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UNIVERSITY OF CALIFORNIA, RIVERSIDE

UNDERGRADUATE RESEARCH JOURNAL

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UNIVERSITY OF CALIFORNIA, RIVERSIDE

UNDERGRADUATE RESEARCH JOURNAL

FROM THE CHANCELLOR

UC Riverside is a national leader in social mobility, educational access, and research excellence, all of which are on display in the 19th volume of the UC Riverside Undergraduate Research Journal. With faculty-mentored research projects across a breadth of disciplines, UCR provides a wealth of opportunities for students to investigate complex questions while building research skills. Each year, I am excited to see how students have embraced this part of their education while further developing their own scholarly interests.

As a research university, one of UC Riverside's most important duties is the creation of knowledge. Creating an environment and structure that fosters innovation to solve our community and the world's greatest challenges is in our university DNA. Our students are making the most of these opportunities and accomplishing truly inspiring work. From parental praise to media representations of indigenous peoples to the behavior of the black soldier fly to the experiences of transfer students, this edition of the Journal covers significant scientific ground in a wide range of disciplines while showing research excellence of the highest order.

Yet, the Journal has something more to offer than discovery. It offers hope for the future led by our students' bold and brilliant minds. I congratulate all the students who contributed to this edition of the Journal, and I express my sincere gratitude to the faculty mentors and staff members that supported these students in their scholarly endeavors.

Sincerely,

Kim A. Wilcox
Chancellor

FROM THE VICE PROVOST AND DEAN

Undergraduate students actively engaging in research is one of the major goals of any research-intensive university. Fortunately for us at the University of California, Riverside, we have programs, faculty, and an institutional culture that promotes such activities for students across the disciplines.

This Journal is just one venue that highlights the impressive research activities that students engage in while at UC Riverside. Whether students are involved in an individual project, working on research team, collaborating on a lab project, or engaged in some creative activity in one of the several relevant departments on campus, such research and creative engagement can be one of the most meaningful intellectual experiences for students during their time at UCR.

No less significant is the honor of having one's work published in an academic journal. Not only will students be able to share their accomplishment by listing a publication on their resume/curriculum vitae, but they also will be able to share their publication with family, peers, future professional or graduate schools, and prospective employers. Published authors also experience the power of leaving a lasting imprint of their meaningful academic work in the Journal, with the university, and in their respective fields of study.

Congratulations to all of the student-authors, faculty mentors, staff, and other support systems who helped make this publication possible. This is a major accomplishment, and the student-authors should be proud.

Once again, congratulations!

Sincerely,

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We are proud to unveil the 19th edition of UC Riverside's Undergraduate Research Journal—a testament to the creativity, intellectual drive, and diverse perspectives of UCR's undergraduate scholars. This edition showcases the groundbreaking ideas and original research that reflect the best of what UCR students have to offer. Each article represents hours of inquiry, experimentation, and revision—and together, they represent the next generation of scholars and innovators. Publishing a journal of this caliber would not be possible without the tireless efforts of our Student Editorial Board and Faculty Advisory Board. Their insight, dedication, and meticulous attention to detail helped transform a collection of manuscripts into a unified volume of scholarly excellence. To the authors: thank you for daring to ask bold, complex questions and for trusting us to share your work. Your research not only enriches your respective disciplines but also strengthens the foundation of undergraduate scholarship at UCR. It has been our privilege to serve as Editors-in-Chief and help bring this edition to life. We hope it inspires the next generation of undergraduate scholars to push the spirit of discovery forward and pursue bold ideas with a deep commitment to learning.

Sincerely,
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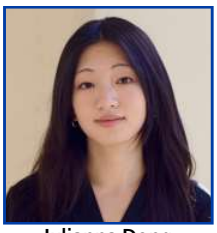

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This 19th issue of the *UC Riverside Undergraduate Research Journal* comes out at a tenuous time for research in America. Our ability to do research is increasingly threatened. Now more than ever, it's vitally important for the public to know about the research we do, to understand its value to society, and to help us defend it from attacks. And that's why I'm so grateful to the undergraduate researchers in this issue. They didn't just do the research—the long days in the lab, the long nights at the library, the hours spent sifting through documents or crunching numbers. They also went the extra mile to tell the world about their research. They wrote it up in a paper, submitted it to a journal, subjected it to rigorous peer review, revised it until it was perfect, and made it freely available to anyone in the world who wants to read it. Their work is a testament to the value of research. Of course, the undergraduate researchers didn't do it alone; equally essential were the members of the *Journal*'s Student Editorial Board who guided submissions through review and publication, and the Faculty Advisory Board members who advised students on the peer review process. And none of this would have been possible without the tireless work of Jennifer Kavetsky and the support of Gladis Herrera-Berkowitz, the CUREL team, and the UCR Division of Undergraduate Education. Finally, I'm extremely grateful to Prof. Morris Maduro for serving as the Chair of the *Journal*'s Faculty Advisory Board for the past decade. His leadership has placed the Journal on a firm foundation as we approach our milestone 20th issue next year. And if you're an undergraduate researcher who would like to publish your work in our 20th issue, please consider submitting to the *Journal*!

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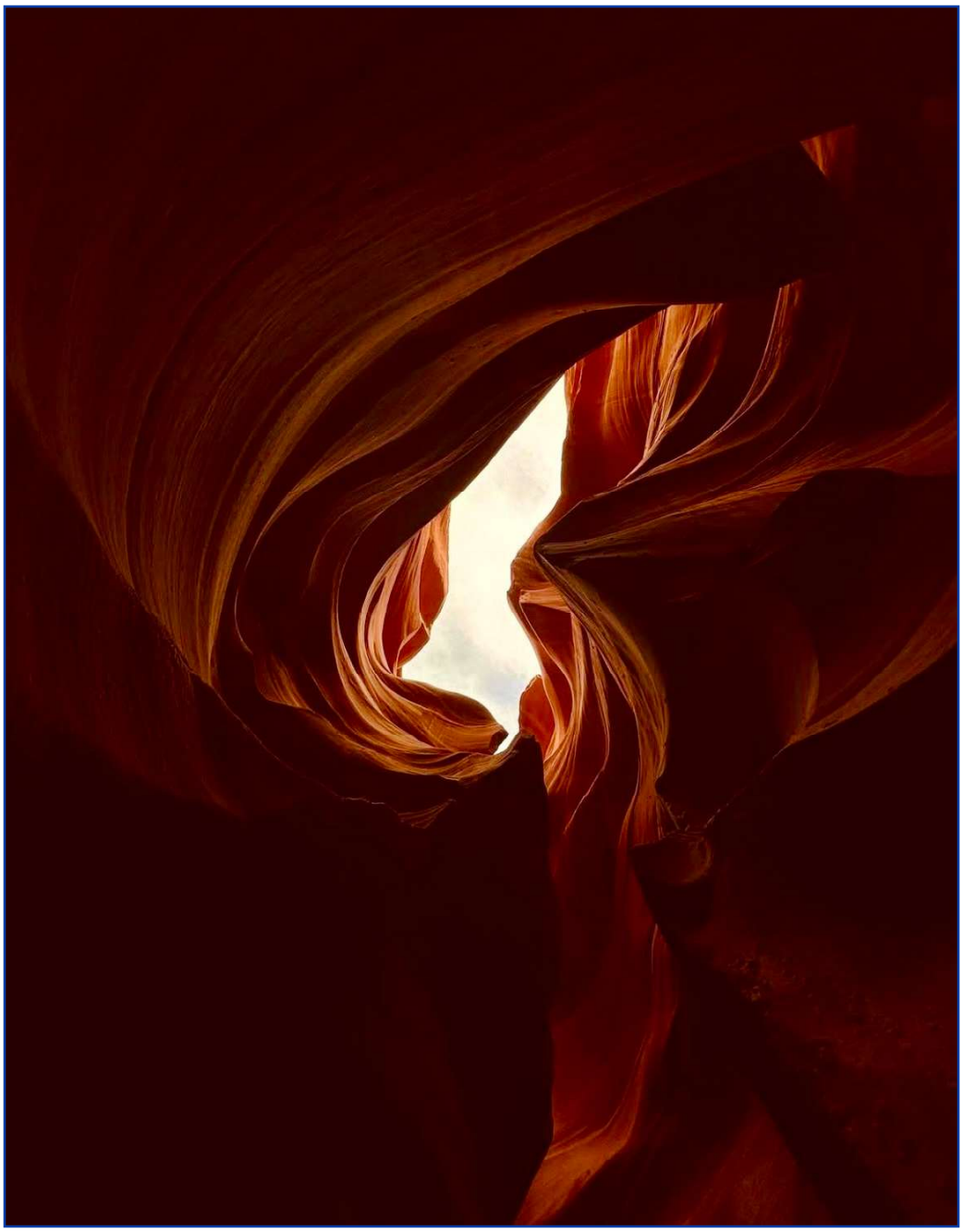
We would like to extend our heartfelt gratitude to Laksh Athappan and Flicks UCR for generously capturing the portraits of all our Student Editorial Board members and authors. Your dedication to preserving the essence of this edition adds a personal touch that complements the hard work and brilliance showcased within these pages. Thank you for your invaluable contribution to the *UCR Undergraduate Research Journal*.

Sincerely,
The UGRJ Team

ABOUT THE COVER



Sreenidhi Surineni

Sreenidhi Surineni is a third-year neuroscience major at the University of California, Riverside, with a minor in philosophy. He conducts research in the Zheng Lab, where he investigates the role of alternative RNA splicing in Alzheimer's disease, and also works on machine learning-based detection of axonal swellings. Outside the lab, he is the founder of Enlight Education, a nonprofit dedicated to bringing hands-on STEM education to underserved students across the U.S. and internationally. Sreenidhi is passionate about neurotechnology, science communication, and bridging research with community impact. In his free time, he enjoys photography, doing triatholons, and reading.

This photo shows the smooth, flowing rock formations of Antelope Canyon in Arizona. The light from above highlights the natural curves and textures of the sandstone walls. The warm colors and unique shapes reflect the natural beauty created by wind and water over time.

Social Perceptions of Fashion

Mindy Tram Hoang, Psychology
Jimmy Calanchini, Ph.D., Department of Psychology

ABSTRACT

The present study examined people's perceptions of others as a function of fashion choices, specifically Western wedding dresses. A total of 250 UC Riverside undergraduate participants viewed a series of pictures of the model's silhouettes wearing Western-style wedding dresses and reported their perceptions (e.g., confident, original, shy, vain, fun) of the model in each picture. The wedding dresses varied in neckline (i.e., Sweetheart, V-Neck, Halter, High Neck and silhouette (i.e., A-line, Mermaid, Fit and Flare, Ballgown). We found significant, reliable differences in how participants perceived the models as a function of dress silhouette and neckline. Specifically, participants perceived the models wearing the Fit and Flare silhouette to be especially confident, original, fun, and vain, but the models wearing the A-line silhouette to be the least confident, original, and fun. Furthermore, participants perceived the models wearing the V-neck neckline to be especially confident and vain, but the models wearing the High Neck to be the least confident, original, and fun. Additionally, the participants perceived the models wearing the Sweetheart neckline to be especially original, and fun, and the models wearing the Halter neckline especially confident. It is important to note that the Halter, High Neck, and Sweetheart all scored the same in the vain category. This research establishes a relationship between wedding dresses and social perceptions, which brides can use to select the dresses to convey their desired perceptions, and fashion shows and businesses can use to better serve their customers.

KEYWORDS: Social perception, fashion, Western wedding dresses, silhouettes, necklines

FACULTY MENTOR - Dr. Jimmy Calanchini, Department of Psychology

Dr. Calanchini is an Associate Professor in the Department of Psychology and director of the Riverside Social and Spatial Cognition lab. He earned his Ph.D. in psychology with a minor in quantitative psychology at UC Davis. His research relies on both direct and indirect measures of intergroup biases to develop new ways to predict important judgments and behaviors.

MINDY TRAM HOANG

Mindy Hoang received her BA in Psychology from UCR. During her time as an undergraduate student, she was involved in numerous activities including the Honors Program, the Riverside Social & Spatial Lab under Dr. Calanchini, Kappa Kappa Gamma Sorority, ASUCR Internal Affairs Basic Needs Committee, and a brand ambassador for many companies including Victoria Secret Pink, Amazon Prime, and GroupMe. Mindy presented at both the Undergraduate Research Symposium and the R'PSYC Conference, and is now currently working full time at UCR.

Social Perceptions of Fashion

INTRODUCTION

Piano music is booming loudly, which cues the audience to stand and turn promptly toward the direction of the bride entering the beautiful ceremony. As the bride walks down the aisle, everyone gasps. However, before anyone notices the person next to the bride as they make their way down the aisle, all eyes are fixated on the gorgeous white dress that the bride is wearing. Subconsciously, as the bride is walking down the aisle, each person in the audience is not only admiring the bride, but is also making their own perceptual judgment of the bride based on the wedding dress of the bride's choosing. For example, people in the audience could be thinking about positive attributes of the bride such as how confident the bride looks, how original the bride is, or how fun the bride can be. However, there could also be other kinds of perceptions that are made, such as how vain the bride may be or how shy the bride looks. Regardless of what kind of perception is being made, the process of creating a judgment based on a specific element is referred to as a social perception.

Social perception can be applied to any and all objects or settings, such as race, gender, physical features, body movements/behaviors, fashion, environment, etc. Since this can be applied in every situation and context, unfortunately, the act of making social perceptions is oftentimes forgotten or overlooked. Consequently, this research will directly focus on the idea of social perception in the context of fashion. However, to understand the relationship between social perception and fashion, we must first understand what these two different elements are.

Social perception refers to the processes involved when an individual assumes attributes about another individual based on their behavior, values, attitude, etc. (Davis & Lennon, 1988). For example, when people begin interacting with others, inevitably, there is already some sort of impression forming, and getting to know the person would either support the initial thoughts one may have, or the person may turn out to be the complete opposite. This simple act of making social perceptions is thought to be fundamental in sustaining society and promoting consistent communication and human interaction (Barresi & Moore, 1996). Given this, social perceptions are truly important and ingrained in society.

Moving forward, fashion is defined as an expressive and creative way that encapsulates a variety of goals the wearer may have, whether it's moving, feeling, or specific thoughts (Thornquist, 2018). Each person has a different goal or perception they want from their viewers when creating their outfit each day, so the variety of perceptual traits that can be inferred can be boundless. Given this, fashion is typically one of the initial factors that people use to formulate first impressions since fashion can effectively communicate to people about these different social perceptions, as clothing serves as a non-verbal cue (Davis & Lennon, 1988). People frequently overlook fashion despite the intention that is placed within every piece that is chosen for an outfit, as each element sends some sort of message to others, either intentionally or unintentionally. Given this, fashion as a whole is a very important element to consider when it comes to creating first impressions or judgments from anyone who sees the entire outfit put together.

Existing research has demonstrated that fashion choices are related to social perceptions. Whether it is a simple garment or an elaborate piece, perceivers make inferences about other people based on the clothing they wear. However, many types of clothing exist that are worn for different kinds of occasions or environments, such as everyday wear or important life events, like weddings. Despite the cultural and personal significance of weddings to brides, grooms, families, and friends, there is little research that has examined social perceptions of wedding dresses. Wedding dresses are one of the most important outfits one wears in a lifetime, as weddings are oftentimes considered one of the most special events for many. This is agreed upon in the fashion industry as well; wedding dresses are designed much more intricately than other kinds of outfits. This is because wedding dresses primarily rely on two important items, the aesthetic or style of the bride and the social perceptions of anyone who sees the dress. Given this, this study aims to fill this gap, which will not only advance social perception theory but also provide practical information to related fashion industries. However, before delving into the importance of this research, it is important to set some context and background on wedding dresses.

Social Perceptions of Fashion

Wedding dresses have been a symbol of marriage, love, and weddings for centuries. Brides have realized how important it is to pick out a wedding dress as the style, color, silhouette, neckline, and fabric play a huge part in the decision-making process. More specifically, when it comes to the elements of a wedding dress, both the silhouette and neckline may be key components when selecting a dress, as both elements are what bridal consultants typically take note of during the first bridal consultation. Because of this, I believe both the silhouette and necklines are two of the most important determining factors in a bride's decision making.

There are 14 total silhouettes (Raniwala, 2024), and the 4 most common silhouettes are A-line, Mermaid, Fit and Flare, and Ballgown. The A-line silhouette is composed of a tight bodice and the rest of the dress drops right under the breasts and slightly flares out, which creates the "A" shape bottom (Raniwala, 2024). The Mermaid silhouette is also composed of a tighter bodice at the top; however, this silhouette's main goal is to accentuate the bodice, hips, waist, and flares out around the knee area to make a semi-poofy shape at the bottom (Raniwala, 2024). The Fit and Flare silhouette is similar to the Mermaid silhouette; where it accentuates the bodice, hips, and waist, but gradually flares out at the hem of the skirt (Raniwala, 2024). Lastly, the Ballgown silhouette has a fitted bodice, but the fabric flows down into a larger, dramatic shirt (Raniwala,2024).

Moving forward, there are 15 necklines total for wedding dresses (Varina, 2023), and the four most common necklines are: Halter, High Neck, Sweetheart, and V-neck. The Halter neckline is composed of the top piece running from the front of the gown all the way up and around the neck, typically exposing the shoulder and collarbone (Kleinfeld, n.d.). The High Neck neckline can either sit above or right at the base of the neck, which provides the most coverage in comparison to all of the other necklines (Varina, 2024). The Sweetheart neckline drops down to the front and center of the gown, creating a heart shaped style (Kleinfeld, n.d.). Lastly, the V-neck neckline plunges down to a certain point towards the top center of the bodice, creating the letter "V" (Kleinfeld, n.d.).

Throughout history, despite the variety of silhouettes and necklines, it has been stipulated amongst the bridal community that a white, modest wedding dress style symbolizes purity and elegance, which is why this trend has lasted for many centuries (Fundunk & Cuden, 2017). Given this, if a bride wanted their dress to exemplify these characteristics for their audience, then they may aim for a more modest and white gown instead of something "out of the ordinary" such as a more revealing neckline or tighter silhouette. Furthermore, not only does a white wedding dress represent purity and elegance, but it can also allude to the perception that the bride emulates the characteristics of a "traditional" woman, so if a bride does not select a wedding gown that fits this perception, then there would be room for other types of perception and judgment from anyone who sees the dress, unfortunately (Arvanitidou & Gasouka, 2014). This is why for centuries white wedding dresses have been favored in the West.

When it comes to the dress selection process, not only is it important for the bride to select the dress, but typically, a bride will want to have opinions firsthand from a very selective group of family and friends (i.e., the entourage). However, having an entourage may complicate the decision-making process for the bride, as the entourage could sway the bride in the direction that they did not envision for their big day. For example, if the bride's entourage does not agree on a dress, they can take over the appointment by choosing a wedding dress they prefer and have an existing perception of (Min, Ceballos, & Yurchisin, 2018). Needless to say, the final dress selection process ends up based on different perceptions: the bride's and the entourage's.

However, other than the brides and their entourage's opinion, the bride could be persuaded in different directions based on current wedding dress trends. For example, trendy bridal dresses tends to feature more "extravagant" patterns, colors, and cuts, such as: feathers, sequins, lots of appliques, pastel colors, or even straying away from the traditional white color altogether. This is because people today care about being different and want to be distant from the common trends (Berger, 2008). More recently, Vogue published an article that discusses this phenomenon that currently brides are leaning more towards non-traditional styles of wedding dresses that prioritize showing off personality rather than

staying on the "safer," more traditional style (Neilson, 2024). As brides become more confident in style and select nontraditional dresses, more brides follow suit, which causes a shift in wedding dresses designs, as designers are now straying further away from the traditional modest and traditional style.

Research Question

Do perceptions of brides vary based on the silhouette and neckline of their wedding dress?

Hypothesis

I believe that there is an existing perception people have when looking at an individual's wedding dress. More specifically, I predict that models wearing Sweetheart and High Neck necklines, and A-line and Ballgown silhouettes will be perceived as relatively more timid, reserved, and kind. In contrast, I predict that models wearing Halter and V-neck necklines, and Mermaid and Fit and Flare silhouettes will be perceived as relatively more confident, conceited, outgoing, and fun.

METHODS

To conduct this experiment, undergraduate students were provided a web-based survey (Qualtrics) that was opened at the beginning of the 2023 fall quarter, and remained open until the end of the quarter. Before the survey was released on Qualtrics, the study received IRB approval. In order to participate in this study, all participants were required to consent. This is a within-participant design, as all participants were shown the same 48 images and made their decisions based on the same 15 perceptual traits. It is important to note that all participants were shown 1 image of a model in a wedding dress at a time, and with each image, they were required to report how much they agreed with a series of the preselected 15 perceptual traits. After viewing all dresses and reporting their perceptions, participants also responded to 11 questions regarding their exposure to the wedding industry. For example: "Have you been part of a bridal/groom party within the last year" and "Have you been to a wedding within the last year?" After answering the 11 questions, participants completed a couple of attention checks and demographic questions. Lastly, before being able to exit the survey, all participants looked at a debriefing form and provided their consent (if they chose to) for us to use their submitted data for further analysis.

Participants

A total of 260 undergraduate students who all attend the University of California, Riverside, participated in this study. All participants were recruited on SONA and are enrolled in an introductory psychology course: PSYC001 or PSYC002. Of these 260 participants, 10 were excluded due to providing incomplete data (i.e. not answering a question); therefore, 250 participants were included in the final analysis. The age range was 18 to 24 years. 34% of the participants identified as male, 64% as female, and 2% did not identify as either gender. Furthermore, the participants were highly diverse in terms of race. 1.6% of the participants identified as American Indian or Alaskan Native, 9.2% as Biracial or Multiracial, 1% as Black or African-American, 24% as East Asian, 4% as Native Hawaiian or Pacific Islander, 11.6 % as South Asian, 22.8 % as White/Caucasian, and 16.4% preferred not to answer. Lastly, we also observed the marital status of each participant. 64.8 % of the participants are single, 28.4% of the participants are dating, 0.8% of the participants are engaged, 0.8% of the participants are married, and no participants were divorced or separated.

