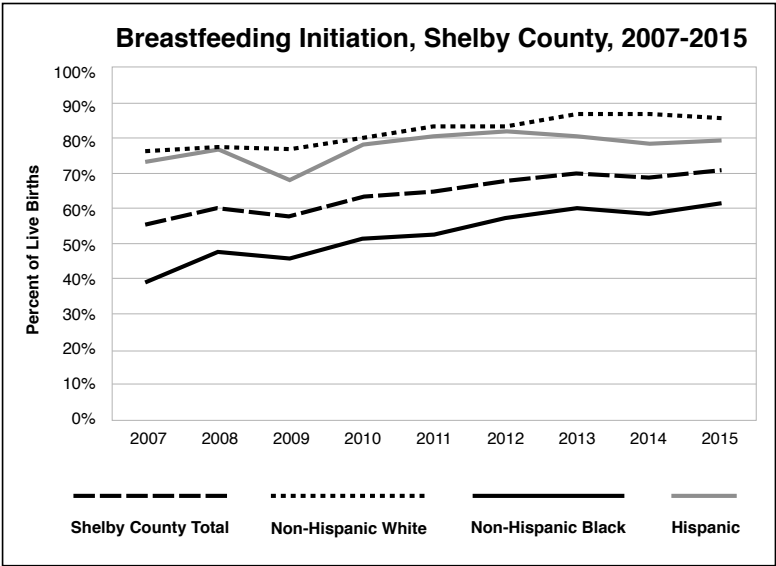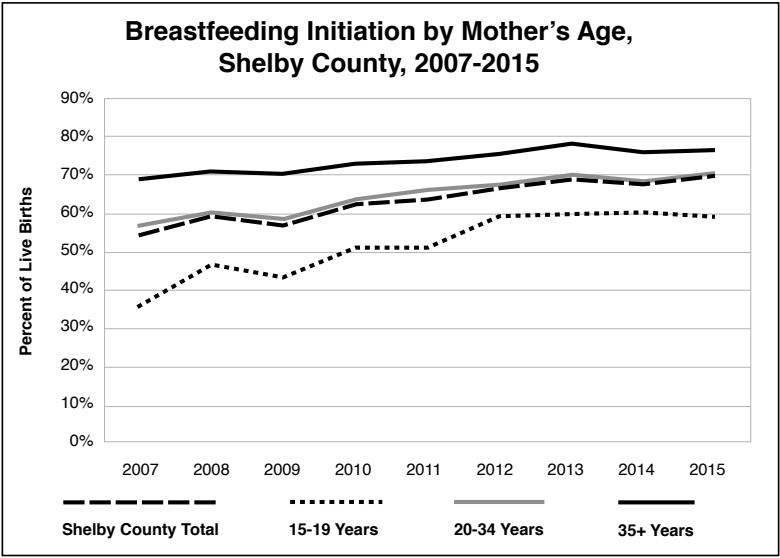

Figure 2. Breastfeeding Initiation by Age, Shelby County, 2007-2015

Data Source: Shelby County Health Department (SCHD), Office of Epidemiology and Infectious Diseases, prepared 3/20/17 from Birth and Death Certificate Files for Shelby County Residents, 2007- 2015, Tennessee Department of Health, Office of Policy, Planning and Assessment, Division of Health Statistics.

The largest age group was the 20- to 34-year-olds, and the majority of the women in the sample were non-Hispanic black. The Hispanic sample is significantly smaller than the other two groups. Table 1 shows the racial make-up of each age cohort in the sample for the first year of the data set, 2007. Again, all of these women initiated breastfeeding and what this table tells us is how this group of women is broken down across

race and age. Well over half (68.5%) of the 15- to 19-year-old group was non-Hispanic black, whereas 11.9% was non-Hispanic white. The 20- to 34-year-old group had almost even percentages of non-Hispanic white and non-Hispanic black women, while 54.0% of the 35+ age group was non-Hispanic white women, and 33.9% of this group was non-Hispanic black women. White women had higher percentages of older women, while, black, and Hispanic women had higher percentages of younger women.

Race 07 * Age 07 Cross-tabulation

| | | | Age 07 | | | |
			15-19 years	20-34 years	35+ years	Total
Race 07	Non-Hispanic White	Count	95	2508	532	3135
		% within Age 07	11.9%	42.3%	54.0%	40.7%
	Non-Hispanic Black	Count	548	2460	334	3342
		% within Age 07	68.5%	41.5%	33.9%	43.3%
	Hispanic	Count	157	957	119	1233
		% within Age 07	19.6%	16.2%	12.1%	16.0%
Total		Count	800	5925	985	7710
		% within Age 07	100.0%	100.0%	100.0%	100.0%

Table 1. Cross-tabulation of Race and Age, 2007

Table 2 is shown in order to illustrate the change in the racial make-up of each age group over nine years. The percentage of non-Hispanic white and Hispanic women aged 15 to 19 years old declined by 0.7% and 5.9% respectively, while the percentage of non-Hispanic black young women increased by 6.6% from 2007. The actual numbers of women in this age group decreased across all three racial categories, but the difference in the number of non-Hispanic black and non-Hispanic

Race 15 * Age 15 Cross-tabulation

| | | | Age 15 | | | |
			15-19 years	20-34 years	35+ years	Total
Race 15	Non-Hispanic White	Count	77	2265	464	2806
		% within Age 15	11.2%	33.1%	41.8%	32.4%
	Non-Hispanic Black	Count	517	3795	440	4752
		% within Age 15	75.1%	55.4%	39.6%	54.9%
	Hispanic	Count	94	792	207	1093
		% within Age 15	13.7%	11.6%	18.6%	12.6%
Total		Count	688	6852	1111	8651
		% within Age 15	100.0%	100.0%	100.0%	100.0%

Table 2. Cross-tabulation of Race and Age, 2015

white women persisted. In 2015, there was an increase in the number of non-Hispanic black women aged 20 to 34, and 35+ years old. This increase, combined with the decreased number of non-Hispanic black 15- to 19-year-old women, suggests a positive future trend toward fewer teenage pregnancies.

One unexpected result from this analysis was the overwhelming percentage of 15- to 19-year-olds in the sample that were non-Hispanic black. If you picked a woman from this age group, it would be 5.75 times more likely that she would be black than white. This illustrates a quite large disparity in who the teenage mothers are in Shelby County. In 2007, there were 95 white 15- to 19-year-old women compared to 548 black women. In 2015, these values remained relatively equivalent, with 77 young white women and 517 black women in this age group.

Discussion

Non-Hispanic white and hispanic women have higher percentages of their populations initiating breastfeeding than the Shelby County average. Non-Hispanic white women have slightly higher percentages of initiation than Hispanic women, which is contrary to the common finding that Hispanic women are more likely to breastfeed (Trigo 2014). The reason for this different finding cannot be determined from this analysis, but how long the Hispanic women in this sample have resided in Shelby County or the United States in general should be explored further. The longer a woman has lived in the United States, the less likely she is to initiate breastfeeding (Trigo 2014). The non-Hispanic black population consistently has lower rates of breastfeeding initiation than all other categories. It is important to take note of the fact that Shelby County has seen improvement in the breastfeeding initiation rates of its mothers, but a gap between non-Hispanic black women and other groups continues to exist. In 2007, there was a 37.1% difference between non-Hispanic whites and non-Hispanic blacks, and in 2015 this difference dropped to 24.4%. This demonstrates the necessity for continued research into why this disparity continues and how it can best be addressed.

Age of the mother is also an important indicator for the likelihood to initiate breastfeeding. Young mothers oftentimes share many characteristics that make them unlikely to breastfeed, such as low education, low income, and being unmarried, and this shows in their breastfeeding

rates. Women age 15 to 19 exhibit lower initiation rates compared to the Shelby County average and compared to older women in the sample. In 2007, women 35+ years old were almost twice as likely to breastfeed as women aged 15 to 19. This difference improved between 2007 and 2015, where the 35+ year-old group had 17% more women initiating breastfeeding than the 15- to 19-year-old one. The 20- to 34-year-old group exhibited breastfeeding rates that were close to the Shelby County average. The 35+ year-old group exhibited the highest breastfeeding rates of the sample. From 2007 to 2015, there was a 13.9% increase of non-Hispanic black women initiating in the 20- to 34-year-old group. The number of non-Hispanic white women decreased from 2007 to 2015 in both the 20 to 34 and 35+ year-old groups, while the number of non-Hispanic black women increased in both. Giving birth at an older age carries less risk than giving birth as a teenager and, while women older than 35 do carry some childbirth risks that inevitably come with aging, they are still more likely to initiate breastfeeding and have better birth outcomes than significantly younger populations.

Limitations

The limitations of this research are mostly due to the nature of the data set itself. There is no variation in the dependent variable, because this sample contains only women who answered 'Yes' when it came to initiating breastfeeding. Due to missing values in the data, the exact number of women who did not initiate breastfeeding cannot be determined. This does limit the analysis, because we cannot know anything about these women. The categories used for both independent variables, race and age, were provided by the Shelby County Health Department. The age variable does not include mothers who were under the age of 15, and the racial categories are quite broad, possibly obscuring smaller ethnic groups within these larger categories. This analysis does not address the complex reasons behind how these initiation trends occur or how the place (Shelby County) specifically influences them. This study does not take into account the varied and complex reasons behind the initiation disparities seen, including phenomena like systemic racism in healthcare and the increased stress level that black women experience in everyday life. These are ideas and concepts that should be taken up with further research.

Conclusion

This study indicates that there are significant relationships between breast-feeding initiation, race, and age of the mother. Black and Hispanic women are less likely to initiate breastfeeding than white women, and the older a mother is, the more likely she is to initiate breastfeeding. The trends found in Shelby County fit into what has been said on the national level about what type of women breastfeed. This data also mirrors the national trend of racial disparities amongst breastfeeding women. Across all racial and age groups, breastfeeding initiation has increased over the time of the sample, but the differences between racial groups have remained significant. Across the United States, we see health outcomes improving but racial disparities persisting. This can be frustrating, because we have at our disposal many of the tools needed to fight this, including Baby-Friendly hospital designations and increased breastfeeding-friendly workplace policies, which are two resources that research has proven increase breastfeeding initiation among low-income, low-education, and minority mothers.

Breastfeeding maximizes infants' positive health outcomes and reduces infant death rates. An increase in breastfeeding in Shelby County could greatly impact other infant health measures. Shelby County has struggled for decades with a comparatively high infant mortality rate, and this research provides a tool with which to understand this. There are hundreds more young, non-Hispanic black mothers, and the intersectionality of race and age can produce devastating outcomes for infant mortality. Shelby County has seen a decrease in its overall infant mortality rate, but black infants are still 2.5 times more likely to die than whites (Quander 2014). Infant mortality is a multi-faceted, complex issue that cannot be simplified to a single cause. What I argue here is that this study could be used, along with others, to identify potential target areas for future policies and interventions dealing with breastfeeding and infant mortality. Some of this work is being undertaken by various organizations in Shelby County with positive outcomes already being seen. By implementing interventions designed to decrease the number of teenage mothers, particularly black mothers, and to increase breastfeeding initiation for all individuals, Shelby County can see improvement not just in its overall infant mortality and breastfeeding initiation rates, but in its racialized health disparities as well.

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Tierica Gibson

Skeptical Sisterhood: A Sociohistorical Analysis of Identity Arrangements and the Schism between Black and White Feminists

Faculty Sponsor
Dr. Ladrica Menson-Furr

Abstract

There are many factors that have contributed to differences between black and white feminists, such as racism within early women's movement groups, and white feminists' evasion of the race question as it relates to black women's rights. This article, however, looks at the group identity arrangements of black and white women on the meso-level that influence the development of the two feminist ideologies and their activism. It argues the existence of a process-like social phenomena that determines how the schism between black and white women occurs, beginning with the way in which black and white women arrange their group identities. These identity arrangements are responsible for the development of their group's feminist ideologies and activism, and the differences within them lead to contrasts within black and white women's feminist ideologies and activism. Such contrasts create issues between the two groups of women while attempting to work together in women's coalitions.

Introduction

After the exit polls from the 2016 presidential election revealed the polarizing results between white women and black women, Jamilah Lemieux, writer and the vice president of Men's and News Programming for InteractiveOne, penned her opinion on why she would not be participating in the Women's March held January 21, 2017. In her open letter she articulated,

> I've never felt anything remotely resembling sisterhood with White women. Friendship, affinity, fondness, love—sure. Sisterhood? Nah. That sense of loyalty, interconnectedness, accountability and shared struggle simply isn't there (Lemieux 2017).

This particular feeling is not new to black women who have felt throughout decades in America that there was no "shared struggle" or "interconnectedness" between the two groups of women.

Previous literature centered on the distinct feminisms of white and black women only scratch the surface in exploring the root of the issues between white and black feminist movements. However, the importance of this research lies in its exploration deeper into the fundamental beginnings of sociopolitical movements to uncover the sociological causes of discord between white and black feminists, their feminist ideologies, and their movements. To explore these factors, I propose to investigate two questions: First, what are the possible sociological causes for tumultuous relationships between white and black feminists, and second, what implications do these causes have for present and future coalition work between the two groups?

As aforementioned, the lack of shared political and social struggle with white women has been documented by black women throughout feminist history. Although the struggles of white and black women may have converged at different points throughout the history of feminist movements, the end goals were not similar. It is important to note that the end goals of black and white feminist movements were dependent upon and shaped by the presence of race–its privileges for some, and its consequences for others. Not only were the end goals for these distinctive movements ultimately influenced by race, but the fundamental ideologies upholding their movements and the arrangement of collective identities within the groups were important as well. This research will primarily focus on an arrangement of collective group identities in white and black feminist groups, their feminist ideologies and movements, and how these

114

ultimately lead to a schism between black and white feminists.

This body of work takes an interdisciplinary approach; fusing academic fields such as sociology, political science, and history. Furthermore, this research uses a mixed methodology, sociological theories, and an analysis of primary and secondary historical texts to frame the body of work. Black feminist theory was used as a guiding framework throughout the research to not only privilege the experiences of black women, but also because of the peculiar standpoint black women possess that gives them insider knowledge of social processes and phenomena. This standpoint and insider knowledge is a staple of black feminist theory and became integral within this research when analyzing and interpreting the historical texts.

Literature Review

Framing Processes

Social movement theorists define a social movement as a struggle over meanings and beliefs (Paxton and Hughes 2007). Scholars within this field have identified three interdependent factors that create a social movement: political opportunities, resource mobilization, and framing processes (McAdam, McCarthy, and Zald 1996). This research will focus on the framing process within a social movement and how it can be influenced by the arrangement of collective group identity. Framing largely refers to a group's conceptualizing and meaning construction of the social movement in which it participates. In other words, framing becomes a negotiation of shared ideas, beliefs, and meanings in order to identify and define situations in need of change (Benford and Snow 2000). Framing also allows agents to identify areas within their lives they believe are problematic and plan strategic action in order to find solutions and act on them.

Most of the collective action that emerges out of the framing process is contingent upon culture and the saliency of the group identity or what the collective group has determined is most important based on its shared culture (Jasper 1997; Goodwin and Jasper 1999). According to these theorists, adding cultural materials to the framing process creates movements in which people become "consumers of existing cultural meanings and producers of new meanings" (Tarrow 1992). This research asks: What shared culture exists between white women and black women outside of having the same gender? Does gender work the same way for

white women and black women? Are there outside forces determining the way gender works for different women? These questions are important when analyzing even an aspect of feminism commonly assumed white and black women share. Identities such as gender, race, and sexuality, as well as factors like socioeconomic status and privilege, can be considered when a group collectively decides they are important. When these identities are framed they are then given the ability to produce new meanings in terms of ideologies and movement mobilization.

This research will attempt to link emergent ideologies and the meanings placed on the black and white feminist movements to the schism among black and white feminisms. Doing so will also allow the research to explain that a group's operationalization[1] out of the framing process determines the climate and relationship between groups as coalitions. Understanding the framing process can also help those researching women's coalitions search for deeper insight into how rifts can negatively affect relationships between women of different races, especially white and black women, on the meso level. It is important to note that the framing process is not similar to arranging identities. While group identity arrangement can take place during the framing process, it occurs when the collective group categorizes its identities in an array of distinct ways. As these theorists have argued, the framing process itself is a mechanism in which groups use these identities to determine areas in need of change that affect group members' lives in some manner.

Intersectionality and Identity Saliency

A common theme throughout this research is the idea of groups collectively arranging their identities. As aforementioned, these arrangements are influencers of the feminist ideologies that emerge out of the framing process which are then operationalized into distinct, sometimes conflicting, movements. While there are a myriad of ways for groups to arrange their identities, this research focuses on two: identity saliency and intersectionality.

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[1] Group operationalization is the process by which ideas materialize through the strategic planning and actions of an individual or group.

According to theorists that study Identity Theory, identity saliency occurs when identities are organized hierarchally with identities of most importance, or salience, situated at the top of the hierarchy and those with lesser salience and representation of self are located along the lower tier (Forehand, Deshpande and Reed 2002; Burke 1980; Callero 1985; Stryker 1968). These theorists gave little attention to how this particular arrangement of identities translates into ideologies and movements when they are framed. While there is an abundance of literature discussing the existence of identity saliency, there is little to no literature on the relationship between race and identity saliency on the meso level which provides an opportunity to contribute to filling in the gap.

There are some theorists, such as Peggy Thoits (1985), who have argued that factors such as age, sex, and race can overlap with social roles as they are transferred into social interactions, and such overlapping can produce role conflict and social strain (Thoits 1983). Her research states that as identities overlap they influence the nature of interactions between individuals. While Thoits' research is centered on the micro level of these interactions, we might ask what the overlap of these identities means for interactions between groups of women on the meso level?

Many black feminist scholars have introduced the idea of intersecting identities, or intersectionality of identities as they relate to black women and people of color (Crenshaw 1995; Settles 2006; Collins 2000). These identities intersect in such a way that the salience of one or more categories can influence the saliency of another, and can shape the experience of gender for women of color (Hurtado 1989). The "matrix of domination" as Patricia Hill Collins states, boils down to power structures for black women (Collins 2000). In other words, the intersections of identities located at the margins of power and privilege can open the doors for social and political colonization by groups with powers and privileges that transcend social, political, and economic institutions.

On a meso-level, producing shared meanings and beliefs of the world can strengthen the group. The conscious knowledge that intersectionality produces influences how black women approach the issues affecting their group. Black women's issues become multidimensional; therefore, these issues produce multidimensional feminist ideologies and ultimately multidimensional movements. Thus, intersectionality and the saliency of multiple identities constantly crossing one another depen-

dent upon social placements, becomes not only a permeating factor of knowledge, but a major mechanism in which black women interact with the outside world through these multidimensional movements. The role identity arrangement[2] plays within this research is integral and serves as a fundamental factor in the schism among black and white feminist groups in ideology and movement work.

Coalitions

Coalitions are contrasted with identity-based groups in that coalitions are formed across identity-based groups, and according to Reagon (1983), become spaces of difference, confrontation and risk. Patricia Hill Collins states we must be aware of forming coalitions out of oppression because of the contradictions that arise, such as privileges. Collins suggests that coalitions of activism must be formed only after each group comes to terms with the "multiple systems" of oppressions and privileges that shape our lives (Collins 1993). Thus, coalitions are formed because of shared necessity to achieve a common goal across identity-based groups (Matsuda 1991). In order to achieve coalitions that span across different social and cultural factors, but also have efficiency in making progress toward goals, Collins states there should be a reconceptualizing of identities as "categories of analysis" (Collins, 1993). We must therefore shift how we think about the nature of oppression in order to understand the connections among the identities that structure our lives.

Scholars studying women's coalitions have also considered the potential rewards and consequences of intersectionality, or the lack thereof, on the interconnection and interrelations of potential and formed coalitions (McCall 2005; Collins 2003; Vázquez 1993, 1997). Such rewards include a collective power in resistance of shared oppressions across those intersections that become coalitions themselves (Collins 2003), and women from various ethnic backgrounds examining the effects of male privilege and patriarchy in their own unique lives and strategically planning a front to combat the causes (Vázquez 1997). The lack of intersectionality or the

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[2] Identity arrangement is a term I use to describe the process by which individuals or groups examine their identities, determine their saliency, and organize them in a manner that becomes beneficial to their everyday lives.

118

sense of interrelation as a minimum requirement for coalitions can become detrimental to the goals of those women on the margins of society due to loss of shared belief in a particular struggle or oppression (Collins 2003). When viewing intersectionality as a matrix of domination as Crenshaw and Collins have theorized within the black feminist framework, coalitions can be understood as forming due to separate groups having shared goals relating to unsatisfying areas of their lives (Crenshaw 1995; Collins 2003).

There is existing literature and research that looks at the relationship between black and white feminists and their movements, especially from a historical perspective. However, I found no literature that looks at the sociological cause for the schism between black and white women's coalitions in terms of group identities. Thus, my study aims to contribute to the larger body of literature by examining how race and racial privilege affect group identities, and in turn what implications those group identities have on activism. How group identities are structured, either as a hierarchy of saliency, or intersectionally, determines the operationalization of their social movements agreed upon during the framing process.

Differences in feminist ideologies can result in disagreements in movement strategies and overall goals when coalitions attempt to affect relationships between racial groups of women. This study focuses on women because of the longstanding history of American feminism and the many attempts at women's activism throughout history. Thus, my research hypotheses address the root of the process: group identity arrangement based on race. The first hypothesis states black women are more likely than white women to have racial identity saliency. The second hypothesis states black women are more likely than white women to have saliency of multiple marginalized identities that intersect. I hope to advance the current understanding of the differences and conflicts within black and white feminism by relying on an interdisciplinary approach to research that can enrich the sociology of the findings.

Data and Methods

This research includes the analysis of primary sources obtained from the University of Memphis Library. Also, this research uses interview data obtained by the National Opinion Research Center (NORC) located at the University of Chicago in the 2014 General Social Survey dataset (hereafter GSS). The GSS is an annual survey distributed nationwide in which

participation is voluntary, offers multi-stage probability sampling, and is considered representative of the United States' population of adults (gss. norc.org). Within the 2014 GSS dataset, this research relies on a subset of 1,292 respondents within the total 3,842 respondents and chooses to analyze multiple relationships between the variables *Race of Respondent* [RACE], *Gender Saliency* [GENDSAL], and *Race Saliency* [RACESAL] while interchangeably layering the variables *Sex of Respondent* [SEX] and RACE.

Measures

The variable RACE is an independent variable that measures the self-identified race of the respondents. The values of the variable are characterized by the labels white, black, and other. Out of a total of 3,842 respondents, 75.5 percent identified as white, 15.2 percent as black, and 9.0 percent as other. Additionally, out of all female respondents, white women accounted for 73.7 percent and black women accounted for 18.0 percent.

The variable SEX is an independent variable that measures the self-identified gender of the respondents. Its value labels are male and female. Out of a total of 3,842 respondents within the dataset, 44.6 percent identify as male and 55.4 percent identify as female.

The variable GENDSAL is a dependent variable I recoded from the original variable R's *Gender is Important*, or IDSEXIMP. The original variable is an ordinal one that measures respondents' importance of gender from 0-10, with 0 characterized as 'Not at All' and 10 as 'Completely.' IDSEXIMP was recoded into GENDSAL by merging values 0-4 into the new recoded value '1 – No Importance,' the value 5 was recoded into value '2 – Somewhat Important,' and values 6-10 were recoded into value '3 – Very Important.'

The variable RACESAL is a dependent variable I recoded from the original variable R's *Race is Important*, or IDRACIMP. The original variable is an ordinal one that measures respondents' ranking of the importance of race from 0-10, with 0 characterized as 'Not at All' and 10 as 'Completely.' IDRACIMP was recoded into RACESAL by merging values 0-4 into the new recoded value '1 – No Importance,' the value 5 was recoded into value '2 – Somewhat Important,' and values 6-10 were recoded into value '3 – Very Important.'

120

Analytic Plan

To suggest any associations between the variables, first the dependent variable RACESAL was crosstabulated with the independent variable RACE while adding a layer for the variable SEX. This was done to assess the responses of groups by race and gender, only focusing on the responses from black women and white women. Next, the variable GENDSAL was crosstabulated with the variable RACE while adding a layer for SEX. Doing so allowed the research to analyze the percentage differences between black and white women's responses to the interview questions. A chi-square test was conducted to test the association between each crosstabulation. It is important to note the statistical procedure cannot account for intersectionality of multiple categories that could influence women respondents, especially black women. Thus, the research will depend more on the percentage differences between black and white women's responses, and sociohistorical analysis from primary texts.

Results

Table I displays the descriptive statistics for the independent, dependent, and recoded dependent variables used in the research. I found that most respondents believe gender is important in their lives, as there was a mean of 8.38 out of 10. I also found that respondents are seemingly neutral on the importance of race within their lives. Unlike gender, the mean was 5.95 when respondents were asked about the importance of race within their lives. The majority of respondents; however, were self-identified as white and female.

Table II is a crosstabulation of RACE and GENDAL and shows responses of females in percentages to measure the level of importance of gender within their lives. According to Table II, women across races believe gender to be of high importance in their personal lives. The data indicated that 87.2 percent of white women responded 'Very Important,' while 90.8 percent of black women and 85.0 percent of other minority women also responded 'Very Important' when asked about gender saliency. When analyzed as groups, particularly within black and white female respondents, the data suggests that both groups of women have a high saliency for gender as there was a percentage difference of 3.6 percent between their responses. According to the chi-square statistical testing (X=51.080, P<.001), the relationship between the variables GENDSAL

Variables	M	SD
Independent Variables		
RACE	1.33	.635
SEX	1.55	.497
Dependent Variables		
R's Gender is Important	8.38	2.34
R's Race is Important	5.95	3.497
GENDSAL (Recoded)	2.80	.508
RACESAL (Recoded)	2.26	.848

Table I. Descriptive statistics for all variables in analysis

Source: General Social Survey

and RACE is highly significant at the .001 level and corresponds with literature analyzing gender saliency in women's lives throughout waves of feminism. The Gamma value is .567 (p<.001) which suggests a moderate association between the race of the respondent and whether or not they believe gender to be important.

Table III is a crosstabulation of the variables RACESAL and RACE and shows the response percentages among female respondents measuring racial saliency within their lives. There is a significant difference across variables shown in the crosstabulation table. When asked if

Gender Saliency	White	Black	Other
Not Important	19 (3.4%)	7 (5.4%)	0 (0.0%)
Somewhat Important	52 (9.4%)	5 (3.8%)	6 (15.0%)
Very Important	484 (87.2%)	118 (90.8%)	34 (85.0%)
Total	555 (100.0%)	130 (100.0%)	40 (100.0%)

Table II. Crosstabulation of RACE and GENDSAL

Source: General Social Survey [2014 Merged File], N=725

race is important in their lives, the responses among white women seem to be much more evenly spread among the response choices rather than heavily concentrated within one response as seen with the crosstabulation between GENDSAL and RACE. When RACESAL and RACE were crossed, only 47.2 percent of white female respondents responded 'Very Important,' while 25.2 percent responded 'Somewhat Important,' and 27.4 percent responded 'Not Important.'

This is a stark difference between the responses of black women and other women of color represented in the data. When asked if race is important in their lives, 71.5 percent of black women within the data responded 'Very Important,' 13.8 percent 'Not Important', and 14.6 percent for 'Somewhat Important'. With a 24.1 percentage difference between white and black women's responses for 'Very Important,' we can suggest that black women are more likely to assign a higher saliency for race than white women. According to the chi-square statistical testing ($X=66.919$, $P<.001$), the relationship between the variables RACESAL and RACE is highly significant at the .001 level. The Gamma value is .410 ($p<.001$) which indicates a moderate association between the two variables.

Race Saliency	White	Black	Other
Not Important	151 (27.4%)	18 (13.8%)	7 (17.5%)
Somewhat Important	139 (25.2%)	19 (14.6%)	3 (7.5%)
Very Important	261 (47.4%)	93 (71.5%)	30 (75.0%)
Total	551 (100.0%)	130 (100.0%)	40 (100.0%)

Table III. Crosstabulation of RACE and RACESAL

Source: General Social Survey [2014 Merged File], N=721

In order to integrate the data within the literature of intersectionality, we can analyze the two crosstabulation tables together. Although the GSS does not currently have variables relating to intersectionality and SPSS does not compute for intersectionality, these two tables when analyzed in relation to each other can give us further insight into group identity intersectionality.

Discussion

In order to discuss the results of the data collected in a holistic manner, the data tables must be interpreted in conjunction with one another to see and understand this research's assertion of black and white women having different arrangements of their identities on the meso level. It is equally important to rely on history while discussing the data findings to not only humanize the data, but to also show the reoccurrence of the schism among black and white feminist ideologies and movements throughout American feminist history. Thus, this research will focus on the Women's Suffrage Movement and the Student Nonviolent Coordinating Committee (SNCC) during the Civil Rights Movement as historical examples.

The right to vote is viewed by some as the pinnacle of citizenship as an American. For Black Americans, the path to suffrage was a rocky, turbulent one filled with many pitfalls, especially for black women. Even while women were granted the right to vote by the ratification of the Nineteenth Amendment on August 18, 1920, black women nationwide were not permitted to vote until the signing of the Voting Rights Act in 1965 by President Lyndon B. Johnson. As the data and previous literature revealed, race influences the salience of both race and gender not only on the micro level, but also on the meso level within group identity. To go one step further, history reveals that it is the privileging and marginalization of race that determines how a group arranges its identities, and it reveals the consequences of such privileging or marginalization once it occurs within women's lives as they interact.

When analyzed as groups, particularly within black and white female respondents, the data suggests that both groups of women have a high salience for gender as there was a percentage difference of 3.6 percent between their responses. With a 24.1 percentage difference between white and black women's responses when questioned about race, we can also suggest that black women are more likely to perceive a higher salience of race than white women. The data suggests that white women see a higher salience for gender than race, which corresponds to the researcher's idea of black and white women having different fundamental arrangements of their group identities. Therefore, women arrange the salience of their identities within a hierarchy with gender receiving the most attention within the framing process.

On the meso level, the data suggests that both white and black women identify high salience for gender. History reveals the same on the topic of women's suffrage, as both black and white women during the early Twentieth century viewed voting rights as women's rights (Terborg-Penn 1998). The high saliency for gender spawned the women's club movement in which white women and newly freed black women formed coalitions for suffrage in a white, male dominated political sphere. Organizations such as the National American Woman Suffrage Association and American Equal Rights Association formed to give women the opportunity to lobby for suffrage together. However, decisions on strategy for achieving suffrage and even more importantly who receives suffrage varied across women within these organizations. All of these organizations

were faced with the "race question," and the question of suffrage on the intersection of race and gender formed strong opinions among white and black women (Terborg-Penn 1998).

When identities are arranged within a hierarchy while framing a movement, the identity situated at the top is the identity the group will most likely operationalize within the movement. Whichever identity is decided by the group as more important is taken into consideration over other identities. The data within this research suggests black women have high saliencies for both gender and race, as the majority of black women said that race and gender were both "very important" to them. This corresponds to the research hypotheses and the idea that their identities are arranged by intersectionality. In this case, the saliency of one identity influences the saliency of another identity. The interconnectedness of the identities equalizes their saliencies, and as a result the group has to consider and operationalize all the intersected identities. Therefore, intersectionality not only creates a multidimensional ideology of feminism, but when framed also creates multidimensional movements.

It is also important to discuss the differences between black and white women in the level of agency inferred from the data collected. Racial privilege protects white women from the unfortunate experiences that women of color experience and has the power of blinding the consequences of being a person of color. White women do not have to consider race in every aspect of life, which increases their agency in arranging their group identities. However, there is no agency with intersectionality for black women and other women of color because of the presence of two or more marginal identities. To simplify, identities are interdependent and equally salient; therefore, black women and other women of color cannot choose which identity is most salient in their lives due to the societal disadvantages inflicted upon them.

Historical Analysis

During the Women's Suffrage Movement, the difference is clear in how the salience of identities are arranged for white and black women. As stated previously, this can be attributed to the special privileges and consequences race brings, depending on whether one is a member of the dominant race or the subordinate race. The hierarchically arranged identities for white women in which gender was primary and race was pushed aside

proved detrimental to black women's hope for maintaining suffrage. White suffragists' saliency for gender and marginalization for women of color was clear in their organizations' distinguishing of "women's rights" and "negro rights" from one another (Terborg-Penn 1998). Black women, because their race is not privileged but instead marginalized, were not granted the luxury of simply ignoring race. Equipped with race consciousness, black women were aware of their white counterparts' dismissal of race and racism within the suffrage movement. As Frances Harper stated in 1869, fifty years before the passage of the Nineteenth Amendment, white women's saliency in the fight for not only suffrage rights but also human rights were "for sex, letting race occupy a minor position" (Terborg-Penn 1998).

To reiterate, the presence of racial privilege allowed white women to ignore the institution of race while strategizing for suffrage, and thus, led a movement for suffrage that was centered on gender and not race. In other words, the suffrage movement was a white women's movement. Although black women were integral to the ratification of the Nineteenth Amendment in 1920, it would be forty-five years until black women received enfranchisement. By the sixties, a new wave of movements encompassing a demand for justice reform, voting rights, and civil rights had completely engulfed America and was later coined the Civil Rights Movement. Black and white women during this period of race relations again formed coalitions and networks in an attempt to achieve equality for people of color. However, the ideologies of the two groups of women stemming from the saliency of their identities were just as different as they were in early twentieth century.

A key similarity in white women's identities from the early twentieth century and the sixties was their lack in acknowledgement of racial privilege as a group. Just as the data collected in 2014 suggested white women, when asked if race was important to them, were split among their responses, so were they also during the Civil Rights Movement. To reiterate, 47.4 percent of white women responded that race is "very important" to them, 25.2 percent responded "somewhat important," and 27.2 percent responded that race is "not important." This is a stark difference in the responses that black women and other women of color gave in the data, as their responses were overwhelmingly saturated within "very important." The split among white women's feelings on race in the data is similar to that of the geographical split among white women during the Civil Rights

Movement. Most of the white women who volunteered to help during the Civil Rights Movement lived in northern states and traveled to the South to work with civil rights groups such as the Student Nonviolent Coordinating Committee, or SNCC. Most white women who were natives of the South harbored the traditional racist attitudes and beliefs toward the idea of equality and liberation for people of color (Breines 2006).

As stated previously, the presence of racial privilege and lack of racial consciousness allowed white women to center their framing process, feminist ideology, and movement solely on gender rights and to overlook the effects of race on black women's quest for equality and liberation. In the Sixties during the height of the Civil Rights Movement, racial consciousness had spread throughout the United States by way of knowledge and awareness of the grotesque treatment of black people and people of color. In spite of increased race consciousness, what happens when racial privilege progresses unchecked?

Analyzing the relationship between black and white women, particularly in the SNCC during the Civil Rights Movement, helps us further understand that although northern white women had become aware of the state of racial relations, their feminist ideology and the influence of racial privilege had not undergone much transformation since the Women's Suffrage Movement. White women's feminist ideology had not changed due to a number of reasons: first, as a group, the privileging of gender persisted within their group's identity arrangement and resulted in gender rights remaining as their main goal, and second, the presence of increased race consciousness does not necessarily equate to acknowledgement of racial privilege.