In response to the questions assessing exposure to the wedding industry, for the question, "Have you been part of a bridal/groom party within the last year?", 8% of the participants responded yes, and 92% responded no. For the question, "Have you been to a wedding within the last year?", 26% of the participants responded yes, and 74% responded no. For the question, "Have you watched any shows or seen any social media content related to American weddings within the last year?", 62.4% responded yes and 37.6% responded no. Lastly, for the question, "Did any other factors (such as fabric, poses, sleeves, etc.) influence your opinion?", 88.8% of the participants responded yes, and 11.2% responded no. In order to see what factors may have influenced a participant's decision, we provided an array of potential confounding variables for participants to choose from, as they can choose multiple confounds if they answered yes to the previous question. Given this, 70.8% of the participants considered the fabric (Lace, Silk, Tulle, etc.), 64% of the participants considered sleeves, 60.4% of

the participants considered poses (the way the person was positioned in the image), 4% of the participants considered the background color, and 4.8% of the participants selected no to this question.

Materials

In this study, participants viewed a total of 48 images of Western-style wedding dresses. The dresses varied in neckline (i.e., Halter, High Neck, Sweetheart, V-neck) and silhouette (i.e., A-line, Mermaid, Fit and Flare, Ballgown). This is the manipulated variable. It is important to note that all of the images have been edited to obscure identifying social information about the wearer. All images of the wedding dresses were presented in random order and displayed for at least 15 seconds before participants could move on to the next image.

Figure 1 Silhouette and Neckline Examples

Measures

For each dress, participants rated the extent to which they would infer a variety of perceptual traits about the wearer. We were interested in 5 primary perceptual traits: confident, original, shy, vain, and fun. However, there were a total of 15 traits that were asked because we decided to include 2 additional synonyms apart from the original 5 traits and averaged this together at the end. The 15 total perceptual traits include the following: confidence, outgoing, sociable, creative, original, authentic, shy, timid, reserved, disingenuous, vain, conceited, fun, whimsical, and playful, which is the measured variable. All of these characteristics are reported on a 7-point scale, with the following labels: Definitely Not, Probably Not, Might or Might Not, Probably Yes, and Definitely Yes. The terms coordinate with a range of numbers on the 0-7 scale as follows: 0 represents Definitely Not, 7 represents Definitely Yes, 1-2 represents Probably Not, 6 represents Probably Yes. 3-4 represents Might, and 5 represents "Might Not."

RESULTS

We used a series of ANOVAs to analyze responses for each trait for silhouettes and, separately, for necklines. For silhouettes, we found significant, reliable differences in how participants perceived models on all five dimensions (Figure 2): confident $F(3,249) = 59.05$, $p<0.001$; original $F(3,249) = 12.26$, $p<0.001$; shy $F(3,249) = 38.92$, $p<0.001$; vain $F(3,249) = 36.58$, $p<0.001$; and fun $F(3,249) = 10.96$, $p<0.001$. Participants perceived models wearing the Fit and Flare silhouette to be especially confident ($M = 3.73$, $SD = 0.39$), original ($M = 3.39$, SD = 0.41), and vain ($M = 2.80$, $SD = 0.45$); however, fun perceptual trait scored the lowest out of all of the four silhouettes ($M = 3.30$, $SD = 0.45$). Additionally, models wearing the A-line silhouette were perceived to be the least confident ($M = 3.13$, $SD = 0.97$), original ($M = 3.18$, SD = 0.75), vain ($M = 2.50$, $SD = 0.67$), and fun ($M = 3.09$, $SD = 0.72$), and the most shy ($M = 2.80$, $SD = 0.65$). Additionally, both the Ballgown and Mermaid silhouette fell in the middle between all of the ratings. Participants perceived models wearing the Ballgown silhouette to be confident ($M = 3.36$, $SD = 0.49$), original $M = 3.24$, $SD = 0.52$), shy ($M = 2.88$, $SD = 0.50$), vain ($M = 2.53$, $SD = 0.55$), and fun ($M = 3.20$, $SD = 0.47$).

Lastly, participants perceived models wearing the Mermaid silhouette to be confident ($M = 3.36$, $SD = 0.49$), original ($M= 3.24$, $SD = 0.52$), shy ($M = 2.88$, $SD = 0.50$), vain ($M = 2.53$, $SD = 0.55$), and fun ($M = 3.20$, $SD = 0.47$).

Furthermore, we also found significant, reliable differences in how participants perceived models as a function of dress necklines on all five dimensions (Figure 3): confident $F(3,248) = 156.73$, $p<0.001$; original $F(3,248) = 32.13$, $p<0.001$; shy $F(3,248) = 207.81$, $p<0.001$; vain $F(3,248) = 10.88$, $p<0.001$; and fun $F(3,248) = 63.28$, $p<0.001$. Participants perceived the models wearing the V-neck neckline to be especially confident ($M = 3.78$, $SD = 0.39$) and vain ($M = 2.76$, $SD =0.46$), and the ratings for the original trait ($M = 3.35$, $SD = 0.40$), shy trait ($M = 2.44$, $SD = 0.44$) and fun trait ($M = 3.43$, $SD = 0.42$) fell in the middle between all of the ratings for necklines. However, participants perceived the models wearing the High Neck neckline to be the least confident ($M = 3.32$, $SD = 0.43$), original ($M = 3.26$, $SD = 0.48$), and fun ($M = 3.23$, $SD = 0.43$), while both the shy trait ($M = 3.12$, $SD = 0.43$) and vain trait ($M = 2.66$, $SD = 0.47$) were in the middle between all of the ratings. Additionally, both the Halter and Sweetheart necklines fell in the middle between all of the ratings overall. Participants perceived models wearing the Halter silhouette to be confident ($M = 3.44$, $SD = 0.42$), original ($M = 3.23$, $SD = 0.44$), shy ($M = 2.86$, $SD = 0.40$), vain ($M = 2.66$, $SD = 0.47$), and fun ($M = 3.20$, $SD = 0.47$). Lastly, participants perceived models wearing the Sweetheart neckline to be confident ($M = 3.66$, $SD = 0.49$), original ($M = 3.44$, $SD = 0.41$), shy ($M = 2.60$, $SD = 0.44$), vain ($M = 2.66$, $SD = 0.47$) and fun ($M = 3.49$, SD = 0.42). It is important to note that the Halter, High Neck, and Sweetheart necklines all scored the same for the mean and standard deviation for the vain perceptual trait.

Social Perceptions of Fashion

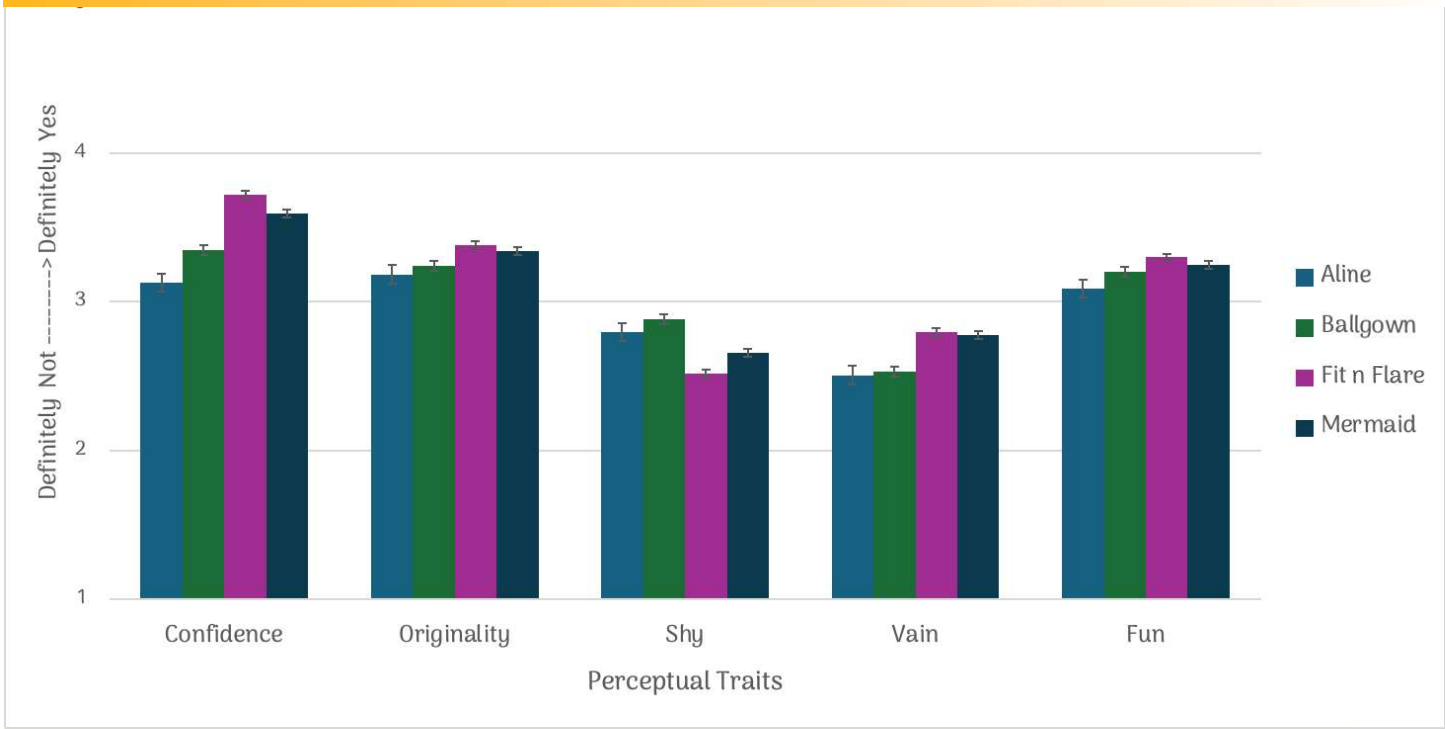


Figure 2 Silhouette Perceptions

Note: Error bars represent standard errors.

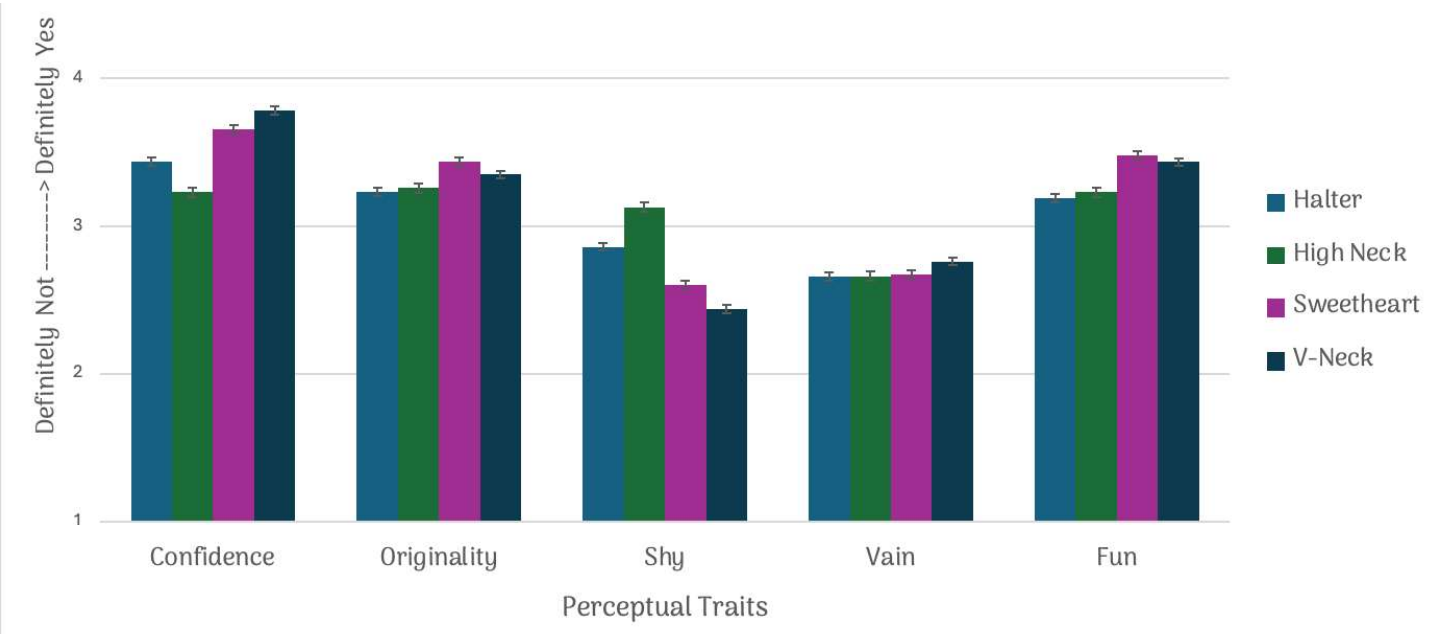


Figure 3 Neckline Perceptions

Note: Error bars represent standard errors.

DISCUSSION

This study examined people's perceptions of others as a function of fashion choices, specifically focusing on Western-style wedding dresses. UC Riverside undergraduate participants viewed a series of pictures of models wearing Western-style wedding dresses and reported their perceptions (i.e., confident, original, shy, vain, and fun) of the dress in each picture. The wedding dresses varied in silhouettes and necklines. We found significant, reliable differences in how participants perceived the models as a function of dress silhouette and neckline. Participants perceived the models wearing the Fit and Flare silhouette to be especially confident, original, fun, and vain, but the models wearing the A-line silhouette to be the least confident, original, and fun. Furthermore, participants perceived the models wearing the V-neck neckline to be especially confident and vain, but the models wearing the High Neck to be the least confident, original, and fun. Additionally, the participants perceived the models wearing the Sweetheart neckline to be especially original, and fun, and the models wearing the Halter neckline especially confident. It is important to note that the Halter, High Neck, and Sweetheart all scored the same in the vain category.

Unfortunately, existing research does not specifically focus on the relationship between social perceptions and wedding dresses. Instead, it only focuses on social perceptions and fashion more generally. This research helps cover what is currently missing, as it observes the specific relationship between social perceptions and wedding dresses instead of the broader relationship between social perceptions and fashion. Additionally, existing research also does not examine any kind of perceptual traits people are making. This research helps bridge this gap that is currently missing in the literature, a relationship between wedding dresses and social perceptions, which brides can use to select the dresses to convey their desired perceptions. Not only do these results benefit and inform brides, but benefits fashion designers and businesses as well, as fashion shows and businesses can use this information to better serve their customers. When fashion designers need inspiration as to what perceptions are trending in order to create bridal gowns, they can create wedding dresses based on the perception that are popular or trending to satisfy their clientele. Businesses can also profit as well, as trendy wedding gowns will increase revenue for those in the fashion industry.

Limitations and Future Directions:

Given that there are a variety of components in a single wedding dress, unfortunately, there were a couple of elements that were not included in this research. To begin, we only examined 4 kinds of silhouettes and necklines, but there are a total of 14 different kinds of Western wedding dress style silhouettes (Raniwala, 2024), and 15 different kinds of Western wedding dress style necklines (Varina, 2023). With 4 silhouettes and 4 necklines (totaling 48 images with 15 perceptual trait questions), the survey reached an average time of approximately 45 minutes, so due to the time, we decided to cut down on both elements. Furthermore, our study only utilized five main traits (e.g., confident, original, shy, vain, and fun) with 3 synonyms for each trait (15 total perceptual questions) which allows each participant to be their own comparison group, and makes the data more statistically powerful. However, there are more than these 15 traits that exist when making social perceptions, which is why the 15-trait constraint is a limitation within this study.

Another limitation of this study is finding a cohesive background across all 48 images. Even though all of the backgrounds were neutral, having a cohesive background may eliminate potential noise, as 4% of the participants did consider this element when making their perceptual opinion. Additionally, not only was the background of the images a limitation, but we also obscured each model's face in each image as well. Obscuring the model's faces in each image increased internal validity, as this eliminated any potential perceptions people may make about a person's facial features, otherwise known as the halo effect. In contrast, taking out the facial features decreases its external validity, as in reality, people do make social perceptions of faces whether consciously or unconsciously, so facial features cannot be taken out of consideration when making these social perceptions in the real world. Furthermore, this research did not thoroughly examine each individual element of the wedding dress in terms of fabric and sleeves, given that a large number of participants did reconsider this in their

overall decision; as 70.8% of the participants considered the fabric (Lace, Silk, Tulle, etc.), 64% of the participants considered sleeves.

Lastly, it is important to note that in this research, we primarily focused on Western-style wedding dresses. However, Western-style wedding dresses are not the only kind of wedding dresses that are widely used across the nation, as different cultures wear different garments for their special day. Given this, in the future, I would like to expand this research to include different kinds of wedding outfits across different cultures, as this research is just as important for those who do not wear a Western-style wedding dress.

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Indigenous (Mis)Representation in Emerging LLM Research Methodologies

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ABSTRACT

The American road to the present has been dominated by injustice, massacre, and the genocide of Indigenous peoples. However, this past has been perpetually mythologized and whitewashed, ideologically reinforcing settler-colonial systems of control. Popular histories of the American westward expansion often allow the nation to evade responsibility for the injustices embedded in the U.S.'s nation-building. This study examines the perpetuation of Indigenous historical misrepresentations through cinematic portrayals of Native Americans and the reemerging accessibility of these portrayals through conversations with Large Language Models (LLMs) and related forms of layperson's historical research. Fifty-two progressive Western films were compiled by prompting OpenAI's ChatGPT and Google's Gemini, in addition to scraping the top Wikipedia results from Google's search engine. These films were then analyzed on various aspects of positive, negative, and absent representation of Indigenous people. Through this analysis, the inadequacies of LLMs in understanding historical and cultural ethics are illuminated. By evaluating critical dimensions in casting practices, prevalence of tropes, and narrative framing in the selected films, an image of a continuing and evolving cultural genocide emerges. The findings suggest that the integration of LLMs in research practices only exacerbates the spread of misinformation, undermining efforts by Indigenous and activist academics and filmmakers to challenge reductive stereotypes. This research advocates for enhanced digital literacy and critical engagement with AI-driven tools to mitigate their detrimental effects on historical understanding and cultural representation, contributing to a broader discourse on the ethical implications of AI and its role in the preservation and dissemination of marginalized histories.

KEYWORDS: Indigenous representation, Western film history, Large Language Model (LLM), Artificial intelligence, Internet research efficacy, History education

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INTRODUCTION

Moments of victory largely define U.S. history as it is known to the layperson. Nearly any American could provide a clear sequence that contains the landing of the Pilgrims, the signing of the Declaration of Independence, the success of the American Revolution, the drafting of the Constitution, the perseverance of the Union through the Civil War, the end of the "Wild West," victory in the World Wars, and the fall of the Soviet Union. However, anything beyond the most basic ideas of these events is susceptible to and victim of perpetual propagandizing and mythologization.[1] Numerous causes, both antecedent and symptomatic, for this paradigm can be postulated and have filled thousands of volumes throughout the historiographical and sociological canons. Attributing the causes of this situation is not the focus of this paper. Instead, this study highlights cinema as one of the foremost tools of historical education for Americans outside of classrooms and provides ample opportunity for mythologization of U.S. history.[2]

For numerous Americans, western films provide context regarding this formational era of our nation's history, while also demonstrating profoundly visible propagandization and glorification regarding the removal and genocide of American Indigenous peoples. Redface, the attempt by a non-Indigenous person to appear so, and the prototypical "Hollywood Indian" were both endlessly propagated in this genre, excluding Native peoples from participation in the production and storytelling of westerns.[3] Numerous academics from across various disciplines share a consensus on the harmful impacts of stereotyping in media, identifying the real-world discrimination and hate it can often produce. Due to centuries of erasure and suppression of Native voices in academia, sources authored by Indigenous peoples have fallen into greater and greater obscurity, particularly given the overwhelming quantity of sources now available through the World Wide Web. With little exposure to these perspectives, they are only rarely cited in academic studies.

As the digital and internet age has progressed, the advent of Large Language Models (LLMs), Artificial Intelligence programs with the ability to mimic human language to communicate with the user and other Artificial General Intelligences (AGI's) has muddied the layperson's research of history, a field already rife with misinformation and predatory rhetoric. This study seeks to understand, on a limited scale, the implications of this new method of information gathering as it pertains to the Indigenous peoples of America.[4] Through interactions with Google's Gemini chatbot and its integrated search engine, in addition to a shallow Wikipedia exploration, a list of fifty-two Western films was produced. These films were presented by the LLM as fair representations of the history of American Indigenous peoples, suggesting to a non-academic audience that they offer valid expressions of Indigenous perspectives. Through analysis of this dataset, alongside historical and academic literature about the portrayal of Indigenous peoples in film, this study produces a review of literature regarding Native Americans in the Western genre

1). Joanne Esch, "Legitimizing the 'War on Terror': Political Myth in Official-Level Rhetoric: Political Myth in Official-Level Rhetoric," *Political Psychology* 31, no. 3 (June 2010): 357–91, https://doi.org/10.1111/j.1467-9221.2010.00762.x, 366-372; Jonathan Friedman, "Myth, History, and Political Identity," *Cultural Anthropology* 7, no. 2 (1992), 202-204.

2). John E. O'Connor, "History in Images/Images in History: Reflections on the Importance of Film and Television Study for an Understanding of the Past," *The American Historical Review* 93, no. 5 (December 1988): 1200, https://doi.org/10.2307/1873535, 1202-1203; Debra Donnelly, "Using Films in the Development of Historical Consciousness: Research, Theory and Teacher Practice," *History Education Research Journal* 17, no. 1 (April 1, 2020), https://doi.org/10.18546/HERJ.17.1.09, 116-117.

3). Laurence M. Hauptman, "Mythologizing Westward Expansion: Schoolbooks and the Image of the American Frontier before Turner," *The Western Historical Quarterly* 8, no. 3 (July 1977), https://doi.org/10.2307/966995, 272-275.