The relationship between white and black female students who participated in the SNCC, both during and after Freedom Summer in 1964, is a testament to the idea of white women's lack of knowledge in racial privilege. As Winifred Breines wrote in *The Trouble Between Us*, during and after Mississippi's Freedom Summer in 1964, the SNCC had grown exponentially. The once small organization made up of black students had grown from just 20 staff members in 1962 to over 200 staff members and around 250 volunteers in 1965, and the organization witnessed a 20 percent increase in white members. Many of these held leadership positions within the organizations (Breines 2006). Like many organizations, there were organizational issues that arose that became very political. Two

white, female students, Mary King and Casey Hayden, authored a paper addressing gender stratification within leadership positions of the SNCC in the fall of 1964. By 1965, the two women authored a paper titled, "A Kind of Memo: Sex and Caste." In the statement, the two white women compared the treatment of blacks in America to the way all women were treated as a whole in society (Breines 2006).

As the papers were distributed and became a part of the new meaning for radical, second-wave white feminism, it caused an uproar internally within the SNCC. It also damaged the relationship between black and white female members, since black female members felt the messages within the papers were counterproductive to the movement (Breines 2006). Black women were well aware of sexism and the issues concerning gender in the SNCC, but they were focused on justice and equality for people of color outside their organization. Breines (2006) later wrote, "White women were the ones who publicly raised gender issues in the SNCC, and the issues were embraced by white women elsewhere in the movement – which may have confirmed for black women that these were white women's concerns, or at least the narrow focus on gender was."

King and Hayden's memos subsequently cast a negative light on the SNCC among white feminists, and the attention to "male chauvinism" within the SNCC weakened the message and demand for equal rights, justice, and liberation for all people of color. The relationship between black women and white women within the SNCC never healed as black women were focused on the SNCC's original goals and felt white members were overlooking the racial matters at hand, as well as their own part in the rising racial tensions within the SNCC (Breines 2006). Ultimately, black women within SNCC did not necessarily disagree with white women's assessment of sexism, but felt adding a platform in their organization for the sexism all women faced was counterproductive to their movement on the issue of inequality on the basis of race.

The strained relationship between black and white women within the SNCC shows the differences in the goals and priorities of the two groups of women working together. The research again suggests that white women as a group arrange their identities within a hierarchy of importance (meaning white women have a higher saliency for gender than race). This causes not only racial issues to take a backseat, but also prevents white women from being fully aware of their own racial privilege. On the other

hand, black women, because of intersectionality, are aware of their social position at the margins of multiple identities and the consequences, sub-ordination, and potential domination these intersections generate. Thus, black women must have salience for both gender and race and give their energy in organizing and fighting for the rights of both marginalized identities.

Conclusions and Limitations

Ultimately, this research found that the schism between black and white feminists is not only caused by the differences between the two identity arrangements, ideologies, and movements, but comes as a result of the amalgamation of these. Intersectionality goes beyond just the idea of intersecting identities. The crux of intersectionality as a theory lies in the domination and subordination on multiple levels that occurs at the margins of those intersecting identities. Therefore, intersectionality is identity arrangement rather than an experience that black women have the privilege of choosing.

Black women are born into at least two marginalized identities: being black and being female. The occurrences at the margin of this specific intersection are capable of producing dangerous consequences for black women mentally, emotionally, and even physically. The intersection of race and gender for black women also gives them a special vantage point on the inner workings of society that becomes special knowledge for survival. Intersectionality and the experiences it produces make race and gender for black women inseparable both in their daily lives and their activism within a collective group.

This study also found that identity saliency is present with white women's collective identity, but, in contrast to intersectionality, their identities are arranged within a hierarchy in which one identity is most important. The preferred ideologies also receive the most resources, which will be transformed into activism. I found that gender serves as the most salient identity to white women as a collective, unlike black women's identity arrangement in which race and gender are equally salient. This study found that race lacks saliency among white women's identities due to racial privilege. This lack of racial saliency is integrated within the white feminist ideology and stalls the development of racial consciousness while also limiting white women's acknowledgement of their racial privilege.

So, how do race and gender become polarizing for black women when working with white women? Almost identical with these research findings, history also reveals there is a split among white women concerning their feelings about the importance of race. This split within this group corresponds to the research's idea that due to their heavy saliency of gender, along with the presence of racial privilege, white women are able to choose when to allocate resources to activism regarding race. The inconsistency of racial saliency within white women's ideology and activism causes issues while working in coalitions with black women whose feminist ideologies and activism requires both gender and race to be equally salient.

The historical analysis of women's coalitions during the Women's Suffrage Movement and the Civil Rights Movement serve as examples of the inconsistency in white women's orientation towards race and the effects such inconsistency had on the relationship between black and white feminists. Although black and white women worked together in their efforts to gain suffrage, there was a split among white suffragists concerning race, with some fearful that black women receiving suffrage would increase the political power of black men. Other white women rejected the idea of complete enfranchisement of black people, while continuing to solicit the help of black women and generating black women's distrust of white women in the process. Forty-five years later, the distrust was still present as white women had been able to vote since the ratification of the Nineteenth Amendment while voting rights were stripped from black women, and white women did not offer any help in maintaining black women's suffrage (Terborg-Penn 1998).

White women's inconsistency of racial saliency was present during the Civil Rights Movement as black and white female students participated in the SNCC. The relationship was strained as the white female members wanted to address what they perceived as sexism within in the organization and publicly, also anonymously, expressed their displeasure. The action taken by these members weakened the power and original platform of the SNCC, which focused on racial justice and equality for people of color, as second-wave white feminists began circulating the essays outlining the concerns of sexism within the organization. It was clear to the black women within the SNCC that although in the same organization, black and white women had separate priorities. The distrust grew so rapid-

ly that white members were later expelled from participating in the SNCC as the organization moved toward black nationalism under Stokely Carmichael's leadership (Breines 2006).

The rift among white and black feminists still exists in the present-day and was reflected in the exit poll data from the 2016 presidential election, in which more than half of white females voted for Donald Trump. The overwhelming majority of black women voted for his white, female opponent, Hillary Clinton–a stark difference. The distrust was apparent from the writings of many black female scholars who theorized how such a split vote could occur among white women. Sociologically explaining the rift between white and black feminists while incorporating identity theory and social movement theory was formally unchartered territory and warranted attention.

Future research relating to this study can benefit from incorporating qualitative research methods including focus groups and in-depth interviews with women from various racial backgrounds self-identified as feminists. Researchers may also want to consider expanding the variables to include age, socioeconomic status, and even sexuality to add multi-dimensions to women's identity and the effect the variables may have on white and black feminist ideologies. Lastly, future researchers examining the relationship between black and white feminists can advance this study by increasing the sample size of the data to better represent the population size of black and white women.

Recommendations for Women's Coalitions

Many black women were left wondering after the 2016 presidential election if working with white women to achieve equality would be conducive to the health and success of their own struggles for equality and justice. Phrases such as "Listen to black women," and "Follow black women" began to ring out from white feminists in an attempt to heal from the election. Although these suggestions from white women seem like a basic starting point for repairing the relationship between white and black feminists, they can be dangerous to the mental, emotional, and even physical health of black women when put into practice. Therefore, I am providing recommendations for present and future multiracial women's coalitions in the Trump era and beyond.

First, and most importantly, white women must acknowledge their

white privilege and believe it is real in its rewards when attempting to work in coalitions with women of color. This acknowledgement will allow them to realize that there are certain aspects of life regarding race and gender they may not understand because of the influences and protections white privilege affords to their racial group. Secondly, it is important to know that black women did not create race or gender, and they are not the engineers of the various forms of racism and sexism. Therefore, it is not the responsibility of black women to end racism or sexism. While phrases such as "Listen, follow, and trust black women" are beneficial in terms of strategy, black women should not be the ones to risk their health by placing their bodies on the frontline in a fight they had no part in creating. Lastly, when participating in coalitions with black women and women of color, white women should make it a goal for their collective group to be united under the common purpose and ideas of the organization in which they belong. When one group is divided, it weakens the power of the entire organization and creates a space for tension, infighting, and distrust.

I have hope that white and black feminists, and women who don't identify with the feminist ideology, can unite and work together to form powerful women's coalitions that enact change for the improvement of society. The best strategy for white women to achieve effective coalitional work with black women and other women of color is to learn as much as possible about other women, their struggles, their pains, and their triumphs. Doing so can begin the process of healing and allow greater cooperation among women. Ultimately, together we are greater than the sum of our parts.

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Eithel Mc Gowen

An Argument for Reducing Value Added Tax Rates in Developing Countries: The Uruguayan Case

Faculty Sponsor
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Abstract

This paper studies the effect of reducing value added tax (VAT) rates on
tax revenue in developing countries. Developing countries have a larger
proportion of firms in the informal sector compared to developed coun-
tries, which translates into greater tax revenue gaps and higher tax evasion
rates. The hypothesis is that a reduction in VAT rates will decrease revenue
in the short run. In the long run, lower rates will create an incentive for
small and medium-sized informal businesses to become formal, which
will offset the negative impact of the rate reduction and increase revenue.
Using Uruguayan data before and after 2007, in which the VAT rate was
cut, I find that the rate reduction had a positive impact on tax revenue. I
also compare the results of the VAT cut in Uruguay to a VAT increase in
Mexico by analyzing firm level data from the World Bank Surveys. Taken
together, the results of this paper support the hypothesis that reducing VAT
rates in developing countries has a long term positive effect on tax reve-
nue.

Introduction

The Value Added Tax (VAT) was first proposed in France in the year 1954. It was conceived as a tool to tax consumption for either expanding the budget or closing deficit gaps. Since then, it has been adopted in about 160 countries around the world, including every single country member of the OECD except the United States[1].

After its adoption in European countries in the 1960s, VAT rates have seen a clear upward trend throughout OECD countries. The average standard VAT rate for OECD countries went from 15.6% in 1975 to 19.2% in 2015. The VAT has not only gained popularity within developed countries, but also in emerging market economies. The average standard VAT rate in South America is 16.7%, with Uruguay having the highest rate at 22%.
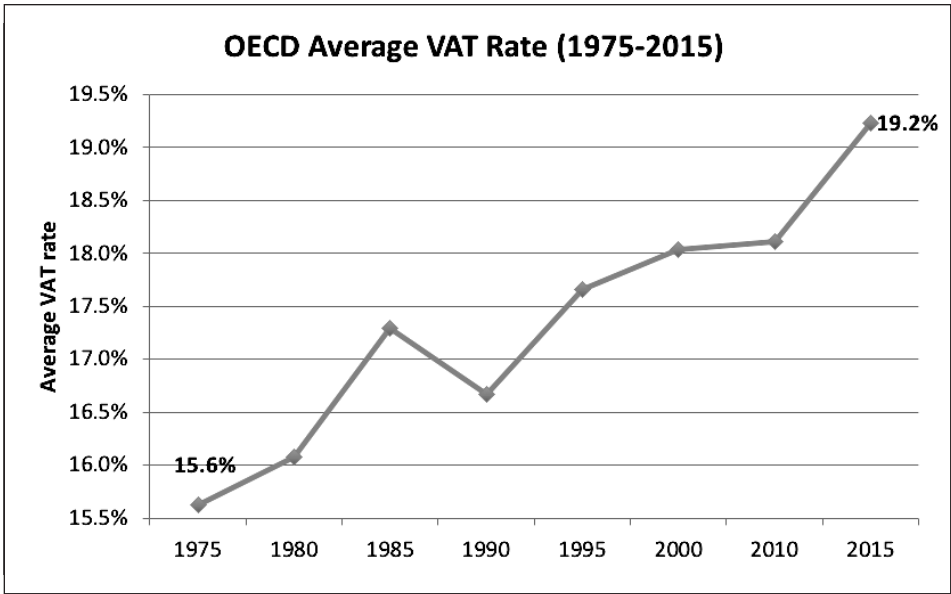

Figure 1. Historical Average VAT rate in OECD countries

Source: OECD database

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[1] Consumption Tax Trends 2014: VAT/GST and excise taxes, trends and policy issues. OECD, 2014.
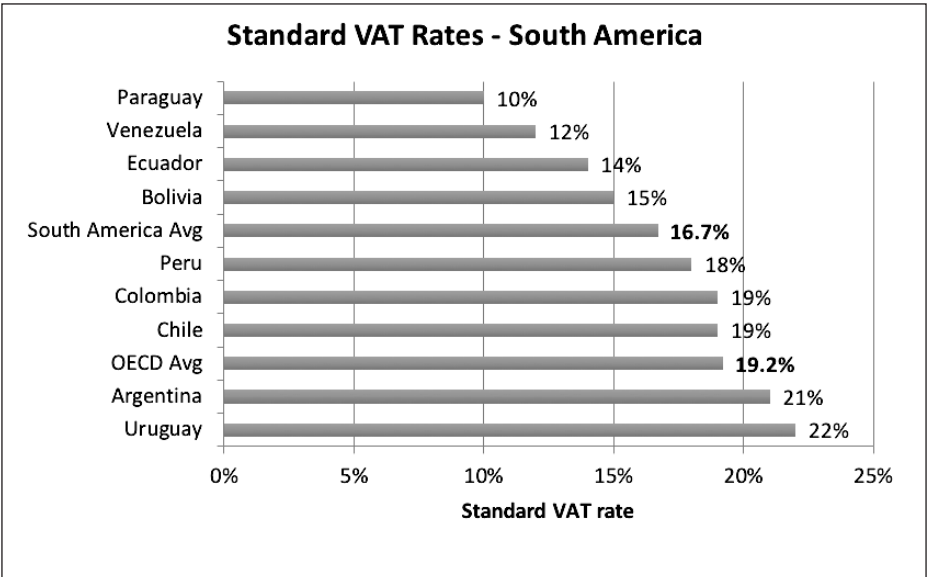
Figure 2. VAT Rates in South America

Sources: PwC Worldwide Tax Summaries, OECD database

Governments in developing countries face a complex series of challenges for taxation that developed countries have been able to solve or attenuate in the past. Well-funded tax authorities and big penalties for not paying taxes, added to a culture that condemns that kind of behavior, together create an environment where the tax revenue gap is minimized. This situation is far from being a reality in emerging market economies, where a large number of small and medium sized businesses operate outside the formal economy. These conditions are evidenced by the proportionally large difference in tax revenues between the developed and developing world. Tax revenues in OECD countries amount to roughly 36% of the gross national income in 2007, compared to 23% in Africa (2007) and 17.5% in Latin America (2004)[2].

The relationship between tax rates and tax revenue has been well studied and argued in the past. One of the most famous arguments on the

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[2] OECD Statistics, stats.oecd.org

topic is the idea of a curve proposed by economist Arthur Laffer, in which there is an equilibrium level of taxation where tax revenue is maximized. This paper argues that developing countries with VAT rates similar to the OECD average VAT rate would increase tax revenue by reducing their tax rate while approaching the Laffer curve equilibrium. The reasoning behind this hypothesis is that, given the significant size of the informal sector and high tax evasion rates, reducing the VAT rate would create an incentive for informal small and medium sized businesses to become formal. In the short run, tax revenues would decline as a consequence of the tax cut, assuming a constant tax base. In the long run, increasing tax revenues from businesses entering the formal economy would offset the decrease caused by the tax cut.

In order to test the hypothesis, I analyze the case of Uruguay, which reformed its tax code in 2007. Uruguay had a standard VAT rate of 23% before the reform, not only the highest in South America, but also significantly higher than the OECD average of 18% at the time. The Uruguayan government reduced its standard VAT rate from 23% to 22%, while also cutting its reduced VAT rate from 14% to 10%.This change in tax policy provides an opportunity to empirically test the hypothesis by simulating a scenario in which the VAT rate was not cut, and then comparing the results to what actually occurred in terms of tax revenue. I also employ firm level data from the World Bank Surveys to further support the results.

Data and Definitions

Data

The data used for the empirical analysis comes from 3 different sources. Gross Domestic Product (GDP) data was retrieved from the historical accounts database of the Central Bank of Uruguay (BCU). Tax Revenue data was collected from the Uruguayan Tax Authority (DGI) monthly reports. Tax evasion estimates were collected also from the Uruguayan Tax Authority (Vallarino 2004), as well as a study performed by the Center for Economic Research (CINVE) of Universidad de la Republica Oriental del Uruguay. Both sources for tax evasion data used the consumption method in which the tax base is calculated by adding up tax collections from end consumers.

144

The firm level data was collected from the World Bank Surveys, a series of surveys taken from a representative sample of an economy´s private sector covering a wide range of topics, one of them being regulation and taxes. The surveys were conducted in 2006 and 2010 in Uruguay and Mexico. They were distributed by private contractors on behalf of the World Bank and completed by business owners and managers. The timing of these surveys is important because they reflect the sentiment of firms towards the tax regime before and after a VAT rate reduction in Uruguay and a VAT rate increase in Mexico. The results should be taken as an additional indicator of tax policy efficiency at the microeconomic level.

Definitions

Value Added Tax (VAT): is a general tax assessed on the value added to goods and services. It is general because in theory it applies to all commercial activities involving the production and distribution of goods. The VAT is considered a consumption tax because it is passed on through various transactions at different stages of the production process and it is ultimately borne by the consumer. It is very common for countries to have a reduced VAT rate that applies to smaller businesses.

OECD: founded in 1960, the Organization for Economic Cooperation and Development is an intergovernmental organization with 35 members that focuses on stimulating economic progress and international trade.

Tax Revenue Gap: a measure of the gap between ideal tax revenues under perfect enforcement (potential tax revenue) and the actual level of tax revenue.

Tax Evasion Rate: the tax revenue gap expressed as a percentage of the potential tax revenue

Informal Economy: all economic activities by workers or economic units that are – in law or practice – not covered or sufficiently covered by formal arrangements[3].

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[3] International Labour Conference, 2002

Informal Sector: a group of production units (unincorporated enterprises owned by households) including "informal own-account enterprises" and "enterprises of informal employers."[4]

Informal Sector Enterprise: Unregistered and/or small-scale private unincorporated enterprises engaged in non-agricultural activities with at least some of the goods or services produced for sale or barter[5].

Laffer Curve: represents the relationship between tax rates and tax revenue. At a tax rate of 0% or 100%, government will collect no revenue. This paper argues that developing countries with a significant informal sector have a VAT Laffer curve that is more skewed to the left, compared to developed nations.
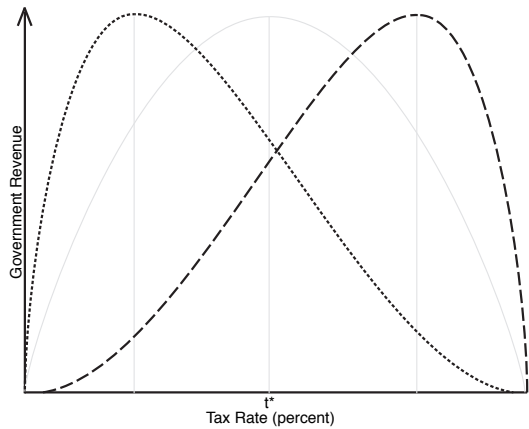

Figure 3. Laffer Curve

Theory

Equation for Tax Revenue

Assuming a flat VAT tax rate, tax revenue (R) would be determined by the following factors: the tax base (B), the tax rate (t), and the tax evasion rate (E).

[4, 5] 15th International Conference of Labour Statisticians

146

$$R = B * t * (1\text{-}E)$$

Function for Tax Evasion

Firstly, I adopt the framework developed by Allingham and Sandmo (1972) to explain the theoretical drivers of tax evasion. The decision to either evade or pay taxes is made by a rational taxpayer or firm under conditions of economic uncertainty due to flaws in the taxation system or distrust for the tax authority. If the expected value of evading taxes is higher than the cost of paying taxes, then the business will choose to evade. The expected value of evading taxes to the perpetrator will then be a function of three factors: the tax rate (t), the probability of being detected (p), and the economic or legal punishment assessed for evading taxes (θ).

$$E = (t, p, \theta)$$

Assuming *ceteris paribus*[6], a decrease in the tax rate (t) will decrease the expected value of tax evasion, creating an incentive for firms to become formal.

The probability of being detected is directly linked to the capacities of the tax investigation division of the tax authority. These capacities range from technology such as powerful databases, to human capital such as trained and motivated tax officers. The International Tax Compact (ITC) states that "the lack of sufficient capacities in tax administrations reduce the probability of detection that again influences the decision of the taxpayer as to evade or not."[7] The punishment for evading taxes is another factor discussed by the ITC that affects tax evasion. But having harsh laws that penalize firms that evade taxes is not enough. A strong justice system that applies those laws is also required to reduce tax evasion in theory.

Secondly, I add to the previous function two other factors discussed in existing economic literature that explain tax evasion: institutional factors (I), and tax morale (M).

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[6] "All other things being equal"
[7] International Tax Compact (ITC) is an initiative launched by the German Federal Ministry for Economic Cooperation and Development (BMZ)

$$E = (t , p , \theta , I , M)$$

Institutional factors, also described as insufficiencies in tax collection, are an issue especially visible in developing countries. It is explained mainly as inefficiencies or corruption of the agency that is responsible for tax administration and collection. As discussed by Fjeldstad and Moore (2009), it is more likely to find corruption when the finance ministry assumes the role of tax authority. Many emerging market economies have created a separate entity as an effort to mitigate corruption and increase efficiency of tax collection.

Tax morale can also be understood as the willingness to pay taxes. According to the ITC, this factor is driven by low quality of services in return for taxes and the perception of fairness from the population, coupled with low transparency of public institutions and the lack of rule of law[8]. The concept of tax morale is generally applied to the individual taxpayer's case. A great example is the difference in attitude towards paying taxes in Scandinavian countries compared to South American nations. In some specific cases, tax morale also affects a business's decision to either pay or evade taxes. Firms perceiving that they are being unfairly taxed will choose to misrepresent their earnings and commit tax fraud.

Finally, I add GDP growth (GDP) to the model as a measure of the level of economic activity in the country, which gives our final function for tax evasion:

$$E = (t , p , \theta , I , M , GDP)$$

Serra (1991) explains that the level of economic activity of a country is a factor that is considered by the taxpayer or firm when faced with the decision of paying taxes. Periods of economic growth and larger profits would create an incentive to pay taxes. Conversely, evading taxes would be adopted as a survival method during contractionary or negative business cycles.

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[8] ITC, 2010

Types of Informal Firms

The following is a classification of informal firms according to La Porta and Shleifer (2008):

Survival View (Type 1): informal firms are not productive enough to ever become formal even if entry barriers were nonexistent. These firms have low human capital and are only able to survive because they do not pay taxes.

Parasite View (Type 2): informal firms that would be able to survive if entry barriers were removed but would choose to stay in the informal sector because it would be a more profitable option given their average productivity.

De Soto's View (Type 3): firms with high productivity levels that would also survive if entry costs were removed and would choose to become formal in that scenario. These types would benefit from entering the formal economy because they are constrained by the size of the firm. Their potential earnings associated with expanding the firm outweigh the costs associated with taxation and regulation.

It is important to discuss the types of firms that exist in theory in the informal sector because this paper assumes that a significant number of tax evading businesses are Type 3 firms. In the case of a VAT cut, each type of business might react differently. A Type 1 firm will never enter the formal economy because of low productivity and human capital, therefore the tax cut would have no effect on this type. A Type 2 firm would also choose to stay informal after a VAT cut because they value higher profitability in the absence of taxes. The only scenario where Type 2 firms would become formal is if tax authorities started to enforce laws more heavily or the punishment for evasion were increased. Consequently, those firms would have a lower value of evading taxes and would choose to be part of the formal economy. Type 3 firms are most likely to start paying taxes after a VAT rate reduction given their high productivity and the potential profits that would come with expansion.

Model Specifications

Adjusting for standard and reduced VAT rates

As discussed previously, this paper argues that developing countries with a large informal sector and VAT rates close to the OECD average VAT

rate would benefit from a tax cut by creating an incentive for tax evading businesses to become formal. I look at the case of the Uruguayan tax reform in 2007, when the standard VAT rate was changed from 23% to 22%, and the reduced rate from 14% to 10%. In order to analyze and quantify the effects of the tax cuts, this paper seeks to estimate the tax revenue gap for the years 2007-2012 (assuming the tax reform did not take place) and compare it to the actual tax revenue gap as reported by the Uruguayan Tax Authority (DGI). Going back to our equation for tax revenue, where R = revenue, B = tax, t = tax rate, and E = evasion rate:

$$R = B * t * (1 - E)$$

Given that there are two different rates, I therefore simplify the equation by replacing the product of the tax base (B) and the tax rate (t) with the potential VAT revenue (VATp):

$$R = VATp * (1 - E)$$

VAT revenue data provided by the DGI and the authority's potential VAT revenue estimations account for revenues from both the standard and reduced VAT rates. In order to estimate the tax revenue gap without the policy change, the tax evasion rate will have to be estimated in the first place.

Adjusting for measurability and data availability

As discussed in the theory section, firms decide to pay or evade taxes given the following function:

$$E = (t , p , \theta , I , M , GDP)$$

Where:

t = tax rate

p = probability of getting caught

θ = punishment for evading taxes

I = institutional factors

M = tax morale

GDP = GDP growth

150

In order to build a model that could estimate the tax evasion rate assuming no policy change (holding t constant), I discard factors that do not meet conditions of measurability and availability of data, such as punishment for evading taxes (θ), and tax morale (M).

Model

The resulting model for estimating tax evasion is the following:

$$E_t = B_0 + B_1 * logGDP_t + B_2 * DGIbud_t + B_3 * DGIeff_t + u_t$$

Where:

E = tax evasion rate

LogGDP = log(Real GDP)

DGIbud = budget of the tax authority as a % of GDP

DGIeff = expenditures of the tax authority as a % of total tax revenue

u = error

t = time period in years

LogGDP is calculated by taking the logarithm of real GDP in 2005 prices, so it is expressed as an elasticity. Increasing LogGDP should lead to decreasing E.

DGIbud is used as a measure of how much money is being allocated by the central government to the Uruguayan Tax Authority (DGI), and acts as a proxy for (p) probability of being caught. The idea is that a funding increase for the tax authority should improve their fraud detection capacities, assuming funds are invested in better technology and personnel training. An increase in DGIbud would lead to a decrease in E. Finally, DGIeff is an indicator of efficiency of the DGI that compares total expenditures to total tax revenue and works as a proxy for institutional factors (I). In other words, it shows how many Uruguayan pesos are collected for every peso spent by the tax authority. Larger values of DGIeff would indicate less efficiency and a higher likelihood of corruption in the tax authority. An increase in DGIeff should cause E to increase.

Variable	Obs	Mean	Std. Dev.	Min	Max
E	12	35.22917	3.881217	27.8	40.1
logGDP	12	5.60818	.0284911	5.563123	5.645853
DGIbud	12	.1551833	.0236693	.1174	.2057
DGIeff	12	1.026667	.1623875	.69	1.28

Table 1. Summary Statistics

	E	logGDP	DGIbud	DGIeff
E	1.0000			
logGDP	-0.5399	1.0000		
DGIbud	-0.1475	0.2751	1.0000	
DGIeff	0.5004	0.0468	0.7111	1.0000

Table 2. Correlation

Results

In order to estimate VAT revenue assuming there was no tax reform, I estimate the tax evasion rate for that scenario by running a time series regression with the model described in the previous section. In other words, I seek to simulate what would have happened to tax evasion holding the tax rate constant. The variables used to estimate tax evasion are real GDP growth, the budget of the Uruguayan tax authority (DGI) for a given year as a % of GDP, and an efficiency indicator used by the DGI. All of these variables are proxies for theoretical drivers of tax evasion described above.

E	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf. Interval]	
logGDP	-49.11814	19.74455	-2.49	0.038	-94.64915	-3.587132
DGIbud	-138.0147	26.64297	-5.18	0.001	-199.4535	-76.57593
DGIeff	26.66702	4.131453	6.45	0.000	17.13988	36.19417
_cons	304.732	110.1111	2.77	0.024	50.81536	558.6486

```
Number of obs =      12
F( 3,    8) =    36.64
Prob > F     =   0.0001
R-squared    =   0.8771
Root MSE     =   1.5952
```

Table 3. Time Series Regression

The model yields an R2 of 0.8771, which indicates that 87.71% of the variation in tax evasion (E) is explained by the variables used in the regression. An F-stat of 0.0001 shows the model rejects the null hypothesis at a 1% level. In other words, the model is robust and statistically significant for estimating tax evasion.

The coefficients of the explanatory variables behave in the direction that theory suggests. Economic growth (logGDP) and the DGI budget (DGIbud) have a negative relationship to tax evasion, while the efficiency indicator of the DGI (DGIeff) has an opposite relationship. As mentioned in the previous section, higher values of DGIeff indicate less efficiency at the tax authority. Additionally, LogGDP rejects the null at a 5% level, while DGIbud and DGIeff reject the null at a 1% level, which means all the explanatory variables are statistically significant individually.

Figure 4. Effect of VAT Rate Cut on Tax Evasion Rate in Uruguay

*Two taxes that represent 0.0024% of GDP were included under the VAT in 2007 and were accounted for.

After developing a robust model to estimate tax evasion, I use actual data for the explanatory variables and plug it into the model to compute the estimated tax evasion rate for the years following the tax cut. By comparing the estimated tax evasion rate, which assumes the tax reform

did not take place, and the actual tax evasion rate, it is clear that the policy change had a favorable effect on tax evasion. Even by assuming a worst-case scenario with the lower 95% prediction interval, the effect of the VAT cut starts to show on the year 2009 and continues to make an impact in 2012 with a 3.43% difference in tax evasion.

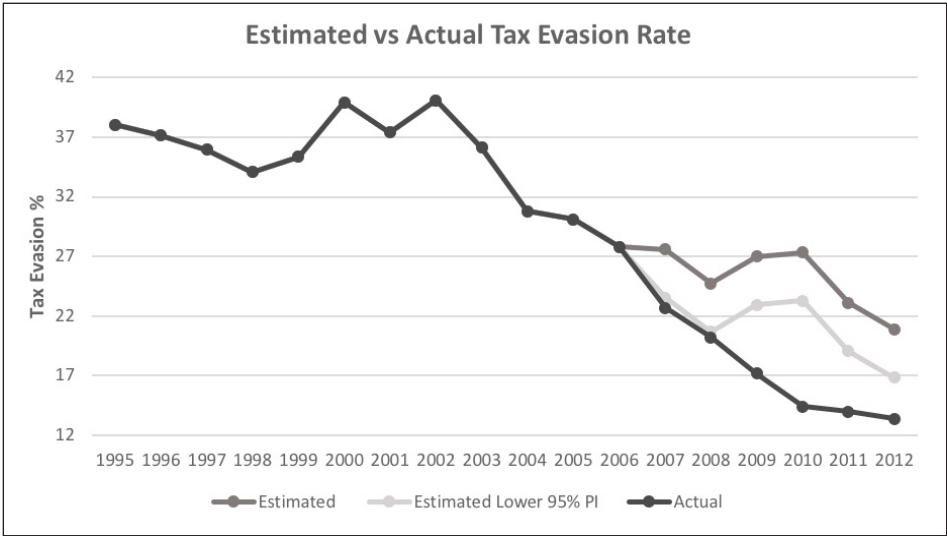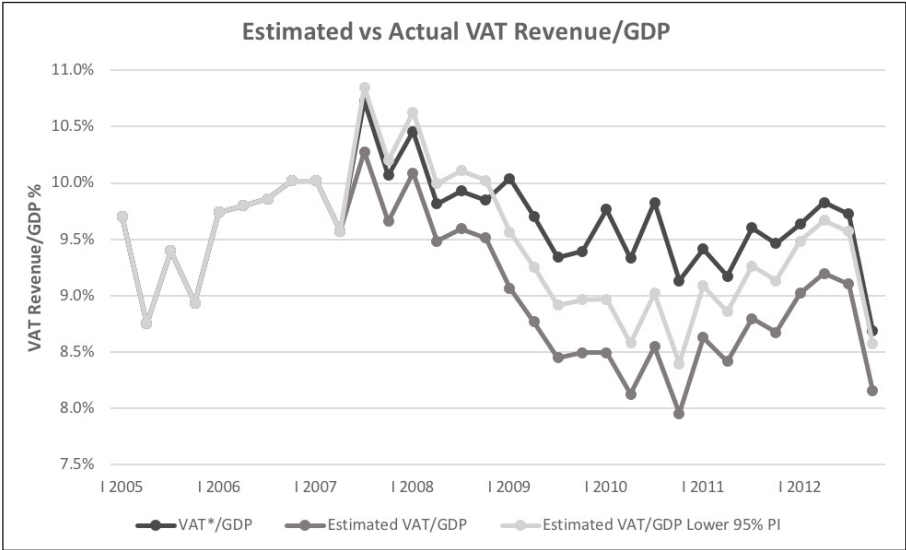*Figure 5.* Effect of VAT Rate Cut on Tax Revenue in Uruguay

*Two taxes that represent 0.0024% of GDP were included under the VAT in 2007 and were accounted for.

In Figure 5, I incorporate the tax evasion data points to the VAT revenue equation to find quarterly revenue estimates. Estimated VAT revenues (no tax cut scenario) are significantly lower than actual revenues, which shows the VAT rate reduction had an overall positive economic impact. Values for the lower 95% prediction interval (95% PI) confirm the original hypothesis of this paper. In the short run, reducing the VAT rate had a negative impact on revenues (95% PI is higher than actual VAT/GDP in 2007 and 2008). By the year 2009, 18 months after the tax reform went into effect, estimated revenues were lower than actual VAT Revenue/GDP. This is a sign that informal firms have come into the formal economy, which broadened the tax base and more than offset the reduction of the tax rate.
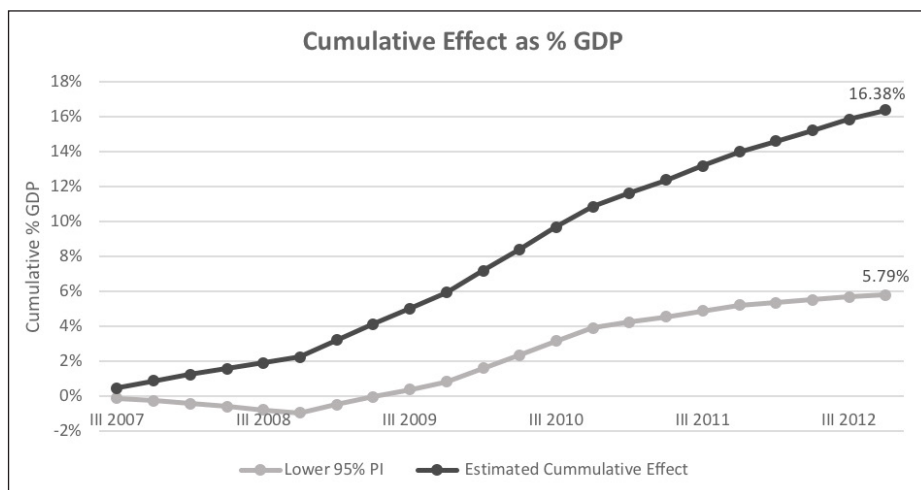
Figure 6. Cumulative Effect of VAT Cut

Figure 6 gives a sense of the magnitude of the VAT cut effect. For the 5-year period after the tax reform, the policy change increased VAT revenues by a cumulative 16.38% of the GDP. Assuming the lower 95% prediction interval, VAT revenues still increased by 5.79% of the GDP cumulatively. These results show that the effect of the tax reform in Uruguay is very significant.