4). Scott Monteith et al., "Artificial Intelligence and Increasing Misinformation," *The British Journal of Psychiatry* 224, no. 2 (February 2024): 33–35, https://doi.org/10.1192/bjp.2023.136; Pranshu Verma, "The Rise of AI Fake News Is Creating a 'Misinformation Superspreader,'" *The Washington Post*, December 17, 2023, https://newsliteracymatters.commons.gc.cuny.edu/wp-content/blogs.dir/8164/files/2024/10/How-AI-fake-news-is-creating-a-%E2%80%98misinformation-superspreader-The-Washington-Post.pdf; Zhuoran Lu et al., "The Effects of AI-Based Credibility Indicators on the Detection and Spread of Misinformation under Social Influence," *Proceedings of the ACM on Human-Computer Interaction* 6, no. CSCW2 (November 7, 2022): 1–27, https://doi.org/10.1145/3555562.

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and develops an understanding of the implications of LLM development and usage on the accessibility of harmful, outdated films and the misinformation they present.

A BRIEF HISTORY OF INDIGENOUS AMERICANS IN THE WESTERN

For as long as humans have spoken, stories have been told. Integral to the survival of early humans, the desire to narrate one's experiences and feelings has been developed through hundreds of millennia of natural selection and evolutionary development.[5] Videography, even as it has surpassed a century of success and progression, is yet another venue for this storytelling. As the cinema has commercialized and grown into a monumental economic powerhouse, accessible to nearly any American, screenwriters and directors have developed a profound influence on the popular consciousness, with the power to present or withhold information from the public. Mirroring the classic drama, the cantastoria, or any oration, filmmaking presents its creators with a unique control over allegory and its bounds, often reflecting the worldviews and desires of the artist.[6] The world the film inhabits is manufactured, allowing imaginary realties to be presented as truth. Filmmakers' own perspectives and biases often shape their work, turning numerous attempts at historical authenticity in film into profoundly misguided historical fantasy.[7]

America's colonial expansion westward is a campaign brimming with tales of genocide and cultural destruction of Indigenous peoples. Hundreds of tribes, thousands of settlements, and hundreds of thousands of people lived on the land that the American empire sought. Through military action, settler-colonial decimation of populations, civil persecution, rape, murder, and genocide, Americans forced the imaginary boundary of America through the ancestral lands of numerous Indigenous peoples. Despite centuries of waging war against the imperial machine, tribes were brutalized until they were forced to surrender, lest they face the fate of those in Sand Creek, Hynes Bay, Howonquet, or numerous other villages of Indigenous who were indiscriminately slaughtered.

By the mid eighteenth century, the dime novel was the predominant form of fiction consumed by Americans; early foundations of the Western Myth were established in these sensational, exploitative renditions of life on the frontier. The Indigenous peoples of the Great Plains were reduced to environmental antagonists or fetishized love interests overshadowed by the determined, rugged cowboy pushing forward America's territory.[8] In 1869, Ned Buntline published *Buffalo Bill, The King of Border Men*, which was adapted for the stage by Frederick Maeder as *Buffalo Bill*, evolving into *Buffalo Bill's Wild West*. Featuring the "real" Buffalo Bill, William Frederick Cody, the show was an immediate hit, immersing audiences in a glorified rendition of western life, featuring Indigenous characters played by both Indigenous and non-Indigenous actors. Touring internationally, the show cemented many of the stereotypes which would define western cinema.[9] The show routinely acted out scalpings and village destruction, with the Indigenous peoples typically portrayed as bloodthirsty savages to be put down by Buffalo Bill. Off the stage, William "Buffalo Bill" Cody pressed further on these stereotypes, proclaiming himself an "Indian fighter," recounting tales of murdering and scalping Indigenous

5). Daniel Smith et al., "Cooperation and the Evolution of Hunter-Gatherer Storytelling," *Nature Communications* 8, no. 1 (December 5, 2017), https://doi.org/10.1038/s41467-017-02036-8.

6). Sean Cubitt, *Videography: Video Media as Art and Culture* (New York, NY: St. Martin's Press, 1993), 174-176.

7). Cynthia D. Bond, "Laws of Race/Laws of Representation: The Construction of Race and Law in Contemporary American Film," *Texas Review of Entertainment & Sports Law* 11 (May 9, 2010): 241-243, 261-263.

8). Ralph E. Friar and Natasha Friar, *The Only Good Indian: The Hollywood Gospel* (New York, NY: Drama Book Specialists, 1972), 9-16.

9). Ed Buscombe, *Injuns! Native Americans in the Movies*, Locations (London: Reaktion Books, 2006), 49-54.

warriors.[10] B*uffalo Bill's Wild West* brought the myth of the American frontier to the public, beginning a century of popular cultural interest in western fiction.

The first publicly screened American commercial film portraying a Native American, now lost, was Wallace McCutcheon's and Edward Porter's 1907 *Daniel Boone*, features the titular Boone seeking vengeance against an unnamed Indigenous tribe who previously attacked his cabin off-screen, getting captured and being tortured before escaping and killing the Chief in hand-to-hand combat.[11] In 1907 alone, six more silent westerns would be produced, marking an increase in popularity of the genre.[12] In this early period of film, few westerns with true character substance were produced. Instead, the focus was on the visual elements of the genre, including the characteristic costuming of Indigenous characters.[13] James Young Deer was the first Indigenous commercial director, directing and acting in dozens of films about Indigenous culture and life. His work on *The Invaders*, directed by Francis Ford in 1912 is particularly notable, and James Young Dear served as one of the first true cultural ambassadors on a Hollywood film set.[14] However, in 1913, D.W. Griffith, famed for directing and writing *The Birth of a Nation*, directed *The Red Man's View*, a sympathetic portrait of Native Americans as a helpless peoples who are pushed further and further west by advancing Whites. Often heralded as the most progressive film regarding Native peoples during the silent film era, the film was the first commercially successful film focused on the Indigenous genocide.[15]

As Americans returned from the First World War and the economic upturn of the 1920s began, film production rapidly increased. By this time, westerns had already become the foremost genre of film, with a majority of them also featuring Indigenous Americans.[16] The western satisfied a nostalgic interest in pre-industrial life, particularly in cities where movies were screened.[17] In turn, the fictionalized domination and conquest in these films fulfilled a White fantasy for times when there was a *savage Indian*, allowing the audience the satisfaction of a fictional victory.[18] When the Great Depression hit, this sentiment only became more intense.

By the 1950s, after nearly a half century of western film production, directors and writers who sought to push the boundaries of the genre began to experiment with its established tropes and stereotypes. John Ford was particularly noted for the complexity of his films, which often had a greater degree of moral ambiguity than did other

10). William Cody, *Buffalo Bill's Own Story of His Life and Deeds* (Chicago: Homewood Press, 1917), http://archive.org/details/buffalobillsownsoobuffrich.

11). Michael Hilger, *Native Americans in the Movies: Portrayals from Silent Films to the Present* (Lanham: Rowman & Littlefield, 2016), 407.

12). Ibid, 408-409.

13). Bob Herzberg, S*avages and Saints: The Changing Image of American Indians in Westerns* (Jefferson, North Carolina: McFarland & Company, Inc., Publishers, 2008), 18-22.

14). Joanna Hearne, *Native Recognition: Indigenous Cinema and the Western* (Albany: State University of New York Press, 2012), 44-53.

15). Michael Hilger, *Native Americans in the Movies*, 409.

16). Beverly R. Singer, *Wiping the War Paint off the Lens: Native American Film and Video*, 1st ed., Visible Evidence v. 10 (Minneapolis: University of Minnesota Press, 2001), 14-23.

17). Frederick Elkin, "The Psychological Appeal of the Hollywood Western," *Journal of Educational Sociology* 24, no. 2 (October 1950), https://doi.org/10.2307/2263795, 76-79.

18). Richard M. Wheelock, "Reconsidering America's Errand: Wilderness and 'Indians' in Cinema," in *Native Apparitions*, ed. Steve Pavlik, M. Elise Marubbio, and Tom Holm, Critical Perspectives on Hollywood's Indians (University of Arizona Press, 2017), https://doi.org/10.2307/j.ctv1gn3t9b.6, 32-35.

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films of the era. Nonetheless, the films of this era reflected a different stereotype of Indigenous peoples, primarily that they were disappearing.[19] Numerous films attempted to capture the plight of Indigenous Americans, but often fell back on White Savior or romantic plotlines to produce sympathy.[20] Further stifling progressive filmmaking at this time was the Hayes Code, which discouraged filmmakers from producing work which could be seen as Anti-American.

Casting remained an issue in Indigenous portrayals in Hollywood even as filmmakers wrote more sympathetic Native characters. Jewish, Hispanic, or Black actors were primarily cast as Indigenous peoples in Western films. Language and behavioral traits were rarely accurate, if not caricatural.[21] In many cases, the Native peoples in the films were played by White actors, particularly when a woman was sexualized in the plot.[22] These casting issues persisted even as the genre declined in popularity.[23]

By the Age of Revolutions in the 1960s and the 1970s, public interest in westerns had begun to fade. Spaghetti westerns and progressive westerns became the predominant films in the genre until they also fizzled out in the 1980s. Films such as *Dances with Wolves* (1990) and *Django Unchained* (2012) carry the legacy of the genre, while pushing racial and ethical boundaries. Despite this, the widespread popularity of the cowboy mythos has passed.

RESEARCH OUTSIDE THE ACADEMY IN THE 21ST CENTURY AMIDST THE RISE OF LLMS

An individual in the U.S. is guaranteed only twelve years of formal historical instruction, only the last few of which are spent researching difficult subject matters. Upon graduation from high schools, students are expected to have the capacity to read and critically understand historical sources and works. This is not the case.[24] Given this inadequacy in the comprehension and analytical skills of many American adults, a reliance on emerging tools, particularly LLMs is to be expected.[25] However, the inadequacies of accessible LLMs are particularly flawed in regards to informed research.[26] Models such as OpenAI's ChatGPT and Google's Gemini often "hallucinate data," a term used by LLM engineers to describe a phenomena in which chatbots produce false, imagined information. This is in addition to lacking the

19). Louis Owens, *Mixedblood Messages: Literature, Film, Family,* Place, American Indian Literature and Critical Studies Series; v. 26 (Norman: University of Oklahoma Press, 1998), 120-125.

20). Jacquelyn Kilpatrick, *Celluloid Indians: Native Americans and Film* (Lincoln: The University of Nebraska Press, 1999), 75-77; M. Elise Marubbio, *Killing the Indian Maiden: Images of Native American Women in Film* (Lexington, Ky: University Press of Kentucky, 2006), 169-174.

21). Michelle H. Raheja, *Reservation Reelism: Redfacing, Visual Sovereignty, and Representations of Native Americans in Film*, Book Collections on Project MUSE. (Lincoln: University of Nebraska Press, 2010), 51-55.

22). M. Elise Marubbio, *Killing the Indian Maiden*, 93-101.

23). Bob Herzberg, *Savages and Saints*, 281-282.

24). Diana S. Hooley, Lee Ann Tysseling, and Beverly Ray, "Trapped in a Cycle of Low Expectations: An Exploration of High School Seniors' Perspectives About Academic Reading," *The High School Journal* 96, no. 4 (April 2013): 321–38, https://doi.org/10.1353/hsj.2013.0018; George W. Moore et al., "High School Students and Their Lack of Preparedness for College: A Statewide Study," *Education and Urban Society* 42, no. 7 (November 2010): 817–38, https://doi.org/10.1177/0013124510379619; Kathryn S. McCarthy and Eleanor F. Yan, "Reading Comprehension and Constructive Learning: Policy Considerations in the Age of Artificial Intelligence," *Policy Insights from the Behavioral and Brain Sciences* 11, no. 1 (March 2024): 19–26, https://doi.org/10.1177/23727322231218891..

25). Peter Brusilovsky, "AI in Education, Learner Control, and Human-AI Collaboration," *International Journal of Artificial Intelligence in Education* 34, no. 1 (March 2024), https://doi.org/10.1007/s40593-023-00356-z, 126-129.

26). Donghee Shin, Amy Koerber, and Joon Soo Lim, "Impact of Misinformation from Generative AI on User Information Processing: How People Understand Misinformation from Generative AI," *New Media & Society*, March 20, 2024, 14614448241234040, ttps://doi.org/10.1177/14614448241234040, 7-10.

ability to understand human sensitivities and emotions to the same capacity a real person would.[27] Thus, it is necessary to analyze the data output a potential lay researcher may receive from these chatbots, in addition to surveying the complementary sources they would likely utilize.

Following the release of media such as *Westworld* (2016-2022), *Red Dead Redemption 2* (2018), *Yellowstone* (2018-2024), *The Power of the Dog* (2021), an *1883* (2021-2022), westerns have made a reentry into the popular consciousness. As fans of these franchises seek further experiences within the genre, the repolarization of older media is inevitable, permitting the harmful ideas expressed in earlier western films to reemerge. The age of many of these films is apparent, and this will likely discourage modern viewers. Regardless, this new popularity presents narratives which serve to produce incomplete and dangerous ideologies regarding American colonialism.

LLM chatbots allow the layperson to conduct research on an incredible scale within seconds; information which could take years of professional research to gather. To understand the output a lay researcher may receive, simple, non-technical phrasing was used in interactions with the LLMs. OpenAI's ChatGPT and Google's Bard were consulted for this study. Additionally, the Wikipedia pages for "Native Americans in Film" and "Revisionist Westerns" were scraped, as they were the first results to come up when searching "Native American Western Wikipedia" on Google, DuckDuckGo, Bing, and Yahoo.

Both chatbot models received the same question: "What are some movies that have well-written Native Americans?" Following the answer, the LLM was told to "Give me 5 more." This process was repeated until the recommendations began to repeat. From these sources, fifty-two films which featured Native Americans characters were produced. These films were compiled and analyzed based on:

- the ethnicity of the director/screenwriters,
- the presence of the environmental hazard trope,
- if Native characters were credited with names,
- if female Native characters were credited with names,
- if any female Native characters had lines of dialogue,
- if the film passed the Bechdel test,[28]
- if the film cast Indigenous actors,
- the critical reception,
- the box office success,
- the presence of the White Savior trope,
- the presence of an Indian seductress stereotype,
- if they contained any violent or sexual exploitation scenes.

27). Fadi Aljamaan et al., "Reference Hallucination Score for Medical Artificial Intelligence Chatbots: Development and Usability Study," *JMIR Medical Informatics* 12 (July 31, 2024): e54345, https://doi.org/10.2196/54345.

28). Bechdel Test (Bechdel-Wallace Test): Method of media analysis regarding representation of women in film created as a joke in 1985 by cartoonist Allison Bechdel. The Bechdel Test asks if a film features two women talking to each other about something that is not a man or concerning a man.

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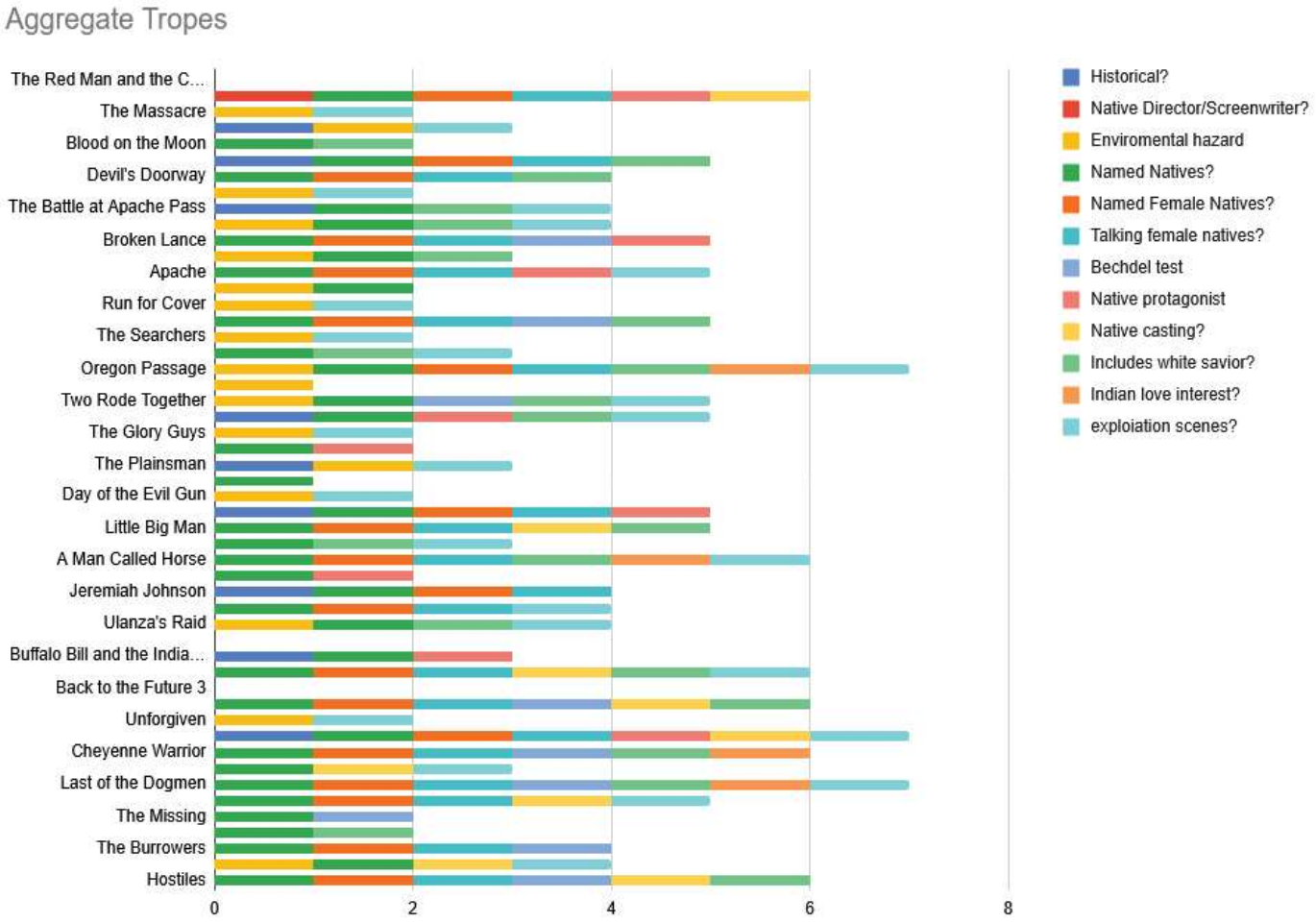

The results are as follows:

- One film, James Young Deer's *White Fawn's Devotion*, was directed by an Indigenous filmmaker.
- Seventeen films included the "environmental hazard" trope.
- Thirty-eight featured named Indigenous characters, while twenty featured named Indigenous women, and of those, twenty also had speaking lines.
- Nine films passed the Bechdel test.
- Nine films featured a Native protagonist.
- Three featured a mixed-race protagonist.
- Nine featured full Native casting.
- Eight featured partial Native casting.

In terms of critical reception:

- Fifteen films received overwhelming acclaim.
- Seven were well received.
- Eighteen had mixed reviews.
- Five received a negative reception.
- Three were critically panned.

At the box office:

- Twelve films earned more than triple their budget.
- Four earned more than double.
- Nine surpassed their budget.
- Five underperformed.
- Seventeen earned less than half their production costs.

Narratively:

- Twenty-one films included a White Savior figure.
- Four featured an indigenous love interest.
- Twenty-six depicted scenes of violent or sexual exploitation.

From this list, only seven were pulled from Wikipedia, four of which were highly progressive films which fulfilled nearly every category. The first film both chatbots typically recommended was the infamous 1970 *Soldier Blue*, whose concluding scene portraying the Massacre at Sand Creek is one of the most shocking ever put on tape. Amidst graphic technicolor footage of simulated rape and child murder, a White protagonist gawks and cries at the scene before him while a White woman serves as the central bond between him and the tribe. Although powerful in its grotesqueness and shocking nature, it fails to capture the humanity of the Cheyenne people. Instead, it revels in their slaughter, fetishizing one of the worst incidents in American history.

When compiling and categorizing this list, the blatant inability of the LLM to produce results which treated Indigenous characters respectfully was shocking. The chatbot was especially ineffective at recommending films which treated Indigenous women favorably, with only nine passing the Bechdel test. This inadequacy is troubling, given the current prevalence of historic misinformation on the internet. With AI's growing role as a journalist, writer, blogger, historian, and internet media creator, this lack of critical analytical ability is troubling.[29] The future of popular history will likely see a surge in misrepresentations if these issues are not addressed.

CONCLUSION

The presence of these westerns is not the problem, but the confident pushing of them by "reliable" tools is highly detrimental to the work of Indigenous academics and filmmakers who are attempting to repair these fields. Outside of the arts, the real lives of Indigenous peoples are deeply affected by these portrayals; individuals are often stereotyped and confined according to the imagery within the films. Native children and youth are particularly likely to be victims of this, both in school and in their own self-image.

For as long as popular media has proliferated in the United States, Indigenous peoples have been otherized and marginalized through these works. Misrepresentation is not a new phenomenon, but it is one that will continue until tools of society are adapted to prevent its continued spread. Given the profit incentive of LLM and AGI companies, significant change which does not contribute to their bottom line is unlikely. However, through educating our peers and the public about these issues, the uncritical proliferation of historically inaccurate and dehumanizing materials may be slowed.

29). Begüm Aydın and Mustafa İnce, "Can Artificial Intelligence Write News: A Research On Determining The Effect Of Artifical Intelligence On News Writing Practice," *Intermedia International E-Journal* 11, no. 20 (June 28, 2024): 24–41, https://doi.org/10.56133/intermedia.1436647.

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Associations Between Community Violence Exposure and Neurological and Behavioral Indices of Extinction Recall in Preadolescent Latina Youth

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ABSTRACT

Community violence exposure increases risk for fear-based disorders, such as anxiety, potentially due to disrupted recall of extinguished fear, whereby stimuli previously associated with threat continue to produce a fear response long after they have been deemed safe. However, this emerging work lacks adequate representation of youth from historically marginalized groups, despite their disproportionate exposure to community violence. As such, this study investigates whether such exposure is associated with neurological and behavioral indices of extinction recall in a sample of preadolescent Latina girls.

Thirty-five predominantly Mexican-heritage Latina girls (M_{Age} = 10.04, *SD* = 1.23, range = 8-12 years) underwent functional magnetic resonance imaging (fMRI) while completing an extinction recall task, assessing their ability to retrieve related but competing memories of previously conditioned and extinguished threats. Following the fMRI scan, participants self-reported their community violence exposure using the *Things I've Seen and Heard* scale. Relative to youth with low community violence, youth exposed to higher levels of community violence demonstrated significantly less ventromedial prefrontal cortex (vmPFC) engagement in response to increasingly ambiguous conditioned stimuli and were also marginally more likely to misattribute threat to conditioned stimuli that were least likely to predict threat.

These preliminary results suggest community violence exposure may contribute to disruptions in extinction recall and elucidate a potential mechanism by which these experiences could elevate anxiety, particularly among an understudied group during a sensitive developmental period of heightened anxiety risk.

KEYWORDS: community violence, extinction recall, anxiety, ventromedial prefrontal cortex, functional magnetic resonance imaging, fear conditioning

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Associations Between Community Violence Exposure and Neurological and Behavioral Indices of Extinction Recall in Preadolescent Latina Youth

INTRODUCTION

Community violence exposure, or instances of violence children encounter outside of the home, is common (> 60%) and has been linked to a range of fear-based disorders, such as anxiety, in adolescence and beyond (Fowler et al., 2009; Green et al., 2010). A growing body of research proposes disrupted recall of previously extinguished fear as one possible explanatory mechanism (Graham & Milad, 2011; Marusak et al., 2021). However, much of this work has yet to include youth from historically marginalized groups, despite their often disproportionate exposure to community violence (Chen et al., 2020). Latinx youth, in particular, witness higher rates of community violence relative to white youth, but remain severely underrepresented in emerging research, and Latina girls, who already exhibit heightened levels of untreated anxiety, may be at heightened risk (Crouch et al., 2000; McLaughlin et al., 2007). As such, the current study explores whether community violence exposure is associated with neurological and behavioral indices of extinction recall in a sample of preadolescent Latina girls residing in the Inland empire, a region in California ranking higher than state average in rates of violent crime (Federal Bureau of Investigation, 2019).

Fear Conditioning and Extinction

Fear conditioning, a form of associative learning, is a widely used experimental paradigm for investigating the neurological and behavioral underpinnings of fear-based disorders, like anxiety (Shechner et al., 2014). During fear conditioning, a neutral conditioned stimulus (CS) is repeatedly paired with an aversive unconditioned stimulus (US), resulting in a CS-US association, whereby the previously neutral stimulus now produces a learned or "conditioned" fear response (CR). Some paradigms also probe safety learning processes (Mullins et al., 2021, 2024) via two CS's, one paired with the US (CS+) and another unpaired (CS-). When the CS+, but not the CS-, elicits a CR, this reflects an enhanced ability to respond adaptively to future aversive events while recognizing situations that remain safe. Importantly, conditioned fear responses may be extinguished after the CS+ is presented repeatedly in the absence of the US, in a process called extinction (Hobin et al., 2003). Finally, extinction recall occurs when the CS- and extinguished CS+, along with a set of blended morphs that fall along a continuum of increasing similarity to the extinguished CS+, are presented again at a later time with the general consensus that low levels of fear responding reflect successful extinction recall and high levels of fear responding reflect poor extinction recall (Michalska et al., 2019).

Extinction Recall in Anxiety Disorders

Anxious individuals often show deficits in extinction recall, as evidenced by heightened fear responding to previously extinguished threats (Garfinkel et al., 2014; Milad et al., 2009). Evidence suggests these deficits are due, in part, to structural and functional alterations in key neural regulatory regions necessary for extinction recall. One such region is the ventromedial prefrontal cortex (vmPFC), which is thought to inhibit the expression of fear and aid in safety learning (Quirk & Beer, 2006). This regulatory role is important as experiences of community violence are instances of learning that condition how future social interactions are encountered. If community violence exposure disrupts activation of the vmPFC, this can maintain or exacerbate anxiety. During extinction recall, anxious adult patients consistently exhibit lower vmPFC activation relative to healthy controls (Britton et al., 2013; Milad et al., 2005, 2007). Further, a study of extinction recall during adolescence found that anxious youth were less able to differentiate between the CS+ and its most similar morph variations relative to nonanxious youth, as evidenced by representationally similar vmPFC activation patterns (Glenn et al., 2020). In a related study, anxious adolescents exhibited a U-shaped pattern of vmPFC activation, showing heightened responding to the CS+ and CS- and reduced responding to their blended, more ambiguous, morphs (Britton et al., 2013). Together, these studies demonstrate that anxious youth have difficulty differentiating between threatening and non-threatening stimuli and regulating their response to increasingly ambiguous stimuli. Importantly, this work rarely considers how social influences, like community violence exposure may shape these neural and behavioral responses.

Associations Between Community Violence Exposure and Neurological and Behavioral Indices of Extinction Recall in Preadolescent Latina Youth

Study Overview

Despite the well-documented detrimental impact of community violence exposure on fear-based disorders (Fowler et al., 2009; Green et al., 2010), research specifically addressing how these experiences confer heightened risk for anxiety remains limited. The current study aimed to address this gap by testing whether community violence exposure is associated with neurological and behavioral indices of disrupted extinction recall in a sample of preadolescent Latina youth. First, we tested the hypothesis that community violence exposure would be associated with deviations in vmPFC activation when viewing increasingly ambiguous conditioned stimuli morphs, such that high community violence exposed youth would exhibit reduced vmPFC responding relative to low community violence exposed youth. Second, we tested the hypothesis that community violence exposure would predict disrupted recall of previously extinguished fear, whereby high community violence exposed youth would be more likely to incorrectly label an ambiguous stimulus as one they had previously experienced as aversive. Characterizing the effect of community violence exposure on this fear-related brain region and behavior may elucidate possible mechanisms through which adverse community-level experiences in childhood confer risk for anxiety later in development.

METHODS

Participants and Procedure

Participants included 35 predominantly Mexican-heritage preadolescent Latina girls (M_{Age} = 10.04, SD = 1.23, range = 8-12 years) residing in the Inland Empire. Participants were recruited via fliers in outpatient mental health clinics local hospitals, and the University of California, Riverside (UCR) Psychology Department shared database of child participants. We received IRB approval for the current study prior to data collection. Participant eligibility was determined by phone screening with a parent. Children were eligible for participation if they were conversant in English, age 8-13 years, self-identified as Latina, were pre-menstrual, and had no contraindications for neuroimaging. While undergoing a functional magnetic resonance imaging (fMRI) scan at the UCR Center for Advanced Neuroimaging, participants completed an extinction recall task assessing their ability to retrieve related but competing memories of previously extinguished threat. Following the scan, participants completed a series of questionnaires assessing demographics and community violence exposure.

Measures

Brain Imaging and Data Processing

Whole-brain neuroimaging data were collected using a 3T Siemens Prisma scanner and 32-channel head coil. During 3 runs of 10 minutes 26 seconds each, 272 functional image volumes with 47 contiguous interleaved axial slices (in-plane resolution 2.5 mm, 3 mm slice thickness) were obtained with a T2*-weighted echo-planar sequence (TR = 2300 ms; TE = 25 ms; flip angle = 50; field of view [FOV] = 240 mm; matrix = 96 x 96). All functional data were anatomically localized and co-registered to a high-resolution T1-weighted volumetric scan of the whole brain, using a magnetization prepared gradient echo sequence (MPRAGE; TE = min full; TI = 425 ms; flip angle = 7, FOV = 256 mm; matrix = 256 x 256; in plane resolution 1.0 mm). Individual echo-planar images were preprocessed and analyzed for each participant using Analysis of Functional NeuroImages (AFNI; Cox, 1996). Preprocessing included despiking, slicetime correction, motion correction, and smoothing with a 4 mm full-width at half maximum (FWHM) kernel. All data were transformed to Montreal Neurological Institute (MNI) space. Blood oxygen level dependent (BOLD) data was scaled at the voxel-wise time series by their temporal means so effect estimates can be interpreted as percent signal change. Using the AFNI 3dDeconvolve function, a linear model was generated to estimate mean task-related vmPFC activation for each presented CS+, CS-, and blended morph.

Extinction Recall

To assess extinction recall, participants first completed a differential fear conditioning and extinction paradigm (Figure 1) consisting of three phases (Britton et al., 2013; Glenn et al., 2021). During the pre-acquisition phase, participants were shown a series of pictures of two women, the CS's, without the US. During the acquisition phase, one woman (CS+) predicted an image of a fearful face paired with a loud, aversive scream (US) while the other woman (CS-) did not. During the extinction phase, the CS+ and CS- were presented repeatedly without the US. Approximately two

Associations Between Community Violence Exposure and Neurological and Behavioral Indices of Extinction Recall in Preadolescent Latina Youth

Figure 1. Fear Conditioning and Extinction Paradigm

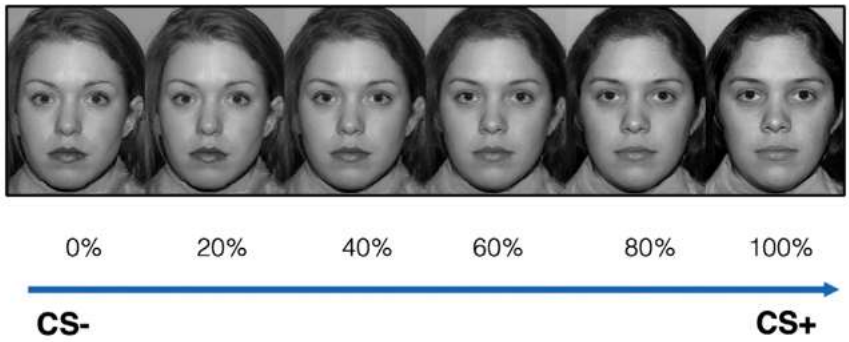

Figure 2. Extinction Recall Paradigm

weeks later, participants completed an extinction recall paradigm (Figure 2) during which they were shown a series of generated morphs blending the faces of the two women from the initial fear conditioning and extinction paradigm at 0%, 20%, 40%, 60%, 80%, and 100% (i.e., 0% = CS-, 100% = CS+). Participants were asked to use a 7-point Likert scale (0 = *not at all* to 6 = *extremely*) to judge the likelihood that the face was previously accompanied by a scream.

Community Violence Exposure

Participants self-reported their community violence exposure via the *Things I've Seen and Heard* scale (TISH; Richters & Martinez, 1993). For each of the 18 items (e.g., "heard gunshots outside your window", "seen somebody arrested", etc.), children reported on a 5-point Likert scale (0 = *never* to 4 = *more than three times*) the extent to which each was true for them. Item-level responses were averaged for each participant such that higher values indexed higher levels of community violence exposure. The TISH demonstrated moderately strong internal consistency in the current sample with a Cronbach's α of 0.64.

DATA ANALYSIS

To assess hemodynamic responding during extinction recall, we averaged vmPFC activation in response to each stimulus to index responsivity to low (CS-/0% and 20%), mid (40% and 60%), and high (80% and CS+/100%) similarity morphs. To assess behavioral responding during extinction recall, we averaged scream likelihood ratings (i.e., "how likely was the face to scream?") for each presented stimulus to index recall of low (CS-/0% and 20%), mid (40% and 60%), and high (80% and CS+/100%) similarity morphs. Whereas the low similarity morphs are most reflective of the CS- (high safety) and the high similarity morphs are most reflective of the CS+ (high threat), the mid similarity morphs represent a blend of the CS- and CS+ and are therefore the most ambiguous. To assess low vs. high levels of community

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violence exposure, TISH scores were mean split (0 = low, 1 = high). Finally, to account for developmental differences in extinction recall, child age was included as a covariate in all models.

Using SPSS (Version 29), a 2 (low *vs.* high community violence exposure) x 3 (low *vs.* mid *vs.* high morph similarity) repeated-measures analysis of covariance (ANCOVA) examined differences in vmPFC responsivity across the morph similarity spectrum between the low *vs.* high community violence exposed youth. A second 2 (low *vs.* high community violence exposure) x 3 (low *vs.* mid *vs.* high morph similarity) repeated-measures ANCOVA then examined differences in scream likelihood ratings across the morph similarity spectrum between the low *vs.* high community violence exposed youth. Finally, to probe any interactions resulting from each ANCOVA, we conducted post-hoc *t*-tests for the low *vs.* high community violence exposed youth within each level of morph similarity.

RESULTS

Descriptive statistics and bivariate correlations for variables of interest are reported in Table 1. Of note, child age was inversely associated with vmPFC activation in response to the low similarity morphs $r = -0.33$, $p = 0.050$. Additionally, community violence exposure was positively associated with scream likelihood ratings when viewing the low similarity morphs, $r = 0.34$, $p = 0.048$.

Neural Index of Extinction Recall

The first 2 (low *vs.* high community violence exposure) x 3 (low *vs.* mid *vs.* high morph similarity) repeated-measures ANCOVA examined vmPFC activation as a neural index of extinction recall, controlling for child age (Figure 3). Morph similarity and community violence exposure interactively predicted vmPFC activation, $F(2,64) = 3.68$, $p = 0.031$. Post-hoc *t*-tests revealed that high community violence exposed youth ($M = -0.08$, $SD = 0.23$) exhibited reduced vmPFC activation in response to the mid-similarity ambiguous morphs relative to low community violence exposed youth ($M = 0.13$, $SD = 0.31$), $t(33) = 2.31$, $p = 0.014$. No group differences in vmPFC activation were observed in response to the low or high similarity morphs, all $ps > 0.201$.

Behavioral Index of Extinction Recall

The second 2 (low *vs.* high community violence exposure) x 3 (low *vs.* mid *vs.* high morph similarity) repeated-measures ANCOVA examined scream likelihood ratings as a behavioral index of extinction recall, controlling for child age (Figure 4). Morph similarity and community violence exposure neither independently nor interactively predicted scream ratings, all $ps > 0.712$. However, given our *a priori* hypotheses, we conducted post-hoc exploratory *t*-tests, which revealed trend-level differences in scream ratings, such that high community violence exposed youth had marginally higher scream likelihood ratings for the low $t(33) = -1.60$, $p = 0.059$ and mid $t(33) = -1.51$, $p = 0.070$ similarity morphs relative to low community violence exposed youth.

CONCLUSION

A long-standing body of research has documented consistent and detrimental effects of community violence exposure on anxiety (Fowler et al., 2009; Green et al., 2010) and more recently emerging work has begun to explore disrupted extinction recall as a potential explanatory mechanism (Graham & Milad, 2011; Marusak et al., 2021). These investigations, while informative, have lacked adequate representation of youth from historically marginalized groups, who frequently face disproportionate levels of community violence (Chen et al., 2020). The current study addressed this gap by testing whether community violence exposure is linked to neurological and behavioral indices of extinction recall in a sample of preadolescent Latina girls, a group exhibiting heightened levels of untreated anxiety (McLaughlin et al., 2007) that has been underrepresented in neuroscientific research on anxiety development (La Scala et al., 2023).

We first tested whether community violence exposure predicted reduced vmPFC responsivity, whereby we expected high community violence exposed youth to exhibit lower vmPFC activation relative to low community violence exposed youth in response to ambiguous blends between threatening and safe stimuli. This hypothesis was fully supported. Youth exposed to higher levels of community violence demonstrated significantly less vmPFC engagement in response to the mid similarity morphs, but not to the

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Variable	*N*	*M*	*SD*	1	2	3	4	5	6	7	8
1. Child Age	35	10.04	1.23								
2. Community Violence Exposure	35	0.76	0.44	0.08							
3. vmPFC Activation - Low	35	0.00	0.34	-0.33*	0.12						
4. vmPFC Activation - Mid	35	0.03	0.29	-0.07	-0.28	0.43*					
5. vmPFC Activation - High	35	-0.08	0.25	0.01	0.09	0.30	-0.08				
6. Scream Rating - Low	35	1.25	1.35	-0.30	0.34*	0.39*	0.08	0.09			
7. Scream Rating - Mid	35	1.55	1.17	-0.28	0.12	0.27	0.11	0.13	0.82**		
8. Scream Rating - High	35	2.08	1.50	-0.20	-0.04	0.18	0.09	0.14	0.46**	0.83**	

Table 1. Descriptive Statistics and Bivariate Correlations. *$p < 0.05$, **$p < 0.01$.

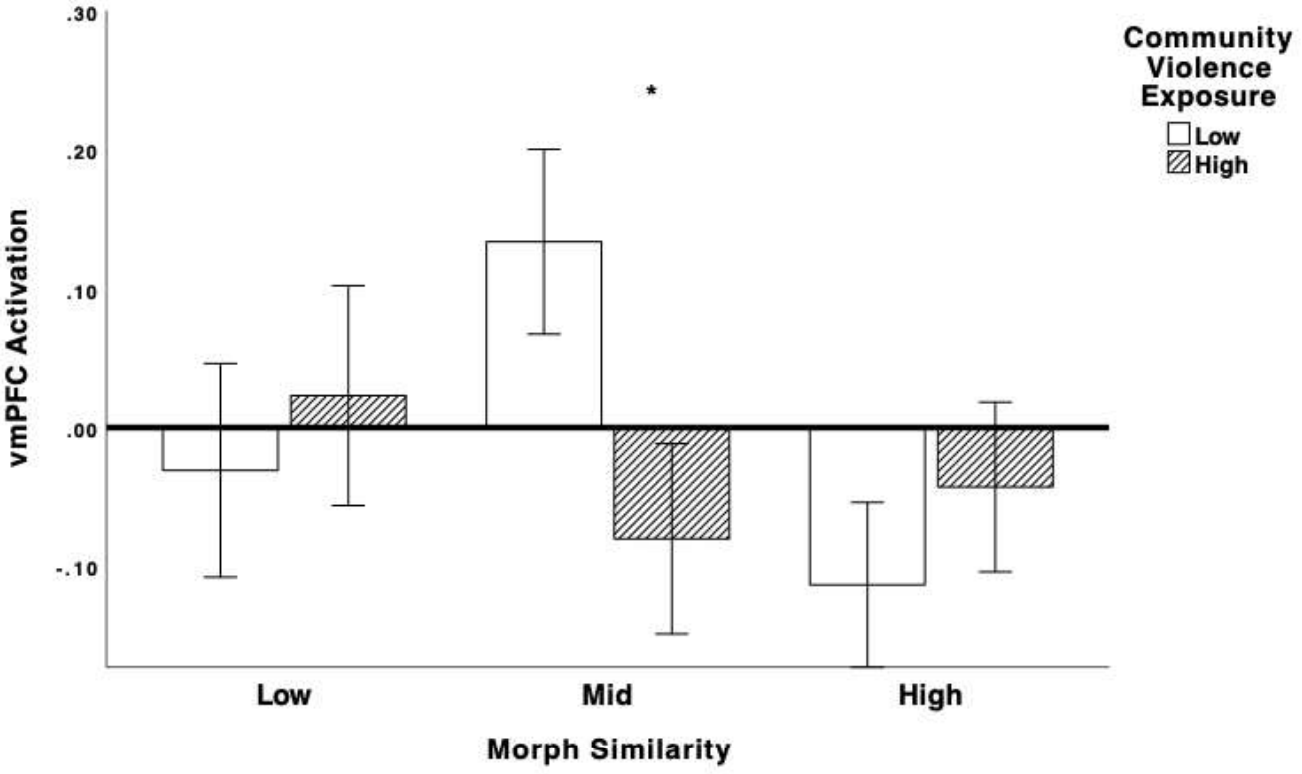

Figure 3. Hemodynamic Response to generalization morphs. vmPFC = ventromedial prefrontal cortex.

Note: Error bars represent standard errors. *$p < 0.050$.

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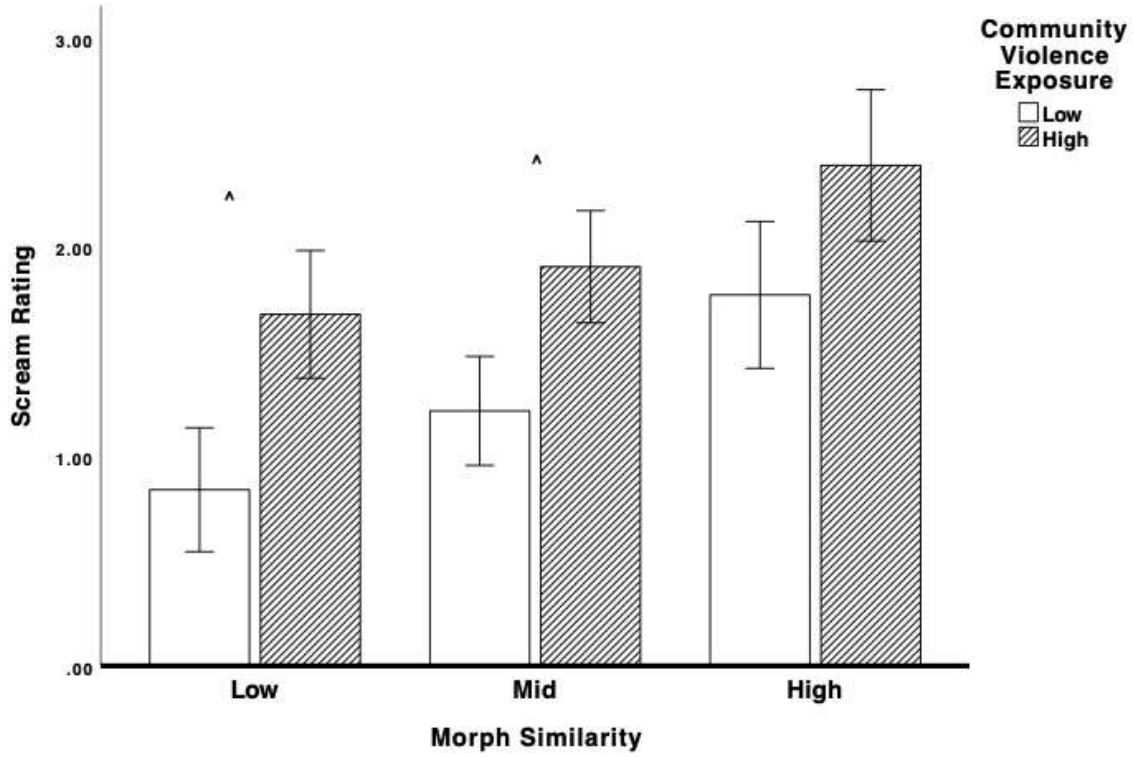

Figure 4. Behavioral Responding

Note: Error bars represent standard errors. ^$p < 0.070$.

low or high similarity morphs. This suggests a decreasing ability to engage regulatory brain regions as stimuli become increasingly ambiguous and suggests that community violence exposure may confer higher anxiety risk, in part, by disrupting regulatory processes when youth are tasked with recalling previously extinguished threats. Thus, community violence exposure may fundamentally alter how youth process fear and ambiguity, which can potentiate how future social interactions are experienced.