Firm Level Data

The World Bank surveyed firms on a variety of topics in 2006 and 2010. One of those topics was regulation and taxes. I look into the survey results for Uruguay and compare them to those of Mexico, another emerging market economy that had a tax reform during that period. Uruguay reduced their VAT rate from 23% to 22%, while Mexico increased their VAT rate from 15% to 16%. The purpose of the analysis is to provide evidence for the impact of the tax policy changes at the microeconomic level. To do so, I analyze the responses of small and medium sized firms, which are the ones most likely to be impacted by VAT rate changes. Data is categorized by size of the firm in workers: Small (5-19), Medium (20-99), and Large (100+).

	2006	2010
Uruguay	618	605
Mexico	1445	1389

Table 4. Universe of Surveyed Firms

Figures 7a and 7b show the percentage of firms that identify tax rates as major constraint for their businesses. The number of Uruguayan firms that had a negative view on tax rates in 2006 dropped after the VAT rate reduction. More specifically, the percentage of small firms agreeing with the premise dropped from 68.7% to 43.6%, while the percentage of medium-sized businesses in that category went from 63.8% to 52.4%. In the case of Mexico, the number of small and medium-sized firms that viewed tax rates as a major constraint increased from 29.8% to 37.2% and from 34.6% to 45.3%, respectively. These findings show that the VAT cut in Uruguay effectively reduced the expected value of evading taxes, while the VAT increase in Mexico had the opposite effect.

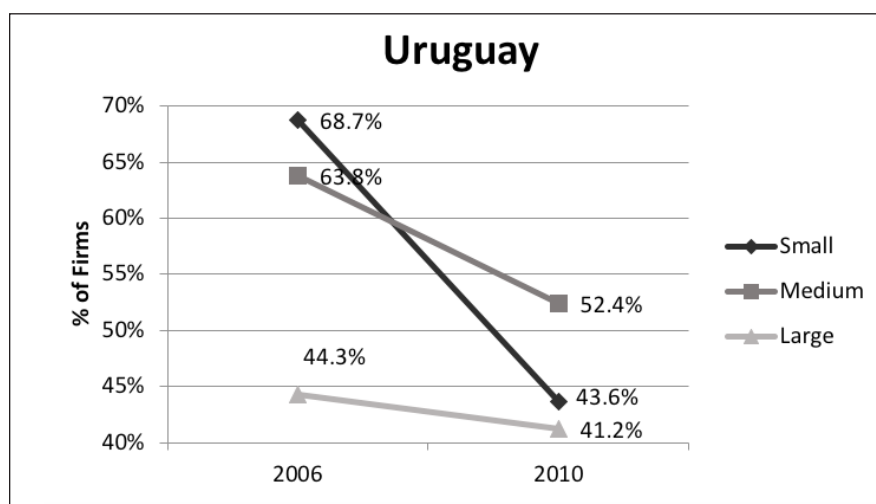**Figure 7a.** Percentage of firms identifying tax rates as a major constraint
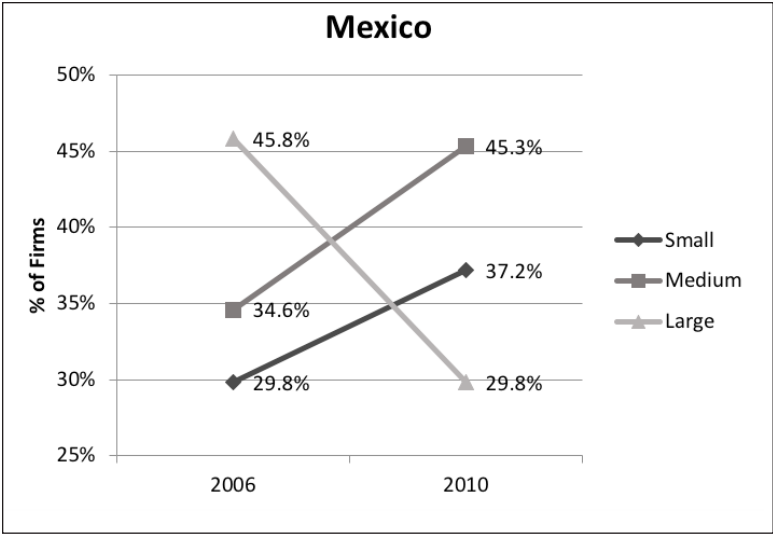
Figure 7b. Percentage of firms identifying tax rates as a major constraint
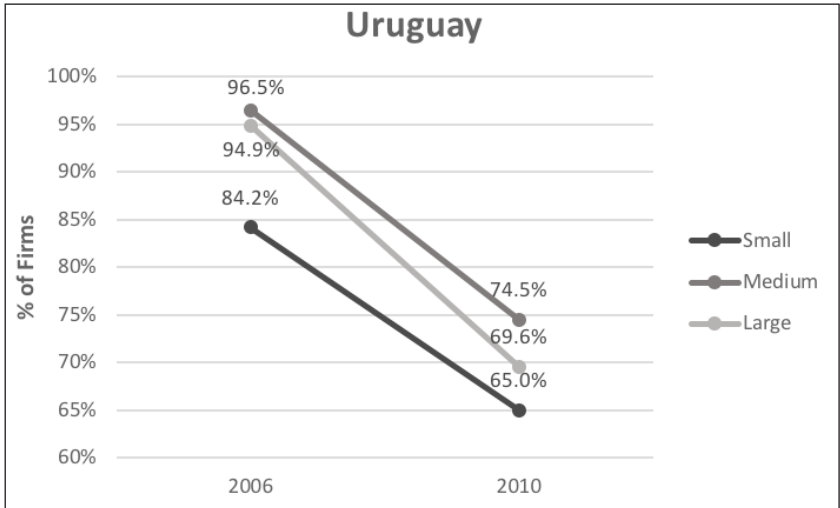
Figure 8a. Percentage of firms competing against unregistered or informal firms

157
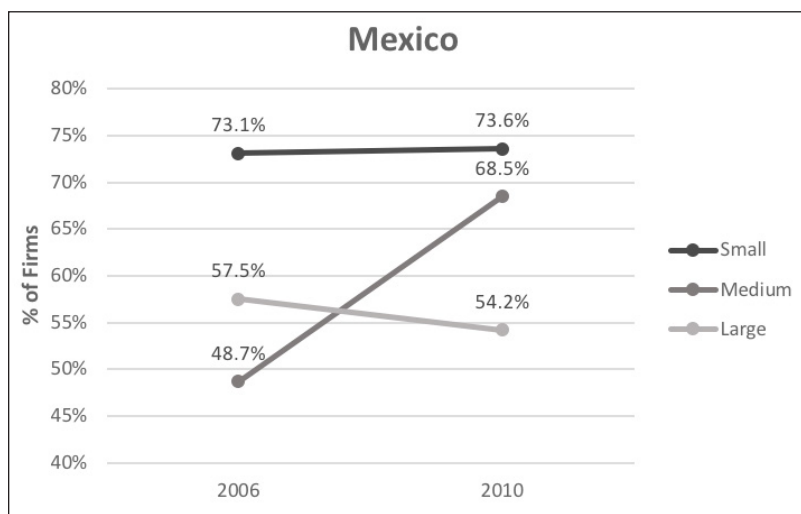
Figure 8b. Percentage of firms competing against unregistered or informal firms

Figures 8a and 8b show the percentage of firms that stated they compete against unregistered or informal firms. The percentage of Uruguayan firms that identified informal firms as competitors in 2006 fell significantly after the VAT reduction. The percentage for small firms decreased from 84.2% to 65.0%, while the percentage for medium-sized firms decreased from 94.9% to 69.6%. The VAT increase had the opposite effect in Mexico. While the percentage of small firms that indicated they were competing against informal firms was roughly unchanged, the percentage for medium-sized firms increased sharply from 48.7% to 68.5%. The survey results on this section provide evidence at the microeconomic level for the impact of the change in tax policy. More precisely, the analysis of the perspective of small and medium-sized firms in Uruguay confirms the hypothesis that the VAT rate reduction created an incentive for informal firms to pay taxes.

Conclusions

This paper seeks to find empirical evidence to support the claim that reducing VAT rates in developing countries with large informal sectors will create an incentive for informal firms to pay taxes, which will lead to an increase in national tax revenue in the long run. In order to do that,

I estimated the VAT evasion rate in the hypothetical scenario where the tax reform did not take place. First, I established a function of factors to explain tax evasion by building on Allingham and Sandmo (1972). Then, I transformed the theory into a model, making adjustments for measurability and availability of data. Finally, I used the tax evasion estimates to arrive at the estimated VAT revenues and compared them to actual figures.

The results of the estimation model give strong evidence to confirm the initial hypothesis. The analysis of firm level data also points in the same direction from a microeconomic perspective. It is important to discuss that data is scarce because research is lacking on the subject. Given that limitation, I include a prediction interval or worst case scenario, which also shows the tax reform would be likely to have a positive effect. It is key to point out that this paper makes an assumption that the informal sector is mostly comprised of Type 3 firms which would be likely to pay taxes if the VAT rate was cut.

The results of this paper provide strong empirical evidence to conclude that reducing VAT rates in developing countries creates an incentive for informal firms to pay taxes, which effectively increases tax revenue in the long run.

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Aston Patrick

"Ur so Hawt:"
The Presentation of Gender in Online Game Streaming

Faculty Sponsor
Dr. Sage Graham

Abstract

This research involved the analysis of naturally occurring data from an online gaming stream for the purpose of assessing communicative strategies in multimodal contexts with a focus on gender and identity. An in-depth analysis of one stream from a female gaming streamer was conducted with analysis of audio and video of the game and the concurrent open chatroom available to her viewers. A qualitative assessment analyzed how she presented her identity to her viewers, and how she maintained or rejected aspects of the female gamer stereotype. The comments from the chat were quantitatively assessed for sexual/inappropriate references and were qualitatively assessed to determine how the viewers challenged or accepted the image that the streamer had presented. The analysis showed that commenters assigned her three identities: improper, manipulative, and unskilled. Raihnbowkidz counteracted these three identities by reappropriating negative comments, consistently showcasing her gaming expertise, and calling for validation from other players.

Introduction

The popularity of video games has grown significantly over time. In 2017 it was reported that "sixty-five percent of American households are home to someone who plays games regularly," and that the video game industry "contributed $11.7 billion in value to the US GDP" in 2016 (ESA 2017). One of the more prominent forms of gaming is online multiplayer games in which players either work with or against other players through an on-line connection, typically through a PC or gaming console. There has been a broadening interest in online gaming in recent years, which has led to the rising popularity of gaming streaming sites such as Twitch and YouTube. On these sites, streamers play video games while simultaneously interacting with viewers through the stream's accompanying chat. Viewers can subscribe to a particular streamer's channel by making a monetary investment which generates revenue for the streamer. Each streamer presents an on-stream persona in order to gain more viewers and increase their number of paid subscriptions.

Gaming has been a male dominated field since its inception. The typical conception of a gamer is a white, heterosexual male. Several studies and organizations have shown that women make up nearly half of the gaming population, though this statistic is debated (Duggan 2015; ESA 2017; Chess et al. 2017; Shaw 2012). In regard to the gaming industry, the International Game Developers Association reported that in 2016 72% of game developers identified as male while only 23% identified as female, though the number of female developers has doubled since 2009 (Legault and Weststar 2016). In eSports, the gender gap is even wider with the lowest estimate of female players being 5% (BBC 2016). There is also a gender divide in eSports earnings with the highest paid male gamer earning nearly $3,400,000 collectively and the highest paid female gamer earning just under $200,000 (e-Sports Earnings 2017).

My research will involve the analysis of naturally occurring data from online gaming streaming for the purpose of assessing communicative strategies in multimodal contexts with a focus on gender and identity. I will be conducting an in-depth analysis of one stream from a female streamer to qualitatively assess how she presents her identity to her viewers and how she maintains or rejects aspects of the female gamer stereotype through her interactions with the commenters in her stream's chat. I will also be quantitatively assessing the comments from the chat for

sexual/inappropriate references and qualitatively assessing the comments to see how the viewers challenge or accept the image that the streamer has presented.

Twitch

Twitch was launched in 2011 and has a daily average of "15 million daily active users" and "2.2+ million unique content creators per month" (Twitch 2017). The main purpose for the founding of the site was to create a "social video platform and community for video game culture" (Twitch 2017). Its main use is for the facilitation of video game streaming. A stream typically consists of a live video feed of the game that is being played with a webcam minimized in the corner of the screen showing the streamer(s) playing the game. For each stream there is an accompanying chat that viewers and the streamer can post comments in. Chats are usually moderated by several moderators (mods) who can remove comments, timeout commenters (disallow them from commenting for a specific period of time), or ban commenters from the chat. In order for moderators to more effectively monitor the chat, a delay can be placed on the chat so that comments can be reviewed before they are posted. What comments or commenters are removed is determined by the general Twitch rules of service and the rules that each streamer sets for their streams.

One of the major reasons the aforementioned punishments may be used is harassment through commenting. This form of harassment (especially in relation to gender) is a common problem on Twitch as it is for many other social media platforms or sites; however, there are certain conventions that are mostly unique to Twitch. One of which "raiding" is when a streamer directs their followers to another's stream, filling the comment section with references to their fan base. This can be a positive experience if both streamers are comfortable with the exchange and the "raiders" are respectful or friendly. In this way, streamers with a greater following can give exposure to newer or less recognized streamers. However, this practice is also commonly used to facilitate harassment especially towards female streamers. Charleyy Hodson in an article she wrote for the website Kotaku UK related her own experience with a negative raid:

> I knew at once that I was being raided by a troll group, because I've had previous experience with this behaviour. As has probably any woman who's streamed. But knowing that the camera was pointing at my face and being broadcast to numerous channels I couldn't watch,

167

engage with or prepare for, I knew I had to be incredibly careful with every single movement to ensure they didn't 'win', they didn't get the reaction they were looking for. It was paralysing. (2017)

Other female streamers and gamers have also shared stories of times in which they were harassed often for simply being a woman working in a "masculine" field like gaming (Chan 2017; Convery 2017; Powell 2016). The most common insults or criticisms aimed at female streamers are that they are incompetent and unskilled players or that their appearance or form of dress is too "slutty." Several controversies have arisen centered around the idea that female streamers who wear "provocative" clothing set a bad example for female viewers of their streams and negatively impact the reputations of other female streamers who do not dress in a similar manner (Grayson 2015). In response, many female streamers have come together to denounce this belief and encourage other female streamers to dress as they please (Grayson 2015). Their stance is that the rampant condemnation for certain female streamers is not based on their clothing choice but because they are female as seen in this quote from streamer Scarletr0se: "It's not a cleavage-caster issue. It's a being a female on the internet issue" (2015).

Dickwolves and #Gamergate

Two of the most prominent controversies in gaming from the last ten years are the Penny Arcade Dickwolves controversy and the Gamergate campaign. The Dickwolves controversy originated in 2010 after Penny Arcade, a popular online web comic, released a strip entitled "The Sixth Slave" (Figure 1). The strip's original intention was to satirize a common element of video games in which the player only needs to save a certain number of victims in order to complete a quest. A slave who is not being saved pleads with the player character to take him along because "Every night, we are raped to sleep by the Dickwolves" (Krahulik and Holkins 2010).

168

Figure 1. "The Sixth Slave" from the Penny Arcade web comic series by Mike Krahulik and Jerry Holkins.

This joke was discussed by several prominent female gamers and game bloggers who expressed discomfort or outright criticized the comic for making light of a real problem that "isn't a central feature of (most) games–at least in the actual gameplay, totally aside from the language used by players" (Shaker 2010). This encouraged other female gamers to come forward and start a discussion about the flippant use of the word rape in gaming to mean "victory over an obstacle or fellow player" (Salter et al. 2012). The writers of the comic, Mike Krahulik and Jerry Holkins, responded with another strip mocking the concerns of the female gamers. The incident soon escalated into Penny Arcade creating Dickwolves merchandise and the continued harassment of the women who had spoken up about the issue by fans of the comic. This incident is reminiscent of similar situations in a nongaming context in which the fears and concerns of women are ignored or dismissed as shown in this quote by Elizabeth Arveda Kissling in her study about street harassment:

> The recognition of street harassment as a tool of sexual terrorism is made problematic by men's refusal to take it and women's fears seriously. There is very little published work on street harassment; it is considered a topic too trivial for serious women to be concerned about. Ridicule thus becomes a tool of silencing, and both the ridicule and the silence support the system of sexual terrorism. (1991)

The #Gamergate campaign is another example of the underlying misogyny that is present in gaming culture. The purported intent of members of the Gamergate movement was to advocate for ethics in games

169

journalism (journalism related to video games or the industry surrounding them); however, the incident that triggered the movement involved a blog post written by Eron Gjoni in which he accused his ex-girlfriend, game designer Zoe Quinn, of "having slept with five journalists for reviews of her game—an accusation later amended to 'favorable coverage' when it was clear that the reviews did not exist" (Mortensen 2016). This spawned attacks on video game journalists as a whole for ethical violations, but the most vicious harassment was aimed towards female critics of the movement. Several women, including Zoe Quinn and feminist critic Anita Sarkeesian, were doxed (their information revealed online) and forced to leave their homes after receiving death and rape threats online (Dewey 2014; Mortensen 2016). Jenn Frank, another doxed, female journalist, wrote that "the endgame is to frighten *all* women out of the video games industry–no matter what they write, film, create or produce–and to additionally frighten anyone who would support them" [emphasis in the original] (2014). The actions of the members of this movement show the toxic nature of gaming culture and why women may be reluctant to become a part of the gaming community.