Next, we tested whether community violence exposure predicted disrupted recall of previously extinguished threat, where we expected high community violence exposed youth would incorrectly recollect that ambiguous stimuli had previously been threatening. This hypothesis was only partially supported. While we did not observe an effect of community violence on this behavioral index of extinction recall, we did observe marginal group differences for the low and mid similarity morphs in exploratory analyses. Specifically, youth exposed to higher levels of community violence tended to endorse higher scream ratings for the morphs that were least likely to be paired with the unconditioned event relative to youth exposed to lower levels of community violence. This suggests that experiences of community violence may disrupt children's recall of the likelihood of aversive events specifically for stimuli that are similar, but not identical, to previously extinguished threats.

The current findings should be considered in the context of several limitations. First, our sample size was modest, potentially reducing statistical power. Future work in larger samples would be informative. Second, this was a cross-sectional design that did not explicitly examine anxiety symptoms. Longitudinal studies testing whether community

violence may elevate anxiety through alterations in extinction recall processes would provide complementary insight into causal mechanisms. Acknowledging these limitations, we view our preliminary results as elucidating a potential mechanism by which community violence can adversely impact anxiety, particularly among an understudied group during an especially sensitive developmental period of heightened anxiety risk. Our hope is that this work may guide future research that will shape the development of culturally informed treatment programs aimed at reducing the burden of systemic and environmental stressors on mental health disparities among historically marginalized youth.

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Evaluating the Impact of Parental Praise on Children's Problem-Solving Persistence

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ABSTRACT

Child-directed praise is commonly seen as a form of positive parenting that promotes child development. However, the impact of praise on child development can differ based on the specific type of praise used. This study examined 250 parent-child dyads to investigate the impact of three forms of parental praise (i.e., process, person, and ambiguous) received at age 4 on children's later problem-solving persistence at age 8. We hypothesized that process praise, which highlights child effort, would foster persistence, whereas person praise, which emphasizes child characteristics, would undermine child persistence. Independent coders rated child-directed praise across a series of challenging parent-child tasks during a laboratory assessment at age 4. Children's problem-solving persistence was assessed by separate sets of coders during these same tasks at age 4 and a set of similar parent-child interaction tasks at age 8. A linear regression analysis, which controlled for child sex, ethnicity, poverty, child IQ, total parental utterances, and prior persistence, revealed significant positive contributions of process praise and ambiguous praise to children's problem-solving persistence. In contrast, person praise predicted decreased persistence at age 8. These results reveal the nuanced effects of different types of parental praise on children's ability to persist during challenging tasks. Future studies will test mediation models to examine how parental praise might influence long-term adaptation through child persistence. The current findings can inform parenting practices and early childhood interventions by emphasizing the importance of effort-based praise in fostering problem-solving persistence in children.

KEYWORDS: Praise, parenting, persistence, problem-solving

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INTRODUCTION

Child-directed praise encompasses verbal acknowledgments that recognize and value a child's actions, achievements, or attributes (Amemiya & Wang, 2018). Parents often use praise to reinforce desirable behaviors, shaping children's self-esteem and self-efficacy in ways that support their capacity to cope with future challenges (Mueller & Dweck, 1998; Gunderson et al., 2013). In this way, praise can play a significant role in fostering children's problem-solving persistence and motivation by promoting effort and encouraging children to push through difficulties (Lucca et al., 2019). As a common parenting practice, praise is often presumed to have positive developmental effects. However, the effects of praise may vary depending on its target of emphasis (e.g., vague praise versus praise about a child's efforts or attributes). Thus, this study investigated three types of praise—*process* focused on effort, *person* focused on inherent traits, and *ambiguous* focused on general outcomes—as related to changes in children's problem-solving persistence during challenging tasks observed at ages 4 and again at age 8.

Parental Praise and Children's Problem-Solving Persistence

Parental praise can take on different meanings (see Gunderson, 2013 for discussion), and may influence a child's ability to persist in problem-solving tasks in distinct ways. Process praise acknowledges the child's active involvement in a task by emphasizing their effort, strategy, and/or ideas (e.g., "That was a clever way to put those blocks together!"). Person praise focuses on the child's characteristics or attributes, such as affirming their intelligence (e.g., "You are so smart!") or ability (e.g., "You are the best artist around!"). In contrast, ambiguous praise lacks a clear target (e.g., "You did it!") and often addresses the quality of the outcome without specifying its cause (e.g., "That was impressive!").

Research suggests that parental praise effects on child development differ based on the specific type of praise administered (e.g., Gunderson et al., 2013). By highlighting the connection between the child's effort and success, process praise may enhance a child's motivation to continue working hard (Zentall & Morris, 2010), promote a growth mindset (Gunderson et al., 2013), improve academic performance (Gunderson et al., 2018), boost self-esteem (Robichaud et al., 2022), and promote self-efficacy during skill acquisition (Mueller & Dweck, 1998). Conversely, by focusing on the child's characteristics and traits, person praise may lead to a fixed mindset wherein the child feels they have little capacity to change their situation (Gunderson et al., 2013), prompting task disengagement (Mueller & Dweck, 1998), and may lead to lower self-esteem (Brummelman et al., 2014). Compared to research on process and person praise, ambiguous praise has shown mixed effects on child development. However, one study found that a combination of descriptive process praise (e.g., "Look at how you organized the beads by color!") with non-specific outcome praise (e.g., "That is amazing!") was associated with higher child self-esteem than either process or outcome praise in isolation (Robichaud et al., 2022).

Children's Problem-Solving Persistence

According to White's Competence Motivation Theory (1959), children are intrinsically motivated to accomplish goals, which strengthens their mastery motivation to persist through challenges and overcome difficulties. However, positive reinforcement, such as parental use of child-directed praise, can further strengthen these motivational processes and foster independence (Harter, 1978).

Persistence is defined as the ability to solve a task while ignoring distractions and enduring uncertainty about achieving a goal (McCall, 1995). Identifying factors that promote problem-solving persistence can inform interventions to support children's capacities to cope with setbacks and approach obstacles as opportunities for growth (i.e., resilience). As children successfully navigate challenging situations, they develop improved problem-solving skills and self-confidence, which enhance self-esteem and competence (Robichaud et al., 2022).

Study Overview

This longitudinal investigation evaluated the unique pathways from different types of child-directed parental praise (i.e., process, person, and ambiguous) during the preschool period at age 4 to changes in children's observed problem-solving persistence from ages 4 to 8. Focusing on this transition period into formal schooling is important because children develop problem-solving skills, cognitive flexibility, and

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mindsets that shape their academic and social success (Gunderson et al., 2013).

This study examined two directional hypotheses and one exploratory hypothesis. First, we hypothesized that children who received more process praise would be more likely to keep trying and persist through challenging tasks because process praise may help children attribute their success to their effort, which encourages them to continue working hard and not give up easily in the face of future challenges. Second, we hypothesized that person praise would reduce later persistence because it focuses on a child's attributes (e.g., appearance, talent) in ways that might lead children to believe their abilities are fixed and unchangeable. Third, we explored the effects of ambiguous praise on later problem-solving persistence. Ambiguous feedback might reduce motivation to persist because it does not indicate what the child did well or how their efforts contributed to success. Alternatively, it could enhance persistence by offering positive reinforcement, as the parent's recognition still acknowledges and celebrates the child's achievements.

METHODS

Participants

The current sample was drawn from a longitudinal study of children's early learning and development. At age 4 (M = 49.1 months; SD = 2.4), 250 caregiver-child dyads completed a laboratory assessment that included direct observations of parent-child interactions across a series of challenging tasks. Children were diverse with regard to sex assigned at birth (50% female), economic status (37.6% in poverty), and ethnicity and race (46.0% Latine; 24.8% multiracial; 18.0% Black; 11.2% White). Primary caregivers were mostly biological mothers (91.2%) or other females serving in a parental role (e.g., grandmothers, aunts).

Four years later (M = 97.1 months; SD = 2.8), 206 families (82.4%) completed a second lab assessment that included age-adapted parent-child tasks. All procedures were approved by the University's Institutional Review Board. Informed consent was obtained from the child's legal guardian at both data waves and child assent was collected at age 8. Additionally, all data were de-identified using alphanumeric ID codes to ensure participant confidentiality. Caregivers were compensated with $25 per hour of assessment and children received a small gift.

Measures

Parental Praise. Parental praise was coded from video recordings of parent-child interactions during four challenging teaching tasks lasting 20 minutes (e.g., sorting beads by color and shape and naming items with wheels; Egeland, 1982). First, the videos were manually transcribed, and parent utterances were counted using the Utterance Boundary Protocol from the Language Development Project Protocol (Goldin-Meadow et al., 2015). Second, independent coders used Gunderson's (2013) Naturalistic Coding Scheme to classify process praise, person praise, and ambiguous praise as present or absent during each task. Third, coder differences were resolved through discussion, and consensus scores were averaged across tasks, yielding excellent intraclass correlation coefficients (ICC) for process (0.98), person (0.98), and ambiguous (0.96) praise.

Child Problem-Solving Persistence. At age 4, a separate group of coders evaluated children's persistence during the same parent-child interaction tasks. At age 8, another set of coders assessed children's problem-solving persistence across 20 minutes of similar parent-child interaction tasks (e.g., puzzle building, naming wooden objects). Child persistence was rated on a 7-point scale (Egeland et al., 1982), with a low score of 1 assigned to a child who actively avoided the tasks and did not engage at all, and a high score of 7 assigned to a child who showed little to no diversion and pure concentration on the task despite difficulties. Discrepancies among raters were resolved through discussion, and consensus scores were averaged across tasks ($ICC_{age\ 4}$ = 0.85, $ICC_{age\ 8}$ = 0.81).

Covariates. *Child IQ* - At age 4, children's cognitive abilities were measured using the Vocabulary and Block design subtests from the Wechsler Preschool and Primary Scale of Intelligence-III (WPPSI-III; Wechsler, 2002). Verbal ability was assessed using age-appropriate measures of receptive and expressive vocabulary. Performance ability was measured using the block design subtest, where children recreated patterns using red and white blocks. A pro-rated full-scale IQ score was calculated by averaging the verbal

and performance IQ scores (Sattler, 2008). *Poverty* - Poverty status was determined by calculating the caregiver's reported total income (e.g., wages, child support) and dividing it by the appropriate poverty threshold. This income-to-poverty ratio accounted for household size and the number of children under 18 residing in the home (U.S. Census Bureau Housing and Household Economics Division, 2007).

Data Preparation and Analysis

Descriptive and bivariate analyses were conducted using IBM SPSS (Version 29). A multivariate analysis of variance (MANOVA) was performed to examine differences in process, person, and ambiguous praise, as well as poverty level, child IQ, and persistence at age 4, based on child sex assigned at birth, Latine ethnicity, and their interaction. Following this, a simultaneous linear regression using the Lavaan package (Rosseel, 2012) in version 4.4.1 of RStudio (RStudio Team, 2021) assessed the effects of process, person, and ambiguous praise while controlling for key covariates (i.e., child sex, Latine ethnicity, child IQ, total parental utterances, and prior problem-solving persistence). Since there were no significant differences between families who completed both waves and those who completed only the first wave across all study variables, missing data were handled using full information maximum likelihood estimation (FIML).

RESULTS

Descriptive and Bivariate Analyses

Descriptive findings and bivariate correlations are presented in Table 1. A multivariate analysis of variance (MANOVA) indicated no significant effects of child sex, Latine ethnicity, or their interaction on the study variables. At the bivariate level, poverty was positively correlated with child IQ, parental utterances, and ambiguous praise at age 4, as well as with child persistence at age 8. Additionally, child IQ was positively correlated with child persistence at age 4, as well as with parents' process and ambiguous praise at age 4, and child persistence at age 8. Children's problem-solving persistence showed significant stability from ages 4 to 8. Parents' total utterances were positively correlated with all forms of praise, and all praise types were positively correlated with one another. Person praise was negatively correlated with persistence at age 8, whereas neither process praise nor ambiguous praise demonstrated significant correlations with persistence at age 8.

Regression Analysis

Table 2 depicts a regression of children's problem-solving persistence at age 8 on process praise, person praise, and ambiguous praise, as well as relevant covariates. Child IQ and persistence at age 4 were positively related to increases in children's problem-solving persistence from ages 4 to 8. However, the quantity of parental utterances at age 4 was not significantly associated with children's persistence. Process and ambiguous praise also contributed uniquely to increased persistence ($\beta = 0.206$, $p = 0.001$; $\beta = 0.170$, $p = 0.006$), whereas person praise predicted decreased persistence. Together, these variables explained 21.9% of the variance in children's problem-solving persistence.

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Means, standard deviations, and correlations among study variables.

Variable	1	2	3	4	5	6	7	8
1. Income to Poverty Ratio	-							
2. Child IQ (Age 4)	.22**	-						
3. Persistence (Age 4)	.08	.20**	-					
4. Total Utterances (Age 4)	.16*	-.10	-.04	-				
5. Process Praise (Age 4)	.08	.13*	.01	.32**	-			
6. Person Praise (Age 4)	-.04	-.08	.03	.14*	.11	-		
7. Ambiguous Praise (Age 4)	.14*	.15*	.09	.33**	.27**	.17**	-	
8. Persistence (Age 8)	.19**	.28**	.35**	.02	.11	-.14*	.09	-
Mean	1.7	95.17	5.42	74.15	1.17	0.29	2.33	5.25
Standard Deviation	1.1	13.5	0.9	18.5	1.4	0.7	1.9	0.7

Note: $p < .05$. ** $p < .01$.

Table 1

Table 2

Standardized and unstandardized estimates predicting children's problem-solving persistence at age 8

Variables	B	SE	β	*p*	95% Bias-Corrected CI LLCI	95% Bias-Corrected CI UCLI
Covariates						
Child Sex	0.014	0.097	0.020	0.836	-0.166	0.221
Latine Ethnicity	0.120	0.098	0.174	0.076	-0.021	0.372
Income to Poverty Ratio (age 4)	0.106	0.037	0.069	0.061	-0.005	0.140
Child IQ (age 4)	**0.173**	**0.004**	**0.009**	**0.023**	**0.001**	**0.017**
Persistence (age 4)	**0.314**	**0.068**	**0.259**	**< .001**	**0.131**	**0.398**
Total Utterances (age 4)	0.006	0.003	0.001	0.931	-0.005	0.005
Predictors						
Process Praise (age 4)	**0.405**	**0.065**	**0.206**	**0.001**	**-0.079**	**0.327**
Person Praise (age 4)	**-0.654**	**0.054**	**-0.163**	**0.002**	**-0.259**	**-0.050**
Ambiguous Praise (age 4)	**0.450**	**0.062**	**0.170**	**0.006**	**-0.039**	**0.286**
		$R^2_{persistence} = 0.22$				
		Cohen's $f^2_{persistence} = 0.28$				

Note: Bold denotes significant parameter estimates

Table 2

Evaluating the Impact of Parental Praise on Children's Problem-Solving Persistence

DISCUSSION

The investigation evaluated the long-term effects of parental praise at age 4 on children's problem-solving persistence at age 8. This age is a key period when children are settling into formal schooling, making problem-solving persistence especially important for their current and future academic success. Interestingly, even though praise statements accounted for only 5% of caregivers' total child-directed utterances, they still had a significant impact on changes in children's problem-solving persistence over time. However, the nature of these effects differed among praise types.

As predicted, parental praise was associated with changes in children's problem-solving persistence, even beyond the significant contributions of child IQ and prior persistence at age 4. First, process praise was positively related to increased persistence from ages 4 to 8. Process praise may encourage persistence because it teaches children that their success is due to hard work and problem-solving strategies. This finding is consistent with prior literature suggesting that process praise increases growth mindsets and mastery motivation, leading to a belief that one can improve one's situation through effort, new learning, and continuing to persist through challenges (Gunderson, 2013; Xu et al., 2024).

Second, in contrast to process praise, person praise showed a consistent negative association with persistence at age 8. Person praise emphasizes children's inherent qualities, such as being "smart" or "good," which can create a fragile sense of self-worth by tying their value to these fixed traits. This type of praise may suggest that success results from who the child is, not what they do, leading children to believe their abilities are fixed and unchangeable. Research suggests that when children who frequently receive person praise encounter failure, they may interpret it as evidence that they do not truly possess the qualities they were praised for, such as intelligence or positive character (Mueller & Dweck, 1998). This can result in feelings of incompetence and low motivation to commit to challenges, as children interpret setbacks as signs of fundamental inadequacies.

Third, ambiguous praise, characterized by vague positive feedback, such as "There you go!" was associated with increased problem-solving persistence at age 8. Notably, ambiguous praise was also the most common type of child-directed praise, which is consistent with previous research indicating that many parents naturally express ambiguous praise in their interactions with children (Brummelman et al., 2014; Robichaud et al., 2022). Although ambiguous praise lacks clear feedback about what the child did well or how their effort contributed to success, it may still recognize and celebrate the child's achievements. This can help the child feel acknowledged and encouraged, fostering motivation to persist. Additionally, because ambiguous praise does not focus on effort or traits, it may reduce pressure on the child to meet exact standards, which can, in turn, make them feel more competent (Morris & Zentall, 2014).

Strengths & Limitations

This longitudinal study featured several important strengths, including observational assessments and the inclusion of several covariates to evaluate the unique effects of parental praise types on children's problem-solving persistence over time. Specifically, persistence at age 4 was controlled to capture baseline levels of persistence. Child IQ at age 4 was included to address cognitive differences that may affect both problem-solving skills and persistence. The variable for Latine ethnicity was included to control for potential cultural factors influencing persistence, while the income-to-poverty ratio addressed socioeconomic disparities. Finally, child sex was held constant to account for gender-related differences in persistence. However, future work would benefit from considering the potential effects of ethnicity-race and/or child sex using multi-group analyses.

Notwithstanding these strengths, several limitations should be considered when interpreting the current findings. First, additional individual difference factors, such as temperament (Smith et al., 2008) and family dynamics (e.g., caregiving structure; Ren et al., 2022), may influence a child's motivation and persistence. Second, cultural context may influence children's perceptions of parental praise. Although our sample was larger and more diverse than those in previous studies, the representation of racial groups was uneven, which precluded our ability to examine these effects within specific ethnic and racial groups. Third, this study was conducted in a laboratory environment, which may not accurately represent real-world interactions between parents

and their children. Additionally, this context may have differential influences on families depending on their cultural or socioeconomic status.

Implications and Conclusions

This study illuminated several directions for future research and intervention. For example, some studies indicate that praise effects may be curvilinear, with excessive or insincere praise potentially leading to an overvaluation of children, fostering narcissism, or creating dependence on external validation, which in turn can lower self-worth and reduce intrinsic motivation (Brummelman & Grapsas, 2020). Inconsistent praise patterns—alternating between over-praising and under-praising—have also been linked to depression and poor academic performance (Lee et al., 2016). Additionally, inflated praise (e.g., exaggerating accomplishments by saying "You are doing an extraordinary job!" instead of "You are doing a good job!") has been shown to lower self-esteem over time in children, while also increasing narcissism in those who already have high self-esteem (Brummelman et al., 2017).

Even within and between praise types, there may be nuanced effects that were not examined here. For example, in their study of ambiguous praise, Zentall and Morris (2010) found that specific outcome praise (e.g., "That was a good drawing!") encouraged mastery behaviors, while generic outcome praise (e.g., "That's cool!") promoted helplessness. Furthermore, Xu et al. (2024) suggest that a balance between process and person praise may enhance self-efficacy and mastery motivation. When process praise slightly outweighed person praise, children demonstrated greater persistence during tasks, highlighting the benefits of a balanced praise approach. Understanding the fine balance between praise types and their developmental impacts can help refine strategies that promote healthy psychological and cognitive growth in children.

Regarding efforts to promote positive child development, these findings could inform parent education programs, equipping parents with praise strategies that foster persistence and resilience in their children. Finally, creating environments that promote children's mastery motivation may reinforce the benefits of praise and support children's ongoing development. The insights from this research can contribute to developing effective parenting strategies, emphasizing the importance of understanding different types of praise in encouraging children's persistence and resilience in the face of challenging experiences.

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Exploring the Effects of the Volatile Chemical Indole on Black Soldier Fly Attraction and Oviposition Behavior

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ABSTRACT

Black soldier fly (BSF, *Hermetia illucens*) larvae are used worldwide for their ability to convert organic food scraps into valuable insect biomass and a digestate that can be used as a fertilizer and soil amendment. As such, BSF larvae are instrumental in the waste recycling industry. However, while there is considerable research dedicated to optimizing rearing of BSF larvae, very little is known about adult BSF behavior. Understanding adult behavior is valuable because it could improve adult mating and egg laying in rearing operations, ultimately leading to increased BSF production and more waste recycling. In this study, we tested if the addition of an attractive compound (indole) to an egg laying substrate would increase adult fly oviposition. We used a cage assay to measure BSF oviposition and landing rates when nearby indole. We documented the frequency that the BSF landed on wooden cutouts treated with indole and weighed the eggs left in those cutouts. Analysis of the results revealed that there was no statistically significant difference in BSF landing rates between indole-associated and control cutouts. However, BSF females laid significantly more eggs in indole-associated cutouts compared to control cutouts. These findings suggest that indole addition to the oviposition area does not increase the number of flies visiting but does increase the number of eggs laid by flies that do visit the site. As such, it is important to examine not just attraction, but also post-landing behavior, such as egg laying, which can also be influenced by chemical cues.