League of Legends

League of Legends is classified as a multiplayer online battle arena (MOBA) in which "two teams of powerful champions, each with a unique design and playstyle, battle head-to-head across multiple battlefields and game modes" (Riot Games 2016). Champions are the characters that players can choose to play during a match. Only one of each champion can be used on each team during a match. Players can move up the *League of Legends* ranking system by winning matches against other players. The ranking system consists of seven ranks: Bronze, Silver, Gold, Diamond, Platinum, Challenger, and Master. Each of the first five ranks are divided into five more sub-ranks denoted by the roman numerals V - I (with V being the lowest rank). *League of Legends* is a highly competitive online game and, according to the game's website, has the "world's largest online gaming community" and "the world's most active competitive scene" (Riot Games 2016). The developers for *League of Legends*, Riot Games, estimated in 2016 that over 100 million people were playing each month (Kollar 2016). *League of Legends* is also one of the most streamed games on Twitch. In September 2017, it was the most watched game

overall at 74.3 million hours and the most watched for eSports at 19.6 million hours (Newzoo 2017).

Literature Review

Anonymity in an Online Setting

Communication in an online environment is affected by the level of anonymity afforded to the user. One part of this phenomenon is known as the online disinhibition effect, which is "defined as a lowering of behavioral inhibitions in the online environment" (Lapidot-Lefler and Barak 2011). This means that a person's behavior or communication choices can be affected by the online setting. There is also evidence to support that a lack of eye contact and heightened sense of unidentifiability can lead to more toxic online behavior such as threats or flaming (Lapidot-Lefler and Barak 2011; Laineste 2010). Flaming is characterized by the use of derogatory language and aggressive behavior directed at other people (Lapidot-Lefler and Barak 2011). In a setting such as Twitch, commenters are afforded a considerable amount of anonymity since they can be identified only by their usernames (which they select themselves). This may affect the ways in which chat participants choose to interact in the Twitch chat.

The Presentation of Women in Games Media

Many studies have proven that a great majority of female characters in video games are hypersexualized (Downs and Smith 2009; Burgess et al. 2007; Ivory 2006; Dietz 1998). Burgess, Stermer, and Burgess found that on video game covers the female characters, if at all present, were usually placed in a background role, in a sexual position, or were cutoff in some fashion (e.g. at the waist) which presented them as objects rather than active characters (2007). Besides the physical presentation of female characters, their roles within games are typically of a secondary or tertiary position and are not playable characters (Ivory 2006). The roles of these characters within the narrative of the game are usually in the form of the "damsel in distress" or the "slutty warrior" archetype (Downs and Smith 2009; Dietz 1998). They are often in need of a male character's help to save them from negative situations. This is often a major quest or a key factor in the main story arc of a game, in which the male protagonist (the player) must save the female victim from the antagonist (Dietz 1998).

What is a "Gamer"?

One of the problematic parts of research into gaming is the definition of what is a "gamer." Organizations like the Entertainment Software Association (ESA) seem to have defined a gamer simply as "someone who plays games" (2017) while other researchers have pointed out that it is not a person's actions that constitutes his/her identity, but rather how s/he identifies him- or herself (Shaw 2012). Within the statistic from the ESA that 41 percent of gamers are female, it is unknown how many of the females or males who completed the survey actually identify themselves as gamers. This is an important distinction, as someone who plays more casual games may be identified as a gamer by these surveys, but not actively participate in "gamer culture" like forums, strategy guides, gaming conventions, etc. Such individuals are much less likely to be subject to online harassment based on their participation in gaming. By not taking into account the method of attaining this statistic (a survey of over 4,000 American households), it becomes much harder to obtain a more accurate picture of the rate in which women participate in gaming culture (rather than simply playing games). The need for an accurate definition of a "gamer" is important for gaming research in general, but also for my own research, as women who identify themselves as gamers (like the streamer I am analyzing) are much more likely to be harassed by others in the gaming community.

Women and Their Relationship with Gaming

The issue of creating games that are appealing to women or have a more diverse representation is a well-researched topic. A great majority of earlier studies into gaming found that women preferred games with a social or communal aspect and story driven gameplay, and would avoid violence whenever possible (Jenson and de Castell 2010; Schott and Horrell 2000). However, newer studies have pointed out the fallacy of assuming that play preference is divided according to gender, and there is evidence that play preference actually varies more by age (Jenson and de Castell 2010; Yee 2017). These studies also did not take into account the varying motivations female gamers might have for playing the same game which newer studies have shown to be much more diverse than originally assumed (Hayes 2007; Eklund 2011; Taylor, T. 2003).

172

When discussing why women and men may play different games or play for different time intervals, other factors besides gendered preference are hardly ever taken into account. In several different interviews of female gamers, the gamers often cited a male presence in the household as a major contributing factor to either a reduction in gameplay time or for losing interest in gaming all together (Schott and Horrell 2000; Eklund 2011; Hayes 2007). Schott and Horrell found that male relations often monopolized gaming devices or discouraged the female gamers from playing, typically by invoking the idea "that males are 'the experts'" (2000). In these cases, some of the women also reported that at the start of gaming they asked a male such as a parent, brother, or partner for advice on their gameplay or character creation while others had the "guidance" of their male relations thrust upon them (Schott and Horrell 2000; Eklund 2011).

Another factor is the harassment that female players often experience in multiplayer settings. Many women are afraid to join the voice channel of a game or reveal that they are female because of the backlash that they often receive from male players (Fox and Tang 2014; Gray 2012; Yee et al. 2007). Gray, in her study about the intersection of gender and race in gaming, interviewed female gamers of color about their experiences while playing in Xbox Live. All of the gamers relayed that they had been harassed because of their gender and because of their race. They also remarked on the ways that white women were often used by their male counterparts: as trophies (attractive but invisible) or as tokens (good gamer but exploited and used for bragging points) (Gray 2012).

More casual forms of sexism can also occur in multiplayer settings as described by female *World of Warcraft*[1] (*WoW*) gamers that Eklund interviewed. They reported experiencing unwanted flirting or advances from other players after disclosing their gender or because of their female avatar, being asked to perform the perceived feminine role of mediator for their guild and being teased for interests like collecting clothing options for their character (Eklund 2011). One gamer said male gamers "think that you need more help just because you're a girl."

Research has also been conducted to see the possible effects of stereotype threat on the performance of female gamers. Stereotype threat oc-

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[1] *World of Warcraft* is an online multiplayer game with a world-wide following.

curs when "negative stereotyping of a group causes its members to fear the risk of confirming it as a self-characterization" (Vermeulen et al. 2016). In two separate studies, participants were divided into three groups: female gamers exposed to negative stereotypes, female gamers exposed to positive appraisal, and a control group. Both studies found that the group of female gamers exposed to the negative stereotypes performed worse than the group whose confidence was boosted (Vermeulen et al. 2016; Kaye and Pennington 2016). One of the studies also included a male control group and found that the female gamers with the positive appraisal performed at the same level as the male gamers. This study also had all participants take a survey of female gamer perceptions. Across all of the female groups, the female gamers "implicitly endorsed" an equivalent level of skill between male and female gamers (Kaye and Pennington 2016).

At eSports gaming events women are typically placed in one of three roles: Halo hoes, cheerleaders, and booth babes (Taylor, N. et al. 2009). Halo hoes are women who attend the event simply to pick up male gamers. Cheerleaders are typically mothers, girlfriends, or other relations who come to the event to support a male gamer. Booth babes are models used to attract gamers to booths featuring new games or technology. They are often used as props in showcases (Taylor, N. et al. 2009).

Women's relationship to gaming is therefore heavily affected by the roles they are expected to play, the sexism they must face in multiplayer settings, and the presumed expectation that they are unskilled players.

Interacting with the Female Gamer Stereotype

The most interesting elements from the interviews of female gamers are the ways, across various platforms, time, and race, that the gamers chose to interact with the stereotypes that are often forced upon them. Four types of reactions were reported by the gamers: *rejection of stereotype*, *utilization of stereotype*, *avoidance*, and *adaptation from stereotype threat*.

The first, *rejection of stereotype*, occurred when the gamers chose to actively rebuke the sexist comments and actions being made toward them. The *WoW* players in Eklund's study and the female gamers interviewed by Gray both spoke of times in which they proclaimed their equivalent competence as female gamers to male gamers who had been harassing them or would engage in "griefing," purposefully irritating or angering the male gamer (Eklund 2011; Gray 2012). It could also be claimed that

the unequivocal agreement among the different groups of female gamers in Kaye and Pennington's study is another example of stereotype rejection (2016). The problematic version of this reaction is when a female gamer rejects the stereotype being placed on her but still places it on other women. An example of this is when the female gamer Fatal Fantasy insisted to Taylor, within her interview, that she was "just there to game" and was not like the other women who had come just "to pick up guys" (otherwise known as "Halo hoes") (Taylor, N. et al. 2009).

The second reaction, *utilization of stereotype*, occurred when the female gamers used stereotypes to their advantage to get items or help from male gamers who made negative assumptions about the female player's skill level and/or competence. However, Eklund makes note that this strategy is dependent upon the context of a heterosexual framework in which "the man helping you [needs to believe] you are a woman offline" (2011).

The third type of reaction, *avoidance*, is simply to avoid the situation all together. A *WoW* gamer, Sanna, stated that she tried to ignore gender whenever possible and, though she is playing a multiplayer game, mostly plays by herself (Eklund 2011). The gamers in Gray's study accomplished avoidance in multiple ways. They avoided male gamers by creating clans with only female gamers in order to create a safe space, and though many of the female gamers "were not aware of their own marginalization," they also actively avoided players who used sexist or racist language (Gray 2012).

The fourth reaction, *adaptation from stereotype threat*, occurred when the gamers actively practiced and increased their skill in a game so that they could exceed the low expectations male gamers had of them, thereby shifting the conversation from their gender to strictly the game. Gray commented that, though playing better than or beating male gamers did reduce or remove harassment, this strategy is problematic since the burden of change is placed upon the women who are being harassed and not the men who are doing the harassing (2012). The one clan that used this technique were often derogatory to other women saying they were "too sensitive" and should not play if they could not handle the harassment from male gamers (Gray 2012).

While some of the female gamers were more consistent with their reactions, it is important to note that some players remarked that their

reaction in a situation is often dependent upon their mood or the particular circumstances within a game (Eklund 2011). Context played an important factor in how the female gamers choose to react.

Overall, it is readily apparent that female gamers are at a disadvantage in gaming culture because of stereotypes that portray them as unskilled and as involved in gaming for the "wrong reasons" (i.e. not for a love of gaming). Women are sexualized, looked down upon by male gamers, and belittled when they try to offer criticism about gaming. All of these factors are a part of the greater context that the following analysis will be the focus of this paper.

Data and Methodology

The data for this study is from a multimodal context in which naturally occurring data was recorded in its various forms simultaneously. The content of the data is 148 minutes of recorded video of a Twitch live stream in which a female streamer, Raihnbowkidz, is playing *League of Legends*. The video was transcribed and cross referenced with the corresponding log of chat interactions that was collected using the Chatty.jar add-on. The stream was originally broadcast July 15, 2015.

Over the course of the stream, Raihnbowkidz completes three matches of *League of Legends* while intermittently interacting with the chat during the matches. Between each match, she directly interacts with the chat by answering questions, telling stories and showing YouTube videos. The number of viewers as indicated by Twitch was sampled every five minutes, and from this the average number of viewers was 971. The chat that accompanied the stream contains 5,602 comments with 1,355 unique participants in the chat according to username. Using the recorded time for each comment, there was an average of 33 posts per minute. The rate of commenting increased between matches and decreased during matches.

After collection, the comments were coded for physical and sexual references, inappropriate language, and support or disapproval for the streamer. Raihnbowkidz's behavior and language were qualitatively analyzed to infer how she presented her identity through her stream and to study how she reacted to sexual comments directed towards her in the chat. A key element was to assess how she maintained or rejected aspects of the female gamer stereotype through her interactions with the commenters.

For the Analysis section, comments from the Twitch chat will be shown with username first within < > brackets, e.g. <Raihnbowkidz>. Physical gestures are transcribed within 2 parentheses, such as ((leans forward)).

Analysis and Discussion

Raihnbowkidz

Raihnbowkidz (real name Anisa Jomha) is a female, early twenties, online gaming streamer who mainly streams herself playing *League of Legends*. She is highly ranked in the game, and during the stream that was analyzed, she was currently Gold IV and trying to rank up during the stream. She is a self-professed "boobie streamer" as she typically is showing off cleavage (Hernandez 2016). The main purpose of this specific stream was to show off a new build (item setup) for the *League of Legends* champion Vi, who Raihnbowkidz played as in all three games that occurred during the stream.

Her Physical Representation

Raihnbowkidz's physical presentation is meant to capitalize on her sexuality. The clothes she typically wears include a low-cut tank top, short shorts, and a push up bra. She also wears heavy makeup. Her appearance is meant to be attractive and provocative. Her movements are also, to an extent, purposefully done for a similar effect. There are several points during the stream in which she stands up to leave the room for a few moments either to go the bathroom or find an item. Each time she makes sure that as she gets up her chest is presented directly to the camera. This behavior is even remarked upon by several commenters.

> Ex. 1   <okeydope> she only stands up so we can get a closer look and im ok with that kek

> Ex. 2   <r0senburg> see why wasnt she sitting down? she stayed there for a second.... she knows what we want Kappa

Viewers often speculate that she uses her mode of dress and controlled movements to increase her number of paid subscribers and donations. The fact that this is necessary in order for her to make money is evident from comments like this:

Ex. 3   <nicola1420> Last time I watched your stream you were in t-shirt, nobody really enjoyed it lol jk

In a way, her choice of presentation gives in to the typical hyper-sexualization of women in video games. It seems to buy into the idea that women are only involved in gaming to attract the attention of male gamers or that a female gamer's appearance will always be more important to her than her gameplay, but in a situation where she is working within a masculine framework, one could argue that her choices are limited.

Comments Related to Physical Appearance or Sexuality

After coding the chat, I found that 38 percent of the comments referenced physical appearance or sexuality. There were several different types of these comments. Some simply stated the word "boob" in some form and sometimes included the image of boobs created by the use of parentheses and periods as seen in Example 4.

Ex. 4   <bloodsharky> (. Y .) Kreygasm

She also received many requests during the course of the stream to do sexual acts or pose in a sexy way. Some were very simplistic while others were more graphic in nature. She was asked the most during the stream to either show her boobs or twerk[2]. Often these requests were in short phrases in the form of imperatives, as seen in Examples 5 and 6 below.

Ex. 5   <thebomber1234> TWERK

Ex. 6   <iceswordtv> SHOW BOOBS PLS

The most striking of the comments, though of a smaller amount, include graphic descriptions, in which the commenters described sexual acts that they wanted to act out with Raihnbowkidz or declarations about their own sexual actions as in Examples 7 through 11.

Ex. 7   <shabalabadingdong69> @Raihnbowkidz im wanking to you right now as we speak

Ex. 8   <vqwertyuiop> can i stick my cock between them

Ex. 9   <youwotmnine> nasty slut take my huge dick in ur oversized pussy

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[2] Twerking is a type of dance in which the dancer shakes their butt up and down.

Ex. 10   <doichimonic> Titty fuckkking you must be amazing

Ex. 11   <1ststackhenry> @Raihnbowkidz I just came in my pants!

In an offline setting, all of these comments would be considered sexual harassment, as they contain unsolicited requests for sexual favors and verbal harassment of a sexual nature (EEOC 2017). The fact that these comments exist shows a level of permissibility perceived by anonymous users in online chats.

Impropriety, Manipulation, and Lack of Skill

With this harassment and sexualized environment, Raihnbowkidz has three characteristics assigned to her by chat participants: improper, manipulative, and unskilled. These characteristics are based on criticisms that some of the viewers assert in their comments.

The commenters who consider her to be improper do so because they find her to be unladylike and that her choice of clothing is inappropriate as it is too revealing. The most consistent type of comment on this subject wanted Raihnbowkidz to stop showing her cleavage as seen in the comments below.

Ex. 12   <dayhack20> HIDE YOUR BOOBS EARN RESPECT!!

Ex. 13   <baltimorefan99>   is it that hard to cover up? Christ.

Ex. 14   <nextgeninc> STOP WITH THE BOOBS

These commenters were not concerned about Raihnbowkidz's reasons for her clothing choices, but simply about the fact that she was dressed in a way that they felt was too provocative. In some cases, these criticisms of Raihnbowkidz's appearance and clothing were aggressive and even violent as presented below.

Ex. 15   <insanity1133> Please kill yourself you little slut

Ex. 16   <sweetcreamonnipples> sluuuut sluuut slut slut sluuut am i the
              only one hearing this instead?

In contrast to comments about her impropriety, there was a smaller set of commenters who were angry that Raihnbowkidz was not showing enough skin or not being provocative enough.

Ex. 17   <bananagonnagetya> bye bitch no nipples no watch

Ex. 18   <onepumpchump09> give the viewers what they want

Ex. 19   <onepumpchump09> twerk or riot

As seen in the examples above, these comments contain a sense of entitlement on the part of the chat participants. They demand a certain level of physical exposure from Raihnbowkidz or for their requests to be fulfilled. By stating that if she does not enact their requests, then they will stop watching or will cause a commotion in the chat.

The second identity assigned to her was that she was manipulative in the way she conducted her stream. This assertion by the commenters is an expansion of the improper identity because they are stating that she is dressing too provocatively, and that her reason for dressing this way is to manipulate her viewers. This manipulation is being achieved by using her sex appeal to gain more paying subscribers and to raise the number of donations contributed to her stream. There was also a common idea that she was misleading viewers by claiming her stream is based on her playing *League of Legends* when in reality she is trying to show off her body for money. Below are examples of comments accusing Raihnbowkidz of this manipulation.