KEYWORDS: Black Soldier Fly, Indole, Oviposition, Attraction, Egg mass, Insect behavior

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INTRODUCTION

Black soldier flies (BSF, *Hermetia illucens*) are used worldwide as biological recyclers because their larvae can ingest discarded, organic food scraps and transform them into useful outputs (Rehman et al., 2023). The BSF larvae do this by digesting food waste and converting it into two products: larval biomass (which can be used to feed livestock and pets) and a digestate that can be used as a fertilizer and soil amendment (Koyunoğlu, 2024; Fu et al., 2022). As such, BSF larvae are instrumental in the waste recycling industry. However, while there is considerable research dedicated to optimizing rearing of BSF larvae and their conversion of waste to usable products, we know very little about the behavior of adult BSF. Understanding adult behavior is valuable because it could improve adult mating and egg laying in rearing operations, ultimately leading to increased BSF production and more waste recycling. In this study, we tested if the addition of an attractive compound (indole) to an egg laying substrate would increase adult fly oviposition

Indole is a chemical often found in decaying matter and plants and has been proven to be attractive to other species of flies (Xing et. al., 2024). While there have not been any studies done to assess BSF attraction to indole, there have been several on other flies that act as decomposers, such as *Musca domestica* (common housefly). Recently, researchers discovered that this species has receptors for detecting indole, suggesting this compound may be important for finding food and oviposition sites (Pitts et. al., 2021). Previous research has also highlighted that these common house flies were able to recognize and were attracted to indole over other chemical attractants (Mulla et. al., 1977). Both houseflies and BSF rely on decaying organic matter as a food source. Therefore, it is reasonable to predict that BSF may also be able to recognize indole as a cue associated with resources. If indole is attractive, it could be used to help guide adult flies to preferred oviposition sites in commercial rearing operations. The more eggs are deposited on preferred sites, the more easily they can be harvested for use in waste recycling.

One way to assess BSF attraction to indole is to measure the effects of additions of this compound on BSF attraction to potential oviposition sites, and on their propensity to lay eggs on these sites. BSF will lay eggs on hard substrates, such as wood blocks or chips, near food waste, compost bins, and other sources of moist, organic materials that will later serve as a food source for BSF larvae. In our experiments to test if the addition of indole to oviposition sites, we used a standardized food diet, known as the Gainesville diet, as the food resource near the oviposition site. This food resource is composed of 50% wheat bran, 30% alfalfa, 20% corn meal, and water. To evaluate if indole is attractive and stimulatory of egg laying, we set up cages that mimicked natural BSF oviposition conditions. Each cage contained a tray with 200g of Gainesville diet and wood blocks affixed to the side for oviposition. Indole dispensers were added to the wood blocks in some cages, while others received a dispenser control with no indole. Flies (~300) were placed in the cages and observed for visitation behavior, then we evaluated eggs laid on the wood block.

METHOD

Our experiment utilizes a cage design that is based off of a previous study that examined BSF oviposition (Zheng et. al., 2013). To see if indole influenced oviposition rates, each cage was presented with one of three chemical treatments, which were placed inside vials attached onto the wooden cutouts. Vials contained a glass capillary tube so that odorants could flow into the cage and be detectable by BSF adults, but flies could not enter the vial to contact the indole. Every cage had two control (empty) vials as well as two of the treatment vials (40 mg indole, 80 mg indole, or a second set of empty vials) (Fig. 1). To reduce cage-specific bias, treatments were rotated between cages every day. For example, if a cage was being tested with 40 mg on Monday, then on Tuesday it will have 80 mg, and on Wednesday it will have untreated wooden blocks only. On Thursday, the cage would once again have 40 mg of indole, and the cycle would repeat. (Fig 2) In addition to the treatment, sugar-water solutions were provided in order to prolong fly lifespan. All flies were purchased as 5-day old larvae from EVO conversion Systems, LLC (College Station, TX, USA) and raised for two weeks on a Gainesville diet in a room with controlled temperature (27 ± 1°C) and humidity (70 ± 5%). Once they progressed to the pupa life stage , the pupae were collected and distributed into cages where they were allowed

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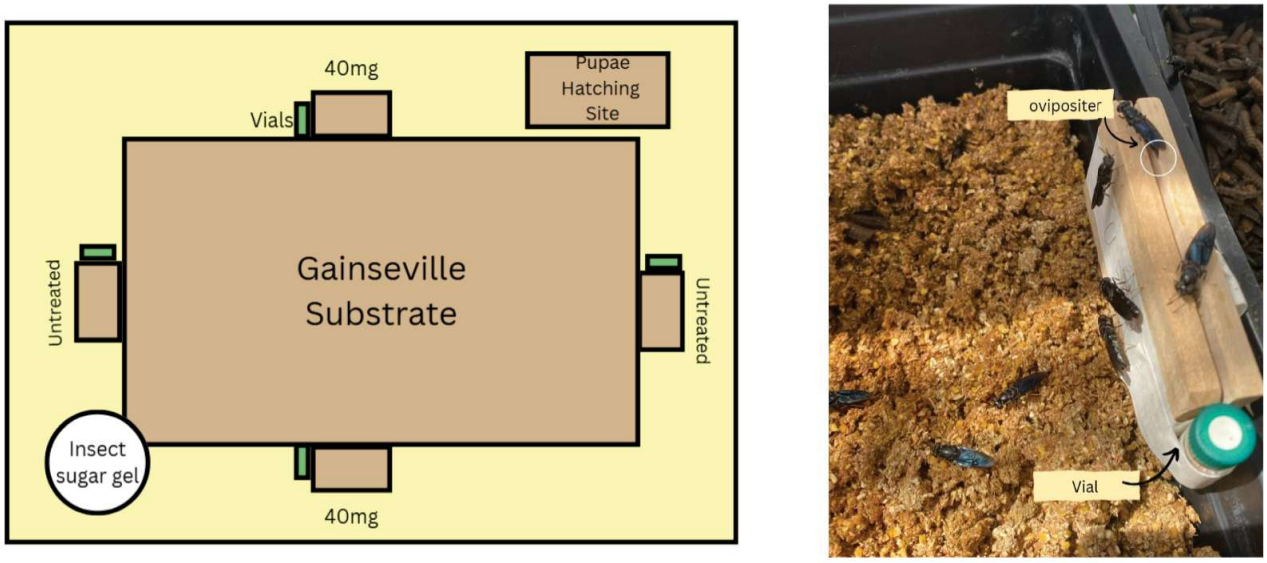

Figure 1. (A) An example of a choice test replicate. In this example, flies are given the choice to land on oviposition blocks (two pieces of poplar craft wood held together) with an indole dispenser attached to the blocks (in this case, 40 mg per vial) or oviposition blocks with empty dispensers. In the other set ups, the choices would be two 80 mg dispensers vs. two empty dispensers, and empty dispensers at all four oviposition block locations. Adults emerge from the tray containing pupae and tests were run when ~50 flies were present in each cage. The insect gel station provides a sugar solution as a gelatin substance, which flies ingest to obtain energy. - (B) BSF adults investigating the wooden cutout with the vials. The vial is taped onto the side. Here, we also see a female pointing her ovipositor toward the inside of the wooden cutout!

to hatch and interact with the cage. Once at least 50 flies were present 5 days, we began experimentation.

Our goals for these experiments were to determine: 1) if BSF adults are attracted to the chemical indole and 2) if the presence of indole near the oviposition site encourages more egg laying. To determine BSF adult attraction to indole, we observed adult behavior in the cages described above. Every time the BSF adult interacted with the wooden cutouts (which had the treatments in the vials attached), a tally was taken. BSF attraction to indole was determined based on how often the BSF adults interacted with the wooden cutouts and for how long (at least 1 minute or less than 1 minute). We set up 6 cages in total, with around 310 pre-pupae placed into every cage. Each cage was observed for 30 minutes every day, for 37 days, from April to May during the summer of 2024. This period was chosen for experimentation because BSF breed the most during warm months, although they can reproduce year-round (Ma et al., 2024). After around 5 days, the pre-pupae emerged as flies and once a critical mass of adult flies was reached, (50 flies), experiments commenced. Each cage was designated as one of the treatments: either 40 mg indole, 80mg indole, or no treatment (control). Each cage had 4 wooden cutouts in total, with two of them receiving vials with the treatment and two receiving only control (empty) vials (Fig. 1). After every observation period, we examined the wooden cutouts for eggs and removed eggs by gently scraping them into a container (Fig. 3). The eggs were weighed on an analytical balance. To ensure equal exposure, we rotated the treatments between cages each day so that every cage received each treatment at least once before any were repeated. For example, cage "A" might receive 40 mg on Monday, 80 mg on Tuesday, no treatment (control) on Wednesday, and then

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return to 40 mg on Thursday. This daily rotation ensured that all flies experienced every treatment in a balanced and consistent manner.

BSF emerge from their pupae shells at different rates, and so fly populations were different in each cage at any given moment. In addition, although each cage started with 310 pupae, not all pupae were able to successfully emerge. To help accommodate for this discrepancy between the cages, we converted our data from raw counts into a proportion instead, which measured the number of responding flies relative to the total number of flies within each cage.

We then conducted statistical analyses on these proportions instead of the raw numbers collected during each trial. This allowed comparisons among cages with slightly different numbers of flies.

We used the statistical analysis software Minitab in order to organize data into proportions and then used Microsoft Excel to conduct a two sample paired t-test and create graphs. The paired t-test analyzed the mean and standard deviation of the number of flies landing on either treated or control wooden cutouts, for each treatment. (40 mg, 80 mg, and untreated). A two-sample paired t-test was also used to analyze the egg data, with the mean egg mass left behind in the treated and untreated wooden cutouts being compared, for each treatment, respectively.

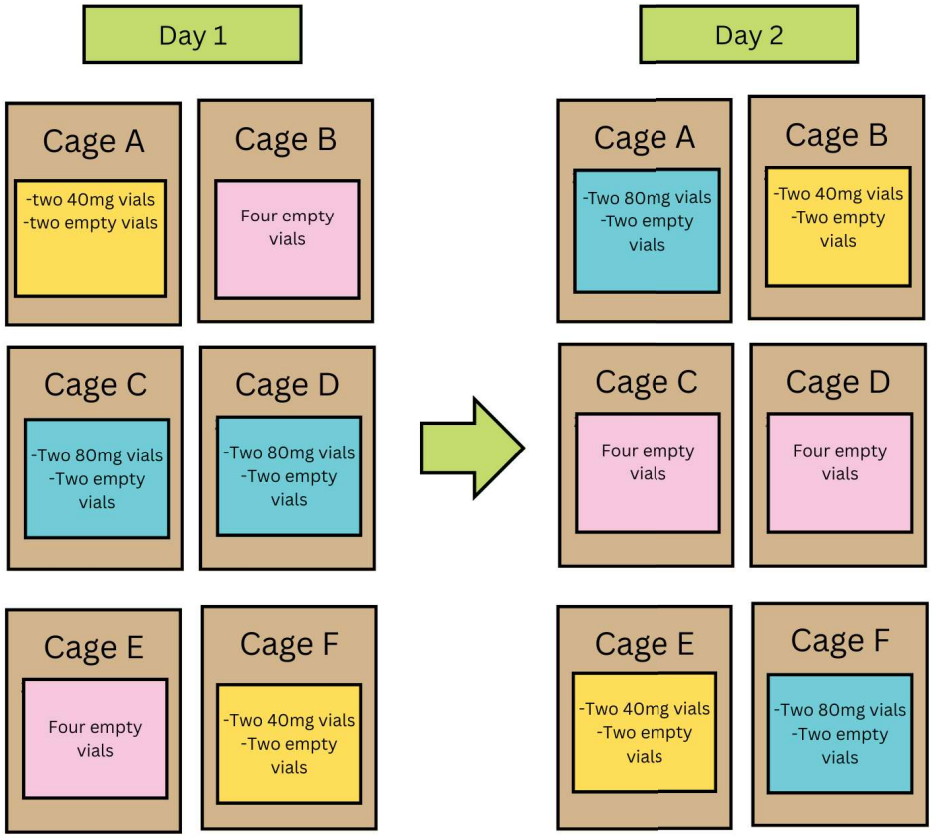

Figure 2. Treatments were rotated between cages every day to prevent any cage specific bias. Here, a sample rotation from day 1 and day 2 shown, where treatments are rotated between days.

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Figure 3. (Left) BSF eggs deposited during an observation period. Yellow eggs can be seen on the insides of the wooden cutouts, where BSF females deposited eggs in the space between the pieces of wood. (Right) BSF eggs scooped up and placed onto a pre-weighed plastic container in order to measure egg weight.

RESULTS

BSF adult attraction to indole

We measured how often the adult flies landed on the wooden cutouts and how long they remained once a landing took place (Fig. 4). Looking at overall numbers of flies visiting indole- treated wood cutouts vs. untreated cutouts (controls), we found no difference in the percent of flies landing on each option (Fig. 4A and 4B). To examine if indole increases the number of flies spending more time on the cutouts (>1 minute), we considered only the flies that fell into this category. Again, we found no significant effect of either indole dose on the number of flies remaining on a cutout for more than a minute (Fig. 4C and 4D).

Effect of indole on oviposition

Egg mass results are shown in Fig. 5. We found that BSF preferred laying eggs in wooden cutouts treated with 40mg of indole, as opposed to the vials with 80 mg or the cage with all untreated vials. For cages with both the 80 mg or 40 mg of indole, the treated options had significantly more eggs compared to the untreated vials in those cages. The cage with 40 mg of indole had significantly more eggs laid on the 40 mg treated wooden cutout compared to untreated cutout and compared to the 80mg and untreated cages.

DISCUSSION

Analysis of the results revealed that there was not a statistically significant difference in the BSF landing on the 40 mg or 80 mg indole-filled vials compared to the empty control ones. However, BSF females laid significantly more eggs in wooden cutouts attached with vials filled with 40 mg of indole in comparison to 80 mg indole vials and untreated vials. These findings suggest that indole addition to the oviposition area does not increase the number of flies visiting, but does increase the number of eggs laid by flies that do visit the site. Our results indicate that it is important to examine not just attraction but also post-landing behavior, such as egg laying, which can also be influenced by chemical cues.

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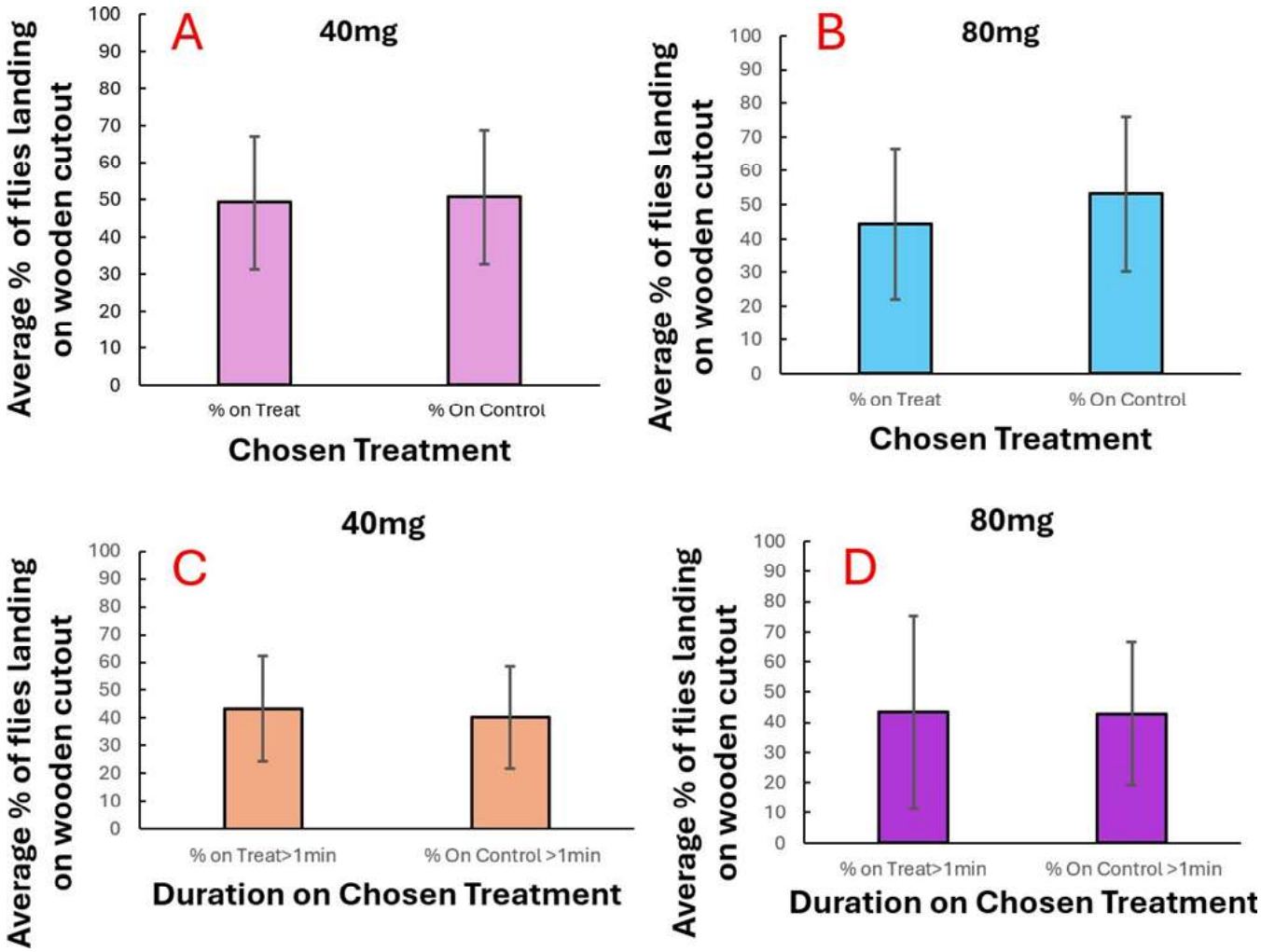

Figure 4. Bar charts depicting the % of flies landing on wooden cutouts per treatment. Bars are the mean percentage of flies across 31 trials, and error bars are the standard error.

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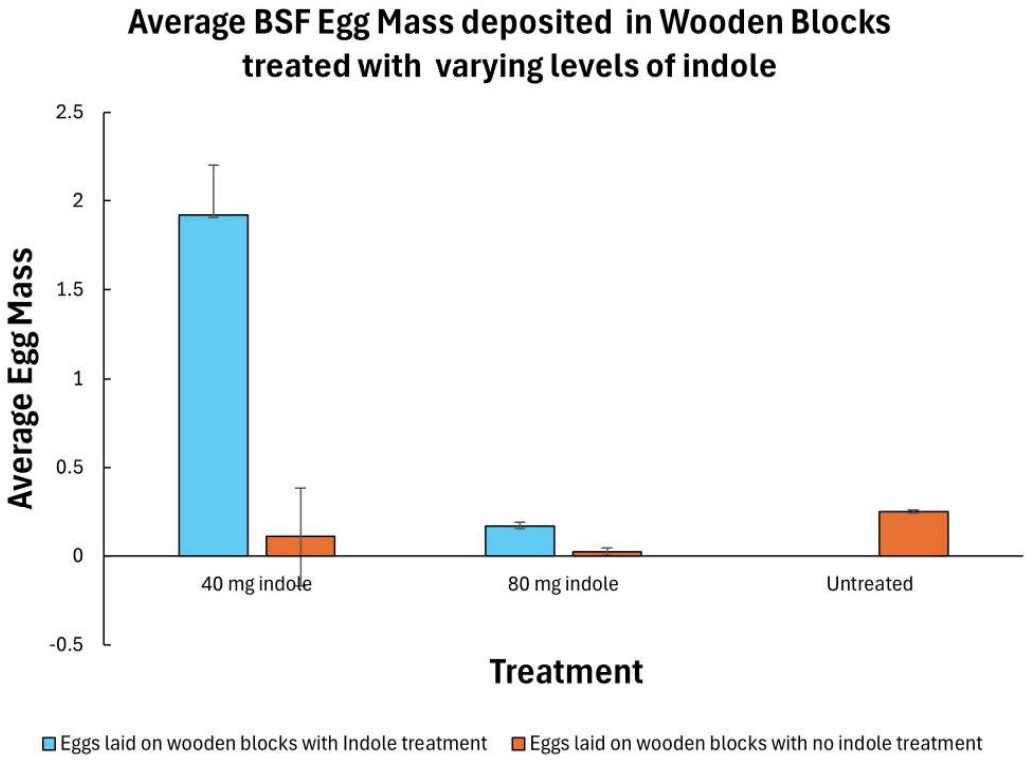

Figure 5. Average egg mass deposited on wood cutouts in different choice test set ups. The first set is 40 mg, with p-value of 0.05627. The second set is the eggs in the 80 mg cage, the p-value is 0.047358. For the eggs in the untreated cage, the p-value was 0.28097985.

We found that indole did not increase BSF adults landing on wooden cutouts emitting volatiles from vials 40 mg or 80 mg compared to untreated wooden cutouts. Additionally, these indole treatments did not increase the number of flies spending a longer amount of time on the wooden cutouts. As such, we can conclude that the adult flies are not differentially attracted to wooden cutouts with indole compared to those without them. However, we did find that, even though landing was not influenced, the likelihood of depositing eggs was. In the 40 mg cages, the p- value comparing egg mass left in treated vs. untreated wooden cutouts was 0.056274. While this is slightly above the standard $p < 0.05$ threshold, it suggests a propensity for oviposition with a low level of indole present. The 80 mg dose was also stimulatory for egg laying relative to the untreated cutouts in the same cage (p-value = 0.04736).

While only the 80 mg cage had statistically significant egg laying differences between the treated and untreated wood cutouts, there were significantly more eggs laid in the 40 mg cages overall, in both the treated and untreated wooden cutouts. This implies that the lower dose of indole may be closer to what the insects might experience with real decaying material, and therefore, may be more stimulatory for egg laying overall. The effect may also carry over to influence neighboring oviposition sites, since adjacent untreated wood cutouts also had more eggs than those in other cages with no indole or a very high dose of indole.

Our results indicate that treating oviposition sites with indole in industrial rearing operations may increase oviposition outputs. As shown in this study, using indole in controlled, small doses can promote egg-laying in BSF. More research is needed to determine the most effective dose, since our work

also suggests that excessive amounts may have the opposite effect. This is seen in the difference in egg mass left behind in wooden cutouts treated with 40 mg of indole compared to those left in wooden cutouts treated with 80 mg. These results suggest that there may be a threshold effect, where higher concentrations become more repulsive than attractive to egg- carrying females.