Ex. 20 <ses1234567890> Hey you need to show your boobs? seriously, your are selling your body for donations?

Ex 21 <sergio99811515> U are a facking fox. Dont stream in the lol[3] chanel go to the wores ones

Ex 22 <urgeofficial> LISTEN @Raihnbowkidz YOU REALLY ARE A GOOD STREAMER, BUT THE FACT I AM STARING AT YOUR BOOBS IN ORDER TO WATCH YOU IS DECEPTIVE, YOU NEED TO ACTUALLY REALIZE YOU ARE BEING A SUCCUBUS

In a sense, these commenters are correct in that Raihnbowkidz has chosen her attire and physical presentation for a specific reason. However, one of the reasons cited for this derogatory language is that she is somehow ruining Twitch as a platform or giving a bad name to female streamers, but this is simply not the case. In 2015, when this stream took place, only 8 women made it into the top 100 streamers on Twitch (Grayson 2015), and Raihnbowkidz's subscriber and view count are relatively low for the platform (Hernandez 2016).

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[3] "lol" is an abbreviation for *League of Legends*.

The third characteristic assigned to her is that of an unskilled gamer, which is part of the stereotype of female gamers discussed above. This form of criticism was not as prevalent in the comments, but comments questioning her skill are seen in Examples 22 and 23 below.

Ex 23   <ffamouz> why are you talking like you know this game, you suck and dont understand it one bit

Ex 24   <robstobbs123> how are you gold lol?

In the first example, the commenter is challenging the identity of skilled gamer that Raihnbowkidz is trying to create for herself by attempting to invalidate the gaming advice and explanations she is giving during the stream. They are blatantly calling her authority in to question. The second example is referencing the ranking that Raihnbowkidz has in *League of Legends* (Gold IV). They are questioning how someone with her (implied) lack of skill could progress to such a high ranking.

In response to these three characteristics that Raihnbowkidz is assigned, she utilizes several methods to challenge the commenters' presumptions.

Challenges to Assigned Characteristics

Raihnbowkidz challenges the aforementioned characteristics assigned to her by reappropriating the negative comments, showing her gaming expertise, and calling for support.

The first type of challenge is in response to the comments that claim she is improper and that she is manipulative. Raihnbowkidz referenced the sexual comments in her chat a very small amount of the time during her stream (only 9.8 percent of her comments). When she did reference them, it was to reappropriate these comments for her own purpose, which was to generate entertainment value. Her main way of accomplishing this was by "attacking back" at the negative comments in a process similar to griefing (purposefully irritating or angering someone), which was mentioned in the Literature Review as "troll-baiting." Since a "troll" makes inflammatory or aggressive statements simply to draw a reaction and receive attention, "troll-baiting" is when someone antagonizes a "troll" to get them to react in the way that "trolls" want others to (i.e. becoming annoyed or angered). Raihnbowkidz often engaged with "trolls"

by responding in a way that would purposefully annoy or further irritate those commenters.

The following exchange is a clear example of "troll-baiting." The commenter calls Raihnbowkidz a "whore" and belittles her for 'whoring herself out for views' (because of the way she dresses) with the possible intention of invoking a shocked reaction from Raihnbowkidz. Instead of reacting that way, she does the opposite by acting immediately hyper-sexual.

> Ex 25   <androb123> You are such a whore please stop selling your self for views that is sad
>
> Raihnbowkidz: I'm "such a whore. Stop selling myself for views." ((leans forward and pretends to lick webcam))…If you- If somebody happened to have their dick right on their screen they would have had like a raihnbow lick. A raihnbow lick. ((roles R))

In theory, this would irritate the commenter further since she is engaging in the kind of behavior that the commenter was deriding her for.

In this next exchange, the commenter is trying to insult Raihn-bowkidz by implying that she is overweight, so, in response, she hyper-bolizes their statement by basically saying 'I'm so overweight that it's like I'm pregnant.'

> Ex 26   <theicyballer2> have you gained weight recently?
>
> Raihnbowkidz: "Have you gained weight recently?" Man, I'm preg-nant. ((stands up to adjust shorts)) Pregnant…I have a goddamn child in me.

By choosing to not react defensively to the insult (insisting she has not gained weight or becoming angry with the commenter), she negates the biting nature of the original comment by turning the insult into a joke.

This form of reaction would fall under rejecting the female gamer stereotype discussed earlier in the Literature Review. It is a direct rebuttal to the comments only addressing her body or reproaching her behavior. She is invalidating the content of those comments by not responding to them in a serious manner. This shows that even though her appearance is crafted to be sexually appealing, she does not see that as the main purpose for her streaming as she rarely acknowledges the presence of sexual comments.

In order to challenge the assigned identity of unskilled gamer,

Raihnbowkidz consistently illustrates her expertise at playing *League of Legends*. Through the majority of the stream, Raihnbowkidz's focus is on her *League of Legends* matches whether she is commenting on other players' strategy or skill, her own gameplay, or shouting exclamations or reactions to what was currently happening in the game. Around half of Raihnbowkidz's comments pertained to gameplay or strategy.

Through these comments, Raihnbowkidz shows her proficiency in *League of Legends* and skill in playing the game. She often makes comments on other players' strategy, as seen in the examples below in which she criticizes other players' gameplay.

Ex 27   Raihnbowkidz: As soon as the Morgana[4] went missing from lane they should have backed off.

Ex 28   Raihnbowkidz: No, don't go back into that, Skarner[5], dude.

In both of the examples, she is remarking that other players on her team should have refrained from hastily entering into battles that would be pointless for advancing in the match.

In other instances, she fairly evaluates her own skill by making note of when she is playing well but also admitting when she is playing poorly like in the example below.

Ex 29   Raihnbowkidz: I was trying to upgrade my R while that was happening and then my fingers slipped on the E. Fuck. I… uh…That was really bad. I tried to upgrade my R mid fight and fucking hit the E…out of panic.

In this comment, she is explaining to her viewers that her intention was to upgrade and activate certain powers (which would be triggered by hitting the E or R keys on the keyboard) for her character, but in a moment of panic, she accidentally hit the wrong button. Instead of pretending like she intended to activate the power or that the mix up never happened, she freely admits that she made a mistake, which shows that she understands

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[4] Morganna is a champion in *League of Legends*. In this case, the character is being played by a player on the opposing team.

[5] Skarner is a champion in *League of Legends*. Here Raihnbowkidz is using the champion name to address the player on her team who is currently playing as that champion.

the game enough that she knows when an action was the wrong one to take.

She also answers questions about the game from the chat to give advice or explanations.

> Ex 30   Raihnbowkidz: "What is the build?" It's Youmuus[6], trinity, last whispers you're ahead or a tank if you're not ahead.

> Ex 31   Raihnbowkidz: That's why you build the youmuus on Vi by the way. Easy picks[7]. If you can lock down somebody, it's an easy pick.

In the examples above, she explains to her viewers what the build (item set up) she was showcasing during the stream was composed of and why that build is effective in the game as it gets a player "easy picks." This shows that she understands the mechanics of the game and what strategies are beneficial to becoming a better player.

It also shows that Raihnbowkidz wants to be seen as a gamer. She never explicitly says that she is one, but by vocally placing a heavier emphasis on the game and by consistently discussing strategy, she is placing her identity as a gamer at the forefront of the discussion instead of allowing the focus to be about her appearance. The purpose of this stream was to show off a new build of the character Vi, which also shows that she intended the stream to revolve around the game and her gameplay.

The final way that Raihnbowkidz challenges the assigned characteristic of unskilled gamer is by calling for validation from another *League of Legends* player. Towards the end of the stream, Raihnbowkidz reads a comment that says that she does not understand the game and that the build (item set up) she is using for the character Vi is a bad strategy. She responds by coming to the defense of the build, which she was showing off on the stream as shown below.

> Ex 32   <ffamouz> why are you talking like you know this game, you suck and dont understand it one bit

> Raihnbowkidz: "Why are you talking like you know this game? You suck, and you don't understand it one bit." I don't think you're a very

high elo[8] if you think that I suck. I- like I'm learning obviously, but like what's coming out of my mouth, or what I do know, comes from Challenger players.

She continues to explain the purpose of the build and then calls the Challenger player (a competitive ranking in *League of Legends*) that mentors her, Allorim, to further validate her knowledge. In this entire interaction, she shows that she is concerned with her viewers' opinions about the character build and the gaming strategy because she makes the effort to explain why the build works, and then calls another player to validate what she is saying. From the way that Raihnbowkidz reacts to these criticisms, and her focus on her gameplay, it is apparent that she wants to be identified as a skilled gamer.

Discussion

Raihnbowkidz both rejects and capitalizes on aspects of the female gamer stereotype. She uses her sexuality and the hate she receives from commenters to create a beneficial circumstance for herself to make money and to use the derogatory statements as a form of entertainment for herself and her fans. She rejects the female gamer stereotype by focusing on and standing up for her gaming strategy when it is challenged.

It is also important to note that one major factor that has an effect on Raihnbowkidz's responses is that a stream is meant to be a form of entertainment. As the streamer, she has to find a balance between the demands of her audience and her desire to be seen as a competent gamer.

From the analysis of the chat, it is obvious to say that many commenters felt that it was acceptable or at least unpunishable for them to use language that in an offline context would constitute sexual harassment or threats. Though anonymity is a factor in the level of toxicity, the

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[6] Youmuus, Trinity, and Last Whispers are all items that a *League of Legends* player can purchase within a match for the character they are playing as.

[7] A "pick" is a knock-out or kill

[8] "elo" is a term used by *League of Legends* players that refers to the ranking system within the game. Raihnbowkidz is stating that she does not believe that the commenter has a high ranking in the game.

types of insults and demands are indictive of the way that women are still perceived in greater culture. The communal comments from her fans show that online spaces can be constructive and supportive. The fans of the stream have the same level of anonymity as the harassers in the chat, which shows that it is the individual in each situation who decides to be derogatory and this kind of behavior is not something inherent to the platform.

This research could be expanded in several ways. For one, an analysis of a greater number of female streamers would prove beneficial to identify patterns of inappropriate language or sexual comments, so that harassment can be better detected and managed in online settings. It would also be helpful to study male streamers to create a comparison between how the two genders are treated in online gaming streaming. This could lead to a better understanding of how harassment in gaming can be lessened or prevented.

I also noticed a similarity between the sexual/harassing comments and catcalling as both are directed at a female target, the harasser is afforded some level of anonymity, and there is the similar context of a woman "invading" a masculine space. Further research that compares online harassment to offline instances could be helpful in determining what aspects of culture are carried over into online settings and how much the anonymity that online discussion affords actually affects the way that people communicate.

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Anqi Wang

Selection Criteria of Hospitality Programs: A Comparison of Undergraduate and Graduate International Students

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Abstract

This paper identifies the importance of various factors between undergraduate international students and graduate international students majoring in Hospitality Management when choosing among different Hospitality programs in the United States. Specifically, the purposes of the study are to: (1) identify the factors that affect international students' decisions on choosing a hospitality program, and (2) compare the similarities and differences between the factors that affect undergraduate international students and graduate international students when choosing a hospitality program. The findings from the data will provide useful information to explain and improve hospitality programs on marketing themselves in order to attract more international students to their programs.

Introduction

The hospitality and tourism industry has always depended on the number of travelers and the amount of travelers' expenditures. During The Great Recession, the declining economy led to a decline in the number of travelers which caused the hospitality and tourism industry to suffer. The world's gross domestic product (GDP) finally increased 4.1% in 2010 (The World Bank, 2016). Since then, the stable economy has resulted in increasing numbers of travelers all over the world and the corresponding increase in expenditures. According to the American Hotel and Lodging Association (AHLA, 2015), "Resident and international travelers in the United States spend an average of $2.4 billion a day [in the hospitality and tourism industry]." International travelers who visited the United States brought approximately $220.6 billion through the hospitality and tourism industry in 2014 (AHLA, 2015). Such a significant amount indicates the importance of globalization and the industry itself. According to the World Travel & Tourism Council (WTTC, 2014), the hospitality and tourism industry generated almost $7 trillion of total economic activity worldwide and supported approximately 266 million jobs in 2013. In addition, the hospitality and tourism industry made a significant contribution to the economy in the United States as the travel industry contributed $2.1 trillion to the economy in 2013 (US Travel, 2013). The increasing demand for the hospitality and tourism industry has also promoted the need for more hospitality and tourism employees. In the United States, there were about 1.86 million employees working in the hospitality and tourism industry in 2013, and the tourism industry will be able to provide 7.9 million jobs by 2015 (AHLA, 2014). This huge job vacancy causes concern for a lack of skilled employees to fill those positions. The other reason for the lack of skilled employment in the hospitality industry is employee turnover. One of the main causes of the high turnover rate is that the employees are sometimes not qualified to be in their positions (Kysilka & Csaba, 2013). This phenomenal growth in the United States has created demand for talented globalized hospitality students, and in turn has resulted in an increased demand for international students to be involved in hospitality programs in the United States.

As the number of international travelers to the United States increased by 6.7% from 2013 to 2014, their contribution to the American hospitality and tourism industry continues to grow (AHLA, 2015). Inter-

national students have played an important role in hospitality programs because the hospitality industry is becoming a more international business (WTTC, 2015). Increasing globalization emphasizes the importance for students to gain the knowledge of different cultures (María Cubillo, Sanchez, & Cervino, 2006). As a result, many international students have sought the opportunity to receive their bachelor's or postgraduate degrees in other nations. Among all of the countries, the United States is the number one destination for receiving a degree (UNESCO, 2014). In addition, USA Today (2016) stated that there were over 865 hotels, with 103,230 rooms, currently under construction and scheduled to open in the United States in 2016. The high demand for talented employees in this industry led to the growth of hospitality and tourism programs in American universities and colleges (Chatfield, Lee, & Chatfield, 2012).

As globalization encourages more students to study abroad and expands the selection of higher education in hospitality programs, the selection criteria become more complicated. According to Kim, Goh, and Gan (2014), U.S. colleges and universities enrolled almost 900,000 international students for the 2013-2014 school year in all majors (Paulson, 2014). In addition, there are already many international students studying in the United States across majors. According to USCIS, the number of international students in United States "grew from 1.05 million in July 2015 to 1.11 million in July 2016, an increase of 5.5 percent" (USCIS, 2016). Many schools also have a large increase in international student enrollment from 2000 to 2014. For instance, University of Tulsa's international student population increased from 6% in 2000 to 20% in 2014 (WSJ, 2015). Hospitality programs are not exempt from this trend.

The distribution of international students in different universities varies. According to the U.S. Citizenship and Immigration Services, "The University of Southern California has more F-1 International students than any other school [that has the petition for approval of school for attendance by nonimmigrant students]" (USCIS, 2014). Moreover, during the 2014 to 2015 school year, The University of Nevada, Las Vegas had a total of 1,185 international students out of 28600 (4.14%) for overall enrollment, and The University of Memphis recorded only approximately 600 international students out of 21,356 (2.81%) overall enrollment (ISO, 2015; Rakow, 2014; UNLV, 2015; UNLV, 2016). The absolute difference is 1.33%. In other words, the percentage of international students at

UNLV is 47.33% higher than the percentage of international students at the University of Memphis. This difference is very economically significant. The large percentage difference of international students between the two schools addresses the importance of understanding factors affecting international students' choice of universities. Several existing studies have identified factors for school selection across majors (Chatfield, Lee, & Chatfield, 2012; S. Lee & Chatfield, 2015; K. Lee, Yuan, Hwang & Kim, 2012). Many existing studies have examined students' selection of universities, colleges, and specific programs in the United States (Daily, Farewell & Kumar, 2010; Hoyt & Brown, 2003; S. Lee & Chatfield, 2015; María Cubillo, Sanchez, & Cervino, 2006). However, limited studies exist that focus on the factors affecting undergraduate and graduate international students who are choosing a hospitality program. A review of literature on how to understand international students' decision making process when choosing a hospitality program in the Unites States is also limited (Hoyt & Brown, 2003; S. Lee & Chatfield, 2015; María Cubillo, Sanchez, & Cervino, 2006; S. Lee, & Chatfield, 2015; K. Lee, et al., 2012). To provide a better understanding of international students majoring in hospitality management, this current study will (1) identify the factors that affect international students' decisions when choosing a hospitality program and (2) compare the similarities and differences among the factors that affect undergraduate international students and graduate international students when choosing a hospitality program.

Literature Review

S. Lee & Chatfield (2015) used eight main factors to examine why students chose Nevada Las Vegas Hotel College based on a very reliable conceptual framework that was constructed by Somers, Haines, & Kenne (2006). These eight main factors were financial variables, net cost, social environment, student background, institutional characteristics, institutional climate, educational achievement, and aspirations. Under these eight main factors, there were also sub-factors. For example, the cost of living and the tuition costs of the institution were the sub-factors under net cost. Among the eight main factors, five factors were also identified as very important by other studies. According to Hoyt and Brown (2003), a highly comprehensive set of factors could produce improved prediction of students' college of choice. In their precise review and summarization of many valuable factors, Hoyt and Brown (2003) analyzed 22 studies that identified

198

the factors affecting students' selection of universities or colleges. They then sorted a comprehensive selection of factors into ten categories based on their importance. Nine main factors ended up in the most important category: academic reputation, location, quality of instruction, availability of programs, quality of faculty, costs, reputable program, financial aid, and job outcomes (Hoyt & Brown, 2003). Their selection of categories indicated that five main factors from S. Lee and Chatfield (2015) are very valuable. Therefore, in this study, we will be focusing on these five factors: social environment, costs, inspiration, finances, and institutional climate.

It is important to understand that there are also factors that are important only to a certain type of student. For instance, K. Lee et al. (2012) focused on studying the factors that affect doctoral students' selection of universities. Chatfield, Lee, and Chatfield (2012) focused on studying the factors that affect undergraduate students' selection of universities. The two studies were focused on different student groups, so the factors in the two studies gave different results. Certain factors used in both studies such as opportunity for assistantships and reputation of universities were found to be essential to international graduate students while these factors were identified as less important for domestic graduate students. Therefore, this study will also consider the important factors based on certain groups of students identified in previous studies.

As mentioned before, when focusing on certain groups of students, many researchers also suggested that the different factor rankings depend on the different types of students (Chatfield, Lee, & Chatfield, 2012; S. Lee, & Chatfield, 2015; María Cubillo, Sanchez, & Cervino, 2006; K. Lee et al., 2012). Under this suggestion, several researchers divided students into different groups, and each group was studied individually. Chatfield, Lee, and Chatfield (2012) categorized students into three groups: (1) in-state, (2) out-of-state, (3) and international. According to their results, net cost was a high-ranking factor for out-of-state and international students, while in-state students were more focused on other factors. Furthermore, Lee et al. (2012) divided doctoral students into domestic and international. This study revealed that domestic and international doctoral students consider the importance of certain factors differently. For example, reputation of program is not as important to international doctoral students as to domestic doctoral students. International doctoral students consider the availability of assistantships to be a more important factor than the

reputation of program. However, domestic doctoral students consider the reputation of program to be a more important factor than the availability of assistantships. The results of the comparison among different groups of students proved the importance of dividing students into different groups based on their characteristics and could help this study to accurately identify the factors affecting international students.

In addition, there were not many existing studies that divided international students into undergraduate and graduate students. According to the results from Obst and Forster (2011), who conducted a survey of students from different countries, the most important reason for most students to receive a bachelor's degree in another country is to improve themselves and become more independent. However, the master's students from other countries are more focused on being able to compete for an international career (Obst & Forster, 2011). For students who wanted to receive a doctoral degree, both domestic and international doctoral students chose the quality of faculty as the most important factor (K. Lee et al., 2012). The diverse reasons for undergraduate and graduate students to receive a degree in another country implied the possibility of different reasons for undergraduate and graduate students to choose among different colleges in the United States. Chatfield, Lee, & Chatfield (2012) surveyed students who were enrolled in the Hotel College undergraduate program at University of Nevada, Las Vegas. These undergraduate students listed career support as the most important factor. However, K. Lee et al. (2012) surveyed a group of doctoral students in Hospitality and Tourism Programs and found that career support was listed as the least important factor. The comparison of the Chatfield, Lee, and Chatfield (2012) and the K. Lee et al. (2012) studies further illustrated the variety of reasons for undergraduate students and graduate students to choose hospitality programs. Therefore, it is important for this study to divide international students into undergraduate and graduate groups.

In this paper we will base our analysis on the following eight factors: (1) career support, (2) finances, (3) inspiration, (4) environment, (5) family support, (6) facility institution character, (7) net cost, and (8) academic perspectives. Additional factors like graduate school opportunities after graduating from the hospitality program, faculty members who are known as excellent researchers, financial support from parents or guardians will also be added based on the different groups of internation-

al students. Furthermore, this study will enhance the value of the factors for international students to choose a hospitality program and measure the importance of different factors that affect undergraduate international students and graduate international students when selecting a hospitality program in Unites States.

Methodology

We developed a questionnaire based on existing studies about factors affecting students' school choice (e.g., Hoyt & Brown, 2003; S. Lee, & Chatfield, 2015; S. Lee & Chatfield, 2014). The questionnaire focuses on three components: (1) the factors for international students, (2) factors in choosing a hospitality program in the US, and (3) unique factors for specific groups of international students. The questionnaire asked respondents to rate 50 items using a five-point Likert scale (1- [not at all important] to 5- [extremely important]). Participants anonymously completed online and on paper surveys. The initial survey included questions about demographic factors: gender, year of birth, country of origin, academic classification, GPA, attending school and hospitality focus. In the beginning of the survey, students were given a definition of international students to guarantee the accuracy of data collection.

Data Collection

The data were mainly collected using the Qualtrics survey software. A paper version of the survey was distributed as well in order to collect more data. Our analysis combined the data from both the software version and the paper version. The survey was approved by the IRB (Institution Review Board) in November 2015. The pilot test was conducted with 30 international graduate students and undergraduate students from 11 different hospitality programs from November to December 2015 from the 1st Hospitality Teaching and Learning conference. We also collected data at the 3rd World Research Summit for Tourism and Hospitality, the 1st USA-China Tourism Research, and the 21st Annual Graduate Education and Graduate Student Research Conference in Hospitality and Tourism in January 2016. The paper version of the surveys were passed out at the beginning of each conference, and the surveys were later collected at the end of each conference. Surveys were not used if the respondent failed to meet the definition of international student. Qualtrics surveys were also emailed to students and professors whose email addresses were available on their

university's website.

Results

Fifty-five participants completed the survey. These participants were international students from 10 different countries who enrolled in 13 different universities' hospitality programs in the United States. The variety of participants provided a more accurate insight for hospitality programs in United States. There were 30 participants who identified themselves as graduate international students and 25 participants who identified themselves as undergraduate international students. The majority of the participants were female (65.5%), consistent with the fact that hospitality programs usually have more female students than male students. For example, the survey data of Chatfield, Lee & Chatfield (2012) included 64% female and 36% male respondents.

Factors in College Choice

Table 1 presents the results of all factors' mean, variation and standard deviation based on the 55 participants. By comparing the mean of all the factors, the top 11 factors were indicated as the most influential ones. Overall results showed that undergraduate and graduate international students had both similarities and differences when choosing a hospitality program.

Table 2 lists the top 11 factors chosen by undergraduate international students and the top 11 factors chosen by graduate international students. By comparing the results of undergraduate and graduate international students, we can identify some similarities between the two groups. When choosing a hospitality program, both undergraduate and graduate international students consider academic reputation of the hospitality program worldwide, variety of course options, living cost, and hands-on experience as part of top ten factors. Academic reputation of the hospitality program worldwide was listed among top three factors for both groups. This is not surprising, considering the fact that companies hire students by looking at the reputation of students' hospitality programs. This trend is especially important for students from Asian countries where the reputation of an academic program sometimes determines students' future career opportunities.

The second similarity of both student groups was the variety of course options. This factor was listed as the fifth important factor for both groups. The importance of the variety of course options indicated that

202

both groups of students focus on learning about different areas of hospitality. The variety of courses may also help students to find their specific interests in the hospitality industry. Hospitality programs should focus on helping students to learn more details related to their specific interests.

The third factor chosen by both student groups among the top 11 factors was living cost. Tuition is already a huge cost for international students. Table 2 shows financial support from parents or guardians as the 9th most important factor for undergraduate international students. Therefore, undergraduate international students receive most of their financial assistance from their parents. Also, the exchange rate and the buying power between the U.S. dollar and the currency of some developing countries makes living costs in the U.S. more expensive than in the international students' own countries. Graduate international students might have family members with them, so the living costs are sometimes the living costs of a whole family. The location of hospitality programs and assistance with living costs are therefore important factors in student choice for both groups.

Hands-on experience was listed as the ninth and tenth most important factors by undergraduate and graduate international students respectively. The importance of hands-on experience to undergraduate students showed that gaining experience is a very important factor because work experience can help students to find a good job in the future. However, opportunities for further study and research are more important to the graduate international student.

On the other hand, there are also some significant differences in the lists of top factors between undergraduate and graduate international students. Undergraduate international students chose academic reputation of the hospitality program and opportunity to obtain OPT (an employment authorization document issued by the US government) as the top two factors. These two factors pointed out that future career opportunities were especially important to undergraduate international students. The reputation would help students to find a job whether they intend to work in the United States or in their own countries. The OPT can also help students to find a sponsor and stay in the United States. On some occasions the company that students worked for during the OPT would be able to provide students with good positions in their own countries. The top two factors chosen by graduate international students, however, were having faculty members who are effective teachers and faculty members who are known

as excellent researchers. For graduate students, good research skills and publication opportunities would be more likely to help them to find a job. A faculty member who was an excellent researcher or effective teacher would better help graduate international students accomplish their research projects. Interestingly, undergraduate international students did not place much emphasis on scholarships or financial aid compared to graduate international students. It is possible that universities and hospitality programs did not offer a lot of scholarships or financial aid to undergraduate international students. There was also a possibility that undergraduate international students were not familiar with scholarships or financial aid from universities and hospitality programs. Also interestingly, undergraduate international students chose Wi-Fi service within the building among the 11 most important factors.

In contrast, graduate international students were very interested in the availability of scholarships for international students in the hospitality programs and financial aid from the universities. The age range of the graduate international students was from 27-years-old to 39-years-old. Considering the age, graduate international students were more likely to have their own families. On the contrary, undergraduate students were mainly supported by their parents. They were not as financially sensitive as the graduate international students. Therefore, graduate international students were more sensitive to anything that was related to finance. The hospitality graduate programs must provide enough scholarship and financial aid to cover at least a part of the living costs of these graduate international students. Graduate international students also chose well-paying job opportunities after graduation as one of the top 11 factors. Graduate international students have to dedicate a huge amount of time to complete their graduate degrees. If most international students in hospitality graduate programs were able to receive a well-paying job after graduation, it makes the time that these international students dedicate worthwhile. As a result, students would be more willing to choose this hospitality graduate program.

Overall, graduate international students showed their interests in doing research. Undergraduate students are more interested in more practical classes that will help them to succeed in the industry.

204

Conclusion

This study analyzes the most significant factors of international students' when choosing a university hospitality program. The results were determined from 50 different factors such as living costs, Wi-Fi service within the building, and availability of tutoring for international students. Overall, the results showed that there were both similarities and differences between undergraduate and graduate international students. The differences, however, indicate that undergraduate and graduate international students should be targeted differently.

After comparing the 11 most significant factors of undergraduate and graduate international students' college choice, we found some interesting results that previous studies have not reported. There were three similarities among the two groups of international students. First, the reputation of hospitality programs was most important for both groups of international students. Second, both groups of international students wanted to learn more about hospitality in order to determine their specific interests within the field, so a wide array of courses was an important concern. Third, finances were an important issue to both groups of international students because different parts of United States have different living costs. There was one significant difference between the two groups of international students. When choosing a hospitality program in the United States, undergraduate international students tend to be more focused on the helpfulness of the hospitality program related to finding industry jobs. However, graduate international students were more focused on the financial support available when choosing a hospitality program in the United States. This is not surprising, because graduate international students were older and more likely to have families to support.

The findings of this study provide substantial insight into hospitality programs in the United States so that they can better market themselves to attract more international students. The findings suggest that hospitality programs should improve their own reputations in the world to attract more international students. The findings also suggest that hospitality programs should provide more resources and courses that will help international students to successfully find jobs in the industry. Doing so would help hospitality programs attract more undergraduate international students. Furthermore, hiring high quality faculty and providing adequate financial support will attract more international graduate students. Also,

because of the time limit, the number of international students that we reached was relatively small.

In conclusion, hospitality programs will give both domestic and international students a small taste of being in an international environment before entering the global workforce. Hospitality programs should identify and accomodate the needs and priorities of international students. Higher enrollment by international students will help all students be more successful in their future careers. The more talented and globalized our human resources become from studying in the hospitality field, the more likely our industry is to have a bright future with high economic growth.

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Table 1. College Choice Factor Analysis for All International Students

#	Items	Mean	SD
01	Academic reputation of the hospitality program worldwide	4.55	0.57
02	Faculty members who are effective teachers	4.45	0.63
03	Variety of course options	4.38	0.80
04	Well-paying job opportunites after graduation	4.33	0.67
05	Opportunity to obtain OPT (Optional Practical Training) after graduation	4.25	1.05
06	Living costs (e.g., house rental fee, dorm fee, food and transportation)	4.24	0.92
07	Strong academic environment within the hospitality program	4.18	0.72
08	Faculty members who are known as excellent researchers	4.18	0.82
09	Offers hands on experience for students in different classes	4.18	0.88
10	The partnership between hospitality program and hospitality companies	4.18	0.92
11	Availability of scholarships for international students in the hospitality program	4.16	1.05
12	Faculty and staff who can provide international students with internship opportunities	4.15	1.06
13	Tuition costs of the school	4.13	1.17
14	Financial aid from the University	4.11	1.07
15	Academic reputation of the university worldwide	4.07	0.79
16	Opportunities to obtain CPT (Curricular Practical Training, including employment, internship experience, cooperative education experience etc.) and work outside of the school while attending the school	4.05	1.08

17	Faculty members with intensive field experiences	3.98	0.91
18	An advisor who helps international students with class selection	3.98	0.93
19	Availability of scholarships for international students in the University	3.96	1.17
20	The overall ranking of the hospitality program in national magazines	3.95	0.93
21	Safety around the campus	3.91	1.06
22	Wifi service within the building	3.87	1.38
23	Offers academic resources to help students on their research (e.g. library access)	3.85	0.76
24	Faculty members have available office times to help students	3.82	0.88
25	Financial support from parents or guardians	3.84	1.33
26	Graduate school opportunities after graduating from the hospitality program	3.76	1.39
27	The hospitality program's philosophy	3.73	0.93
28	Alumni networks	3.73	1.06
29	The reputation of the program in your home country	3.67	1.11
30	Other international student support (e.g., Writing center, ESL)	3.53	1.00
31	Well-known international companies near the university	3.49	1.23
32	College town atmosphere	3.47	1.10
33	The interaction between local students and international students	3.47	1.27
34	The ratio between students and professors	3.45	1.07
35	Mentoring programs for students on campus	3.44	1.17
36	Classrooms with technologies (such as projector)	3.42	1.32

37	ACT/SAT/Toefl/IELTS/GMAT/GRE score requirements	3.38	1.10
38	Diverse nationalities of faculty members	3.36	1.11
39	Volunteer opportunities in the program	3.25	1.32
40	Availability of tutoring for international students	3.18	1.29
41	Parents' opinions about the university and the hospitality program	3.16	1.37
42	Accessible computer labs with available computers and printers for students	3.15	1.33
43	The recommendation from your own country's professors	3.11	1.18
44	Student organizations and clubs within the hospitality program	3.11	1.21
45	Total number of international students in the hospitality program	3.04	1.41
46	A student lounge for students to relax and hang out together	3.02	1.30
47	Classrooms with comfortable seats and desks	2.98	1.25
48	Public transportation around the campus	2.89	1.29
49	Parents or guardians have to support other siblings	2.89	1.52
50	The number of international students from your home country in the hospitality program	2.69	1.26

The following table (Table 2) ranks the most important factors in college choice. Some factors were on the same level of importance, and as a result were listed in the same position. For example, in the list of undergraduate students, there were two equally important factors in the third position, and as a result, the next position is numbered 5 instead of 4.

Table 2. Top College Choice Factors Selected by Graduate and Undergraduate International Students

Rank	Undergraduate Responses
1	Academic reputation of the hospitality program worldwide
2	Opportunity to obtain OPT (Optional Practical Training) after graduation
3	The partnership between hospitality program and hospitality companies
	Opportunities to obtain CPT (Curricular Practical Training, including employment, internship experience, cooperative education experience etc.) and work outside of the school while attending the school
5	Tuition costs of the school
	Living costs (e.g., house rental fee, dorm fee, food and transportation)
	Variety of course options
8	Wifi service within the building
9	Financial support from parents or guardians
	Offers hands on experience for students in different classes
	Faculty and staff who can provide international students with internship opportunities

Rank	Graduate Responses
1	Faculty members who are effective teachers
2	Faculty members who are known as excellent researchers
3	Academic reputation of the hospitality program worldwide
4	Well-paying job opportunities after graduation
5	Variety of course options
6	Strong Academic environment within the hospitality program
7	Availability of scholarships for international students in the hospitality program
8	Living costs (e.g., house rental fee, dorm fee, food and transportation)
	Academic reputation of the university worldwide
10	Offers hands on experience for students in different classes
	Financial aid from the University

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QuaesitUM considers submissions from any current University of Memphis undergraduate student; eligibility also extends to those who have graduated within the last two semesters. Research must reflect University of Memphis student projects. Manuscripts may be single or co-authored, but all authors must have been University of Memphis undergraduate students during the time the research was conducted. Faculty members and graduate students are not eligible.

Content

Papers must discuss rigorous and analytical research performed by the author(s). Submissions should contain within the body of the text a section in which research methodology is described in detail.

All submitted text is to be the sole creation of the author(s) with the exception of correctly cited paraphrases and properly indicated quotations. Co-authored submissions are acceptable as long as all authors meet the eligibility requirements listed above.

Any research involving human subjects must have approval from the appropriate Institutional Review Board. Submitting authors are responsible for adhering to IRB guidelines. Check with your faculty advisor for further information.

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Submissions may not be under review for publication elsewhere.

Format

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2. Include a cover sheet as a <u>separate document</u> that contains author name(s), date, title, citation style, and one of the following categories:

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3. Include an abstract of no more than 150 words.

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   - Include page numbers on all pages except for the title page.
   - Include a references page that follows the appropriate citation format for your field of study.

6. Figures and Tables

   - <u>Use greyscale</u> when possible.
   - <u>Tables should be no more than 5 inches wide</u>.
   - Number and title figures and tables.
   - Place all figures and tables in your manuscript.
   - Also provide a separate file for each table and figure.
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   - Figures must be JPEG, TIFF, PNG, EPS or PDF files.

7. Carefully check that each item in your references section follows the <u>punctuation, capitalization, and italicization</u> conventions of your citation style (APA, MLA, etc.)

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After the review process is complete (usually early March), authors will be notified of the review board's decision. Authors whose papers are selected for publication will receive suggestions for revision from the faculty reviewers and editorial board. Authors are expected to revise their manuscripts before final publication.

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