Previous research has shown that stimulants like sugar, water, color, and even artificial light can be used to help increase BSF oviposition rates (Awal et al. 2022; Romano et al. 2020). This research expands on those findings by proposing the use of a chemical cue usually associated with larval food resources to increase egg oviposition rates. Specifically, we researched indole because it is a chemical found in several foods that BSF larvae can digest. These include cruciferous vegetables (Fujioka et al. 2016), pork (Pensabene & Fiddler, 1996), bread (Sayegh et al., 2023), and rice (Zeng et al., 2024). Indole is a very common stimulant that is found in several types of foods and has been proven to attract many species of flies (Mulla et al.1997; Pitts et al., 2021). Thus, scientists who look to optimize BSF rearing should look into doing more research with BSF and indole to better understand their relationship and the potential uses of indole in rearing productions.

While this research demonstrates that indole has an effect on oviposition rates, but further experiments are needed to determine if indole can be used to manipulate BSF oviposition behavior in rearing operations. In this experiment, the BSF adults did not show a preference for landing on wooden cutouts treated with 40 or 80 mg of indole compared to untreated controls. However, external factors such as sunlight exposure, indole diffusion rate, or even the presence of other flies may be affecting this decision. Future research efforts should build on our study by explicitly isolating these potentially important factors. For example, using devices that limit exposure to a subset of cues, such as a Y-tube olfactometer assay, will help researchers to understand which stimuli are most important for adult BSF oviposition decisions.

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Exploring the Effects of the Volatile Chemical Indole on Black Soldier Fly Attraction and Oviposition Behavior

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Beyond One Hand: Exploring Underlying Mechanisms of Bimanual Haptic Search

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ABSTRACT

In daily life, we frequently feel for objects without vision using our senses, called Haptics. Much of the research that has been done in this area is focused on single-handed searches, with no agreed-upon conclusion on if two hands are better than one. Here, we asked if there is a clear advantage, disadvantage, or no difference in simultaneous bimanual compared to sequential unimanual search. Participants felt for a unique target item that differed in length or texture amongst uniformed distractors with their left hand only, right hand only, and with both hands simultaneously. Additionally, we examined how performance might vary when the distinguishing feature of the unique target was the same or different between the hands. Simultaneous bimanual search showed significantly more efficient search than the sequential unimanual search. Surprisingly, there was no appreciable difference between performance when searching for targets with the same and different features. This suggests that the advantage of searching bimanually is not due to sensory redundancy or perceptual advantages from shared features. Future research will investigate the role that action coupling might play in the bimanual search advantage. These findings can apply to developments in robotics, prosthetics, and rehabilitation processes. Additionally, they can support our understanding of attentional deployment in understudied modalities like haptics.

KEYWORDS: Haptics, Haptic Search, Bimanual, Attention

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INTRODUCTION

Touch is an important ability that allows us to interact with the world and those around us. We often use touch to perform tasks such as looking through one's bag to find keys or feeling for loose change.. Harlow and colleagues' (1958) classic attachment experiment on monkeys demonstrated that the sense of touch dictates their behavior, particularly their attachment-related behaviors, highlighting the fundamental importance of touch on emotional connection and practical tasks. Similarly, humans rely on touch to complete practical tasks, typically using our hands to explore objects and interact with our environment.

Haptic search, a key part of the cognitive psychology discipline, is a process that relies on touch sensation. It is crucial for tasks where vision is limited or absent, such as retrieving items from a cluttered bag, searching under furniture, or reading braille. Kapper and Bergmann Tiest (2013) have set a framework for haptics and explained how individuals search for objects and detect features associated with them. They have uncovered that haptics involve tactile cues and proprioceptive kinematic cues. Studying haptic search helps deepen our understanding of how we process sensory information through touch. It also has many vital integrations in fields from medicine to robotics, yet research considering the contribution of both hands remains limited.

Plaisier and colleagues (2008) used a single-hand search task that demonstrated pop-out and search asymmetry, both perceptual phenomenons related to attention. Participants used only their dominant hand to perform quick sweeps over a search field that contained a textured sandpaper surface that varied in roughness. These findings demonstrate that haptic attention is captured more readily by the presence of a feature, than its absence. Lederman and Klatzky's (1997) study gives further insight into how objects' features give rise to search strategy selection. These studies on single-hand search provided valuable insights into the mechanics of attentional deployment in single-hand exploration. However, the level of integration of this information and to what degree attention can be shared between the hands is not well understood.

Overvliet and colleagues (2008) provided foundational evidence for bimanual haptics experiments that utilize both hands. Their experiment instructed participants to locate a specified target item among uniform distractor items without their vision. The search field consisted of a grid of cubes fixed to the table. The study showed that searching with a single finger was slower than searching with one hand, and using two hands was the most efficient. This demonstrated that more sensory receptors (by using more fingers or hands) led to quicker search, suggesting optimal sensory integration.

In contrast to Overvliet and colleagues (2008), we used a free-range haptic search task, which allowed objects to move freely instead of being fixed in one position. This approach allows for simulation of how objects are searched for in everyday life with unpredictable orientation (Sturgill & Rosenbaum, 2025). Additionally, it allows us to confirm that this effect was not due to exploitation of the fixed array.

Other researchers have investigated if observed bimanual advantages are due to optimal sensory integration between the two hands (Squeri et al., 2012). The authors suggest that if the hands are represented as separate perceptual systems, then one would expect higher perceptual accuracy. However, Squeri and colleagues (2012) discovered that when participants identified the curvature of objects with both hands, the brain did not always combine input optimally. Instead, participants relied more heavily on one hand's input, a phenomenon known as sensory selection. The lack of consistent integration indicates that the bimanual performance advantage may result from motor coordination and spatial labor distribution rather than increased sensitivity to input. This begs the question of if Overvliet and colleagues' (2008) results were due to perceptual sensitivity or spatial labor distribution. Our study was designed to control for the labor distribution, while contributing to the literature on bimanual haptic processing.

HYPOTHESIS AND PREDICTIONS

We investigated if using two hands provides a clear advantage, disadvantage, or no difference in search performance compared to using a single hand. Previous research has shown mixed results for bimanual performance compared to unimanual, citing various mechanisms like multisensory integration and division of labor (Jones & Henriques et al., 2010). We controlled for the division of

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labor between the unimanual and bimanual conditions while using an ecological laboratory task (Sturgill & Rosenbaum, 2025). Additionally, we wanted to test the multisensory integration account by varying the similarity of the judgments being made between the hands. Our questions were both exploratory and theoretical: Would we find clear evidence of a difference between bimanual and unimanual search using a different task? If the previous bimanual advantage was due to a similar mechanism, such as multisensory integration between the hands, then by varying the similarity of the judgments for items being felt, the subsequent performance should vary as well. We predicted that using two hands simultaneously would result in higher efficiency than searching with one hand and then the other sequentially. We also asked if search performance would significantly improve for items requiring the same judgments compared to items requiring different judgments about the relationship between the target and distractors.

If searching simultaneously with both hands is done sequentially, then no difference should be observed between the summed single-hand searches and the observed both-hand searches. Additionally, if using both hands simultaneously places a greater demand on the system, then both-hand searches should be less efficient than the sum of the sequentially performed single-hand searches. Lastly, if bimanual search is sensitive to the similarity of the features of the items being felt by the hands, then searches for targets with the same features should prove more efficient than when the targets do not share the same features.

METHODS

The goal was to measure how quickly and accurately participants identified the unique target within a set of repeated trials. We recorded the time taken to select the odd object and the accuracy of the selection. Using a free-range search task, participants were asked to identify an object that differed from the rest by using touch alone. No visual cues or previews were provided to participants, unlike in the original experiment that utilized this task. The unique target item differed from the distractor items by either texture or length. The length feature was chosen as it is well documented for its systematic psychophysical properties (Stevens & Stone, 1950). Texture differences were equally well studied, as mentioned previously, and allow for greater control of the experiment apparatus.

Experimental Setup

Participants searched in two 6x6-inch plastic containers secured to the table with Velcro straps, which were positioned for left- and right-hand placement. A black poster board was placed above the containers to occlude participants' vision of the search field. Each container held seven pieces, six uniform distractor items, and one target, which was different either by length or texture. All search items were made from PEX pipes, with the diameter kept consistent for distractors and targets (0.5-inch), but varying in length. The distractor items and texture-based targets measured 1.5 inches in length, and the length-based target items measured 1.0 inches in length. The texture-based target differed from the distractors by having small 1mm holes spaced every 3 mm along its length and at every 90 degrees about its circumference. A metal touchpad was positioned between the two containers, which was used to record the duration of the search time for each trial. Participants wore a Velcro ankle strap connected to a Makey-Makey ® device that detected their touch in MATLAB. The Makey-Makey® enabled participants' touch to be captured and translated into a format that the software could interpret and process (Sturgill & Rosenbaum, 2025).

Procedure

Participants completed an Informed Consent Form outlining the study's purpose, procedures, risks, and rights. This study was approved by the Human Research Review Board (HRRB) at the University of California, Riverside. A background survey regarding demographics and hand dominance was administered.

Participants sat centered in front of the table to easily access each search field. They searched for one target item among six distractors using only their sense of touch. Seventy-two trials were divided into nine blocks with eight trials each. The nine blocks comprised three right-hand-only conditions, three left-hand-only conditions, and three both-hand conditions. The order of the blocks was randomized; therefore, the hand condition the participant started with

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was varied. In each of the blocks, the object feature varied among the trials.

Across all trials, participants searched in the right container with their right hand only and the left container with their left hand only. In some subsets of trials items were present in both containers and participants searched with both hands simultaneously. In other trials, participants found items in only one container and searched only that container. If items were present, then that container had a target to be found. This ensured that the only difference across both hands and single hand searches was that both hand searches were performed simultaneously, while single hand searches were done sequentially. At the beginning of each block, participants were told which container(s) to expect objects for each trial and thus how many targets they would need to find.

Once the participant had found the target in the container, they grabbed and held the target item(s) in their hand(s) and tapped the touchpad to indicate the end of the search. They then presented the item(s) under the poster board for the experimenter to see, and the experimenter provided accuracy feedback by stating "correct" or "incorrect." This was recorded by the experimenter using the keyboard with a 1 or 0, respectively. Next, the participant placed the target item(s) in their respective container(s) and removed their hands from the search area. This concluded a trial, and this process was repeated until 72 trials were completed.

Participants/Data

The study was conducted during the Fall 2024 and Winter 2025 quarters at the University of California, Riverside. Fifty participants were recruited from the Psychology Research Participation System (SONA) subject pool and were compensated with course credit. Thirteen participants were removed from the final data set for having incomplete data sets. Therefore, the final data consisted of 37 participants: 67.9% females, 32.1% males, 2.7% left-hand dominant, and 97.3% right-hand dominant. The final data cleaning process involved imputed mean search times per participant per condition. Search times that were longer than 3 standard deviations above the mean search time for that participant in a specific condition were replaced with the participant's mean. This replaced only the top 0.1% of the longest search times per subject and thus less than 3.7% of all data.

Figure 1: Experimental Apparatus

Note: Panel A shows the experiment apparatus as a whole. The two containers are centrally located within the black frame that holds the poster board (not shown). On the left side of the image is the anklet (a black band with red strap and wire). To the right of the poster board frame are the experimenter's keyboard and the cups, which contain multiple sets of the two conditions. Panel B shows the two conditions (Texture left and Length right).

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RESULTS

Participants performed haptic search without vision to determine the target item among distractors. We had two questions: first, if utilizing both hands together provided better performance in accuracy and mean search time, compared to the summed sequential single-hand searches. Second, if performance varied when both hands searched for targets distinguished by different features, compared to when searching for targets with the same feature. Our study examined if bimanual search times would differ from the summed search times of the left-hand and right-hand, which served as a baseline measure. The study used repeated-measures Analysis of Variance (ANOVA) and Tukey's Honestly Significant Difference (HSD) test to assess performance differences between conditions. The research findings are illustrated in three figures, displaying accuracy, mean search time, and efficiency.

The ANOVA supported an appreciable difference, $F(7,252)=2.52$, $p = 0.016$, $\eta^2= 0.07$ between our conditions. Although there was a visual difference between searching for length-based items and texture-based items for single hand searches, the HSD test revealed that there was not an appreciable difference in the proportion of correct responses. There was no statistically significant difference between "left length" and "right length" $t(7)=0.019$, $p = 0.994$. For "left length" and "left texture" in single hand search, there was no significant difference, $t(7)=0.096$, $p=0.096$. This remains the same for "right length" and "right texture", $t(7)=0.102$, $p=0.059$. As for the difference between using a single hand and both hands, the accuracy when searching with one hand was not comparable to that when using both hands, indicated by comparing "left length, right texture" to "right length," $t(7)=-0.081$, $p=0.230$. All pairwise comparisons for the eight groups had a p-value of 0.059 or greater.

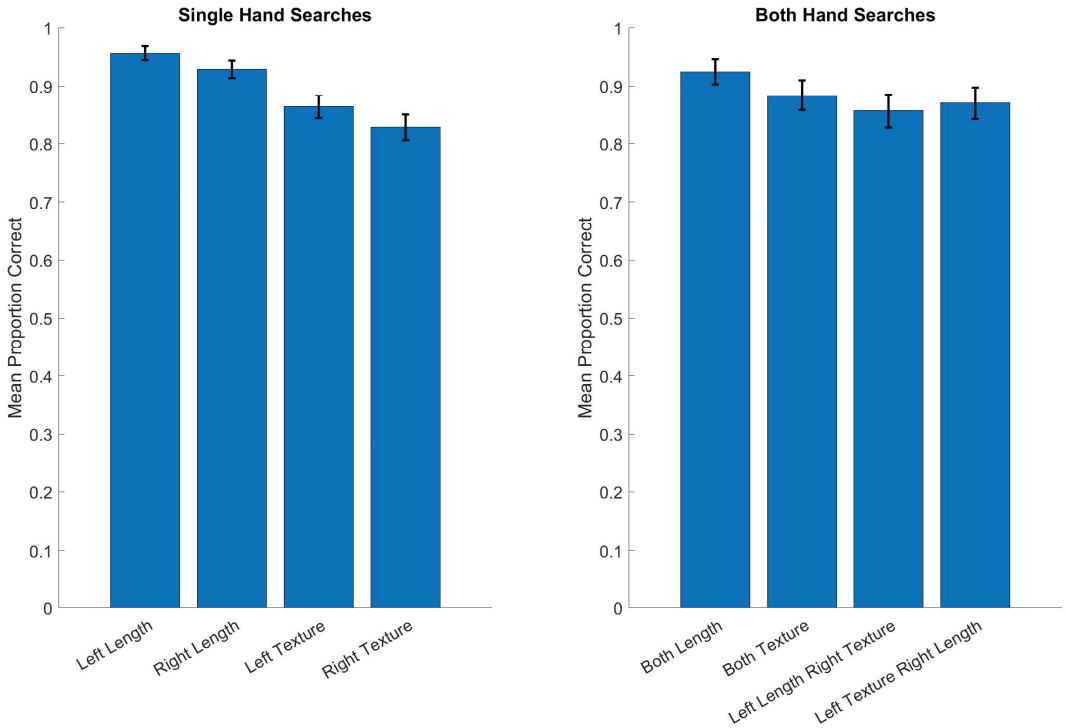

Figure 2: Mean Proportion Correct by Condition Type

Note: Mean Proportion correct (+/- 1 SE) for each of the eight hand conditions tested. The left graph shows the results for single-hand searches paired with length and texture targets. The right graph shows the results for both-hand search conditions, where both hands had the same target or different targets.

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Figure 3 illustrates the mean search time for single, both hands, and the sum of single-hand search trials, depending on the target feature (length or texture) when the hands were searching for the same or different features. In Figure 3A, "Single Hand Search" shows the average search time when participants used only the left or right hand to search for a length or texture target. All four conditions (Left Length, Right Length, Left Texture, Right Texture) resulted in similar mean search times, ranging from around 18 to 21 seconds. This suggests that single-hand search times were consistent, regardless of which hand was used or what feature was being searched for, supported by an average mean search difference of 0.85 seconds, and p-values all above 1.000 across the compared conditions.

In Figure 3B, "Both Hand Search" shows the average search times when both hands were used together to search for either the same feature (Both Length, Both Texture) or different features across hands (Left Length + Right Texture, Left Texture + Right Length). All bimanual conditions resulted in similar times (around 30 seconds), with no significant difference between same-feature and different-feature searches, as observed through an average mean search difference of 9.5 seconds, and p-values all above 1.000 across the compared conditions.

In Figure 3C, "Sum of Single Compared to Both When Same Targets" compares the sum of the individual single-hand search times (gold bars) to the both-hand search time (blue bars) when both hands were searching for the same feature. In both cases (Length and Texture), the sum of the single-hand times is noticeably higher than the both-hand search times.

In Figure 3D, "Sum of Single Compared to Both When Different Targets." This graph presents the same type of comparison as the top left panel, but when each hand searches for a different feature. Again, the blue bars (both

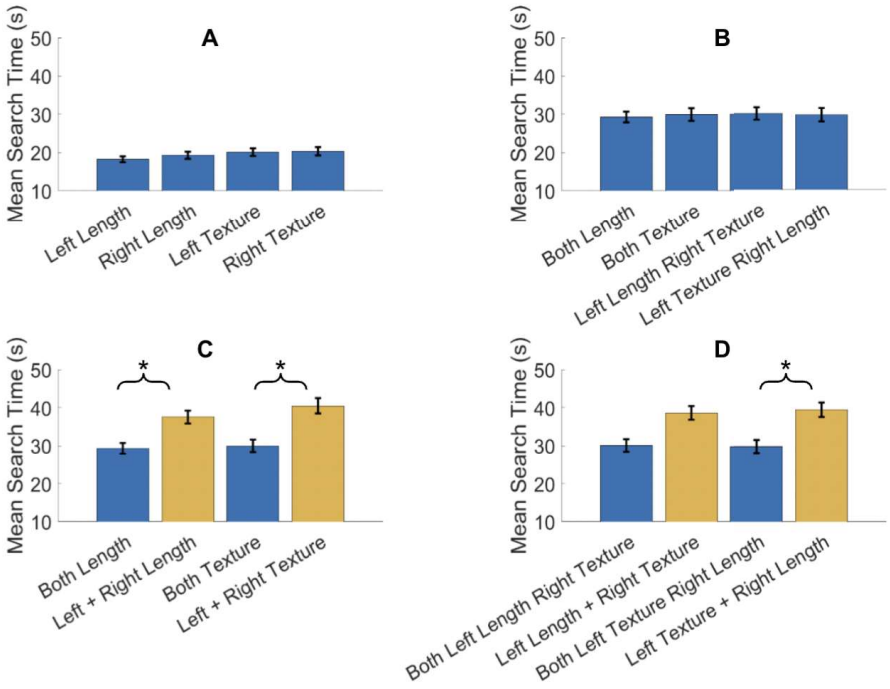

Figure 3: Mean Search Time by Condition Type

Note. Mean search time in seconds (±1 SE) for the eight hand conditions. The top left panel (A) is from single-hand search trials. The top right panel (B) is from both-hand search trials. The bottom left panel (C) is the mean search time when the same targets are used, while the bottom right (D) depicts conditions when targets were different between the hands. Blue bars show observed data. The gold bars are the summed single-handed times from the top left panel. The brackets and the stars depict the magnitude of significance, with one star representing a p-value between 0.05 and 0.01.

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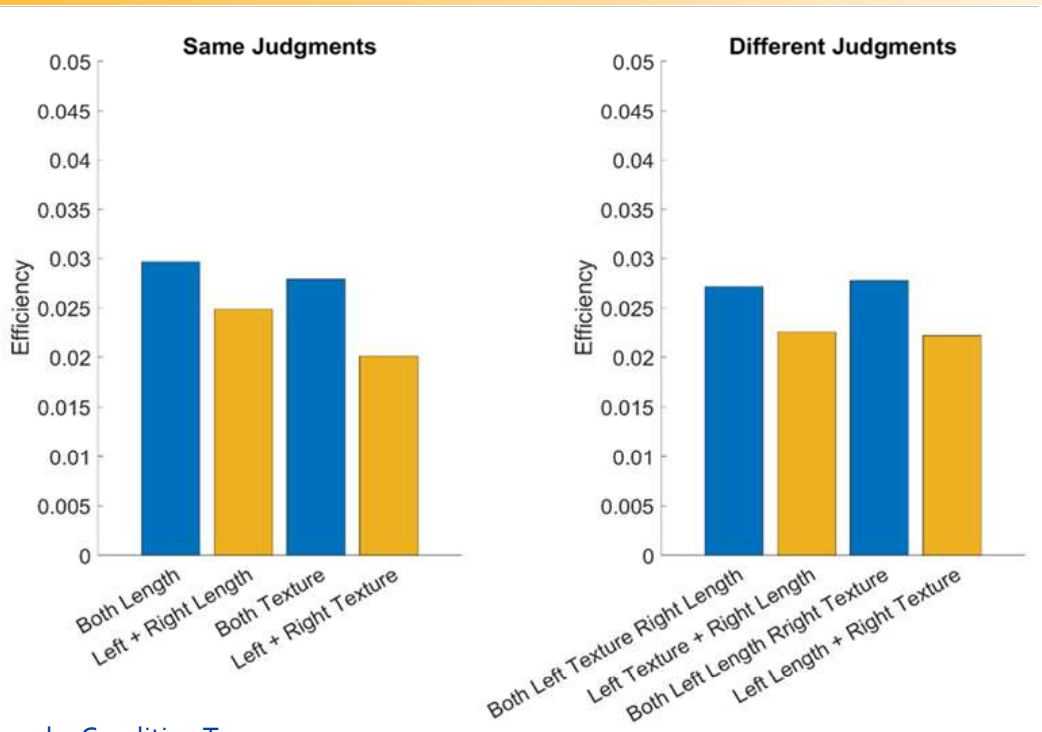

Figure 4: Efficiency by Condition Type

Note. Average Efficiency for Both Hand Conditions. Blue bars represent hand efficiency, and gold bars represent the hypothetical efficiency of individual hands summed together.

hands searching) show faster performance compared to the gold bars (sum of single-hand searches), indicating that even when searching for different features, using both hands together reduced the mean search time.

These patterns in Figure 3 were confirmed through statistical testing. A repeated measures ANOVA detected a statistically significant difference in mean search times between the conditions ($F(7, 252) = 12.78$, $p<0.001$, $\eta^2 = 0.26$), indicating that at least a subset of the search conditions was significantly different from each other. Pairwise comparisons between conditions were conducted using Tukey's (HSD) post hoc t-tests.

When participants used both hands to search for identical features, summed single-hand search times were longer than the observed both-hand conditions. That is, the mean search time in the summed condition "Left + Right Length" was greater than in "Both Length," *t(252) = 3.41, p = 0.031*, with a 95% CI [3.21, 11.87]. Similarly, "Left + Right Texture" took longer than "Both Texture," *t(252) = 3.35, p = 0.050, d = 95% CI [4.25, 16.25]*. This supports the finding that performance when searching with both hands simultaneously was quicker than the sum of the two sequential searches, when the target features were identical.

What about the cases where both hands were feeling different target features? The "Left Texture + Right Length" condition took longer than both-hands. Both Left Texture, Right Length" conditions with those same features (Left Texture + Right Length), *t(252) = 3.33, p = 0.037, 95% CI [3.76, 14.50]*. However, when comparing the opposite conditions "Left Length + Right Texture" and "Both Left Length, Right Texture", the results failed to reach significance, *t(252)=2.82, p=0.121, 95% CI [2.53, 14.05]*. These results show that in three of the four comparisons we tested here, simultaneous bimanual search was appreciably quicker than forced sequential search.

Figure 4 compares the average efficiency across the same and different judgments conditions paired with the conditions where bimanual search and forced sequential search were performed, the conditions that directly address our primary questions. This measure of efficiency was adopted

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from Sturgill and Rosenbaum's (2025) work, where they presented a universal composite measure of efficiency. This measure uses the ratio of observed proportion correct to the expected proportion correct in the numerator and 1+ the average observed time to complete the task in the denominator. Their measure constrains efficiency between 0 and 1, which is reflected in the y-axis. For more details, see Sturgill and Rosenbaum (2025). In our experiment, the expected proportion correct was 0.14 or $1/7^{th}$ in every trial, as the number of distractors was not varied.

The left panel of Figure 4 shows the efficiency scores for conditions where both hands felt for targets that were unique based on the same feature (same judgments). As seen in the panel, the efficiency was higher for the simultaneous bimanual searches (blue bars) than for the summed sequential unimanual searches (gold bars).

Similarly, in the right panel of Figure 4, the observed efficiency was greater for simultaneous bimanual searches compared to sequential unimanual searches. The right panel shows the efficiency scores for conditions where both hands felt for different features, where one hand searched for length and the other hand searched for texture. These convergent results show that, regardless of the similarity in the judgments being made between the hands, simultaneous bimanual search was more efficient. Average efficiency results emphasize that two hands were faster in search times and more effective, which was achieved without affecting the accuracy of the search results. Overall, Figure 4 demonstrated that the simultaneous use of both hands is more efficient than sequential individual hand search when feeling for the same or different targets.

DISCUSSION

Our experiment was designed to investigate haptic search without vision and to understand the difference in performance between bimanual and unimanual search. Our study addressed if two hands would result in higher efficiency and how the search performance differs when searching for items of the same feature in contrast to items that are different; with one texture- and one length-based target. Our hypothesis proposed that performance would improve with the use of two hands over one and searching for items of the same feature would be much quicker. We concluded that the accuracy levels remained consistent across all conditions, between the number of hands used and the varying features of length and texture (Figure 2). Furthermore, the results established that bimanual search had a faster search time than the sum of the individual hands, which verified our hypothesis (Figure 3). When using accuracy and search times to calculate efficiency, two hands were more efficient than the sum of individual hands (Figure 4). Overall, our results showed that even when controlling the work being done by the hands and the similarity of the objects between the hands, the simultaneous use of two hands was more efficient than the sequential use of the individual hands.

Limitations and Further Directions

In our study, all items were standardized PEX pipes to test features one at a time and minimize potential confounding variables that arise from using objects with varying characteristics. However, this approach contrasts with real-world scenarios, where targets involve diverse shapes, sizes, and textures. Although we tried to be as ecological as possible, future research might benefit from using more naturalistic objects to better reflect real-world conditions. Furthermore, our participants consisted only of UCR undergraduate students, so the data may not apply to other age and demographic groups. Another limitation of our study was that participants' hands were always symmetrical in all conditions, making it unclear if this may have influenced performance. This limitation will be addressed in future research by exploring variations in hand positioning.

Future research will investigate how the location of the search containers affects bimanual performance. The symmetry of the containers in our experiment was consistent throughout all trials, but testing different locations where either the left, right, or both hands are closer or farther from the subject could shed light on if there is a bimanual coupling involved. Action coupling, where coordinated movements between hands are naturally linked, can either facilitate a positive effect or constrain actions when searching for items. Examining these factors will give more insight into the underlying mechanisms of bimanual search and how performance is affected.

Beyond One Hand: Exploring Underlying Mechanisms of Bimanual Haptic Search

CONCLUSION

Bimanual haptic search demonstrated significant efficiency and performance benefits compared to single-hand search. In general, the human brain is effective at processing different sensory inputs simultaneously (Stein, Stanford, & Rowland, 2014); however, bimanual search was substantially more effective due to the use of two hands, which supports the overarching points that bimanual exploration provides many benefits. Therefore, these findings highlight the importance of bimanual exploration and its use in everyday life to identify various targets. Haptic search is a diverse field, with implications ranging from prosthetics to robotics. In prosthetics, haptic search can lead to better tactile sensors and give insights into how humans optimize touch to interact with their environment efficiently. Similarly, haptic search can allow robots to use tactile exploration in simple tasks, such as distinguishing objects in clustered environments by using touch alone. It is important to acknowledge that limited research has been conducted so far in haptic search, which emphasizes the need for further investigation to understand other underlying processes.

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Beyond One Hand: Exploring Underlying Mechanisms of Bimanual Haptic Search

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Voces que importan: A systematic literature review of the experiences of Latinx community college transfer students

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ABSTRACT

Latinx students often enroll in community colleges as a pathway to transfer to four-year institutions and earn their bachelor's degrees. However, data reflects disparate rates at which Latinx community college students are transferring to four-year institutions. In this systematic literature review, I use a thematic analysis approach to identify and synthesize common challenges and barriers faced by Latinx community college transfer students. Specifically, I focus on the experiences of these students during their time at community college and after they transfer to a four-year institution. The findings reveal that students experienced nonacademic, academic, and institutional challenges and highlight the need for equity driven programs, policies, and practices that can help foster success among Latinx community college transfer students at both the sending and receiving institutions. Additionally, this systematic literature review on the transfer experiences of Latinx community college students reveals recommendations that will better support their ability to navigate within these spaces. This review concludes by acknowledging the need for more on-going research that values the unique experiences of Latinx community college transfer students so that researchers may continue to provide accurate and impactful recommendations to community college and four-year institution leaders and policy makers to improve transfer rates and degree attainment.

KEYWORDS: systematic literature review, Latinx transfer students, community college, challenges and barriers, Latinx student experiences

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Voces que importan: A systematic literature review of the experiences of Latinx community college transfer students

INTRODUCTION

Latinx[1] students represent a growing part of the U.S. college student population, with over 60% of first time Latinx students choosing to enroll at a community college (National Student Clearinghouse Research Center, 2022). Community colleges have played a significant role in providing access to higher education for Latinx students and the ability to transfer to a four-year institution to attain a bachelor's degree (Cohen et al., 2013; Martinez et al., 2017). Although the data is showing high enrollments of Latinx students through the community college system, only 13% transfer successfully and complete a bachelor's degree (Velasco et al., 2024).

This disparity raises questions about the challenges and barriers that Latinx students face throughout the transfer process. Prior research suggests that Latinx community college transfer students experience challenges such as financial struggles, family responsibilities, and work commitments (Carales, 2020; Solis & Durán, 2022). Once at a four-year institution, Latinx community college transfer students often face difficulties acclimating to their receiving institutions (Del Real Viramontes, 2020; Solis & Durán, 2022; Vega, 2017). Despite these known challenges, the gap reflected by the percentages of Latinx students enrolling to a community college and those that are transferring and attaining a bachelor's degree, underscores the need for further study. The purpose of this systematic literature review is to produce an up-to-date summary that focuses on the experiences of Latinx community college transfer students by using a thematic analysis to address the following question:

1. What does the literature tell us about the challenges and barriers that Latinx community college transfer students face during the pre- and post-transfer process?

This systematic review of existing research on the transfer experiences of Latinx community college students examines the challenges and barriers they face through a thematic analysis to highlight both systemic obstacles and lived experiences. These stories are vital, as each reflects a unique perspective. The findings show that these obstacles occur both before students transfer to a four-year institution (pre-transfer) and after they have made the transition (post-transfer). To address these issues, community colleges must develop Transfer Sending Cultures (TSC), while universities must build Transfer Receptive Cultures (TRC) (Jain et al., 2011). These frameworks emphasize the shared responsibility between institutions, shifting the burden away from students, so that their transfer journey is not treated as their sole responsibility and recognizes the challenges and barriers that impact their success. The goal of this systematic literature review is to provide researchers, educators, policymakers, and higher education leaders with insights that can help create meaningful changes to better support Latinx community college transfer students.

METHODOLOGY

A rapidly growing amount of research is being done that focuses on identifying ways to help Latinx students succeed academically (Crisp et al., 2015). This can make it difficult to stay up to date with the latest findings and evaluate all the information, which is why using systematic literature review as a method can be of value (Snyder, 2019). Using this method will help to assess and synthesize findings, find gaps in the literature, and highlights recommendations that can still be implemented to improve the success of Latinx community college transfer students who pursue a bachelor's degree. This study followed Petticrew and Roberts' (2006) method of review, which included developing a research question, selecting databases and search terms, formulating search criteria, assessing the study quality, and withdrawing data from the articles to answer the research question. Following these steps ensured a structured review process.

Search Procedure

To locate relevant studies, three electronic databases were searched: Academic Search Complete, Education Source, and Education Resource Information Center (ERIC). The initial search began using a combination of the following key search terms and were entered using Boolean operators:

1). In this study I use the term Latinx as a gender-neutral term to include male, female, transgender, gender queer and those who do not identify with the gender binary who racially or ethically identify as descendants of Latin America. The use of this term aims to reflect inclusivity and awareness.

line one, "community college students;" line two, AND "transfer OR transfer process;" line three, AND "Latinx OR Latina/o;" line four, OR "Hispanic OR Mexican;" line five, AND "student experiences OR student narratives;" line six, AND "qualitative research OR qualitative study." The following filters were also selected: full text, peer reviewed, and a publication date between the years 2015 and 2025. This generated a total of 46 articles on Academic Search Complete, 42 articles on Education Source, and 90 on ERIC. A title and abstract screening was conducted, which identified three relevant studies, with a particular focus on narratives or experiences of Latinx community college transfer students. In addition to searching academic databases, the reference lists of selected studies were also examined to identify five additional articles that met the inclusion criteria.

Inclusion/Exclusion Criteria

The following criteria were used to select the empirical studies analyzed in this review. Studies included in the review focused on Latinx community college transfer students and their experiences of the transfer process. Articles were required to use qualitative research methods to look at narrative descriptive data, case studies, or interviews as they provide in-depth insights into student experiences and highlight student voices. Some studies focused on specific student identities, such as Mexican or Mexican American, undocumented students, and Latinx immigrant-origin students. While these groups were not always the primary focus of the study, they were included due to their relevance in understanding the broader Latinx community college transfer experience. Studies were excluded if they did not specifically analyze the Latinx community college student experience. Literature reviews, policy briefs, magazine articles, conceptual pieces, and unpublished theses or dissertations were not considered, as these sources had not undergone a peer-review process to ensure validity.

Positionality Statement

As a Latina student who has spent a prolonged period trying to navigate from community college to a four-year institution, I have experienced first-hand some of the challenges that present themselves when choosing this pathway. My experiences as a first-generation college transfer student have brought me to address the questions proposed in this study. Being a Latina scholar influences how I search, analyze, and interpret research by bringing the awareness and sensitivity needed to empathize and understand the experiences of those with similar backgrounds. Nonetheless, I acknowledge that my perspective is shaped by my personal journey. By reflecting on my positionality, I aim to remain vigilant against biases so that I approach my research critically.

FINDINGS

By using a thematic analysis approach, I was able to identify, analyze, and interpret common findings (Suri & Clark, 2009) and patterns across different literature research. Using an Excel spreadsheet, the articles were organized manually in alphabetical order by author last name, publication date, research method, frameworks, and challenges and barriers. Through this organization, the three overarching themes that emerged from the challenges and barriers that Latinx community college transfer students faced were non-academic, academic, and institutional. Non-academic challenges include personal, social, and financial obstacles that affect students outside the classroom. Academic challenges involve difficulties with coursework and academic performance, while institutional barriers stem from policies, structures, or limited resources that hinder student progress. This review found that Latinx students face all three types of challenges during both the pre-transfer and post-transfer phases.

Pre-transfer Students

Non-academic Challenges

Latinx community college students often share financial responsibilities among their immediate families, have dependents or care for loved ones, and have to work to fund their own education (Del Real Viramontes 2020;2023; Solis & Duran, 2022; Vega, 2017). In Sanches and Morgan's (2022) study, a qualitative approach of transcendental phenomenology was used to explore academic resilience in the transfer process for Mexican and Mexican American community college transfer students. The findings revealed the struggle that a first-generation Mexican American student, Salma experiences, "I guess, like, one of the biggest challenges is like keeping like motivated …because, like I

said it's hard to do it when there's no one that has done it…" (Sanches & Morgan, 2022, p 416). It can become difficult for students like Salma to understand the processes, expectations, and long-term rewards of staying committed to academic goals. This absence of support can lead to feelings of uncertainty and self-doubt which directly impact a student's motivation and persistence. Nine out of the eleven participants in Sanches and Morgan's (2022) study that identified as first-generation students expressed the difficulties of navigating higher education without family guidance.

Academic Challenges

Struggles with developmental education was not only a challenge common among Latinx students, but it increases their risk of stopping out or of prolonging their stay at the community college (Del Real Viramontes, 2023; Murillo, 2024). Developmental education courses are supplemental courses that are designed to prepare students to succeed in math and English college-level courses (CCRC, n.d.). This process can be time-consuming and present itself as a potential barrier if not paired with proper support. Academic invalidation from instructors lowers confidence, (Acevedo-Gil et al., 2015) discourages students from engaging, and potentially impacts their performance in the course. A qualitative study by Acevedo-Gil et al. (2015) examined how Latinx community college students navigated their academic experiences and the impact of instructor interactions on their self-confidence. Denise, a student enrolled in a developmental math course, shared how her professor's demeaning teaching style and deficit-based perspective made her feel academically inadequate. "[My] math teacher is not so great. She's not approachable, she kind of makes fun of you, dumbs you down, makes you feel dumb . . . This one girl asked, 'Can you show me something on the calculator?' and she's like, 'It's right there. You can't see it?'—in front of the whole class. I never ask her any questions" (Acevedo-Gil, 2015, p 110). Denise's experience highlights how negative instructor behavior and deficit-based teaching practices can damage a student's academic self-confidence. Her reluctance to ask questions, due to fear of public humiliation, reveals how such classroom dynamics can create a hostile learning environment, which can be detrimental to student engagement and academic success.

Institutional Barriers

An institutional barrier that Latinx community college students confronted during the pre-transfer process was inadequate academic advising (Castro & Cortez, 2017; Solis & Duran, 2022; Murillo, 2024). This impacted students by limiting their awareness of transfer opportunities and providing insufficient information about available resources. The lack of clear transfer pathways makes it difficult for students to know which community college credits will transfer and count toward their degree (Murillo, 2024; Solis & Duran, 2022; Vega, 2017). As a result, many transfer students are left without proper guidance on course selection, major requirements, and even which institution to transfer to. A qualitative study by Castro & Cortez (2017) intended to understand how Mexican students made meaning of their transfer experiences using semi structured interviews. They interviewed Carola, a student who decided not to apply to UCLA because the price was "kind of scary," as she did not have the financial literacy to navigate through the financial aid process and even admitted to the interviewer that as a junior at a CSU, she was still unaware about financial aid issues. Carola's decision not to apply to UCLA due to financial concerns highlights how limited access to financial aid information and advising can affect a student's confidence navigating the transfer process. This type of support can potentially shape a student's transfer choices, even when they are qualified, and can lead to missed opportunities.

Post-Transfer Students

Non-Academic Challenges

Non-academic challenges that persisted after students transferred were feelings of isolation, and transfer shock (Solis & Duran, 2022; Vega 2017). Being that transfer students are coming into a new educational environment at the four-year institution, feelings of isolation were common among the Latinx community transfer students. In the ethnographic case study by Solis and Duran (2022), the authors examine how 16 Latinx community college students experience the transition to a four-year institution. Leonardo, one of the 16 participants in the study explained, "...everything is thrown at you super-fast paced like, a giant school compared to your community college, you live away from family, you don't know anyone here so if you don't get

involved with something you kind of fail" (Solis & Duran, 2022, p 60). In the same study, students like Juan explained how coming in as transfer students made it difficult to make friends because students who had come in as freshmen had already formed those bonds. This led to Juan just feeling more alone and accepting he had to learn to do things alone (Solis & Duran, 2022, p 55). Sam, an older student, shares "...my age makes it difficult sometimes interacting with younger students…sometimes I feel like an outsider among my peers…because of the generation gap" (Castro & Cortez, 2017, p 87). These narratives underscore the need for four-year institutions to intentionally create inclusive and affirming spaces for transfer students to connect with peers, mentors, and student organizations.

Academic Challenges

Latinx transfer students frequently encounter a more rigorous academic environment with heightened expectations and fast paced quarters, compared to the semester system they are used to, leading to difficulties in maintaining a GPA and course completion. Karla (pseudonym), a participant in Solis & Duran's (2022) case study, shared how difficult it was to adjust to a ten-week quarter system and the impact it had on her grades. This reflects how the lack of preparation for the faster pace and heavier workload at a university can lead to academic setbacks, especially when these expectations aren't clearly explained during the transfer process.

Institutional Barriers

The findings reveal that receiving institutions are not providing enough support to students who are transitioning from the community college to a four-year school. In the qualitative case study done by Del Real Viramontes (2020) findings show how a lack of adequate financial resources impact students. Lucia, a first-year transfer student shares, "...If I wouldn't have worked three jobs during the summer, then I really wouldn't have had another option but to work a few jobs to be able to pay the bills because what TSU provided or what was left after tuition wasn't as much." Limited financial aid and institutional support at a four-year university can place a heavy burden on Latinx transfer students and can threaten their academic performance and overall well-being. Her need to work multiple jobs and rely on family support shows the institution's failure to provide a transfer experience that students can manage and succeed in. Without adequate funding and campus resources students are left to carry the weight of financial stress alone, which can affect their ability to fully engage in coursework or build campus connections.

DISCUSSION

This literature review looked at the challenges and barriers that Latinx community college students faced during the pre- and post-transfer process. With high Latinx student enrollment and low bachelor's degree attainment, multiple factors including pre- and post-transfer non-academic challenges, academic challenges, and institutional barriers impact the trajectory of a student's academic journey. Valuable recommendations from prior research often reflect improving transfer student support (Acevedo et al., 2015; Del Real Viramontes, 2020; Castro & Cortez, 2017) increasing access to institutional resources (Sanchez & Morgan, 2022; Solid & Duran, 2022), implementing support groups (Sanchez & Morgan, 2022), offering counseling, and individualized college and career planning (Acevedo et al., 2015; Sanchez & Morgan, 2022).

Interpretation of Results

As previously mentioned, the three emerging themes that were present in students' pre- and post-transfer experience were non-academic challenges, academic challenges, and institutional barriers. To provide adequate support to Latinx community college transfer students, sending and receiving institutions should unify their processes to ensure student success at both phases of the transfer process. Most participants across the different literature identified as first-generation college students, which significantly shaped their educational experiences and the challenges they encountered. This shared identity often influenced how they navigated academic systems, sought support, and balanced personal responsibilities. Many participants expressed feelings of isolation or uncertainty due to being the first in their families to pursue higher education (Acevedo-Gil et al., 2015; Castro & Cortez, 2017; Del Real Viramontes, 2020; Sanches & Morgan, 2022). For instance, participants described struggling to access financial support and resources, understand institutional processes, and advocate for themselves without prior examples or guidance from family

members. This pattern suggests that being a first-generation student is not only a demographic marker, but also a critical factor that informs how students engage with the college environment. Students not only experience challenges and barriers navigating unfamiliar territory when starting at community college, but also they endure this a second time once they transfer and have to navigate unfamiliar territory at their four-year institution. They are already starting at a disadvantage, yet their increasing presence highlights their persistence and determination. While students bring cultural and social capital from their families, upbringing, and communities, institutional support remains essential. By valuing these strengths and incorporating them into academic programs and support services, schools can help students succeed and feel more included in these academic spaces.

Recommendations for Future Research

While this review provides valuable insight into the experiences of Latinx transfer students, with a majority being first-generation students, future research should expand its focus to include LGBTQ Latinx students, undocumented students, and other Latinx non-traditional student populations, such as student parents, re-entry students, students with disabilities, veteran students, foster-youth students, and formerly incarcerated individuals. These students often face intersecting challenges related to time, financial constraints, mental health, and systemic barriers that are different from those of traditional students. Theoretical frameworks such as Critical Race Theory, Transfer Receptive Culture, Intersectionality, and Community Cultural Wealth were commonly used across the literature to highlight Latinx transfer student experiences. Additional frameworks that could further enrich this research include Chicana Feminist Epistemology, LatCrit, and Queer Theory, as they offer important perspectives for understanding the diverse and intersectional identities within the Latinx student community.

Institutions can implement effective strategies to improve degree attainment among Latinx community college transfer students by developing well-recognized and structured transfer programs that are supported at both community colleges and four-year institutions. It is critical that these transfer programs are created in way that are tailored to each student's academic and career goals. A key strategy is to expand academic advising and institutional support by hiring more advisors, faculty, and institutional agents to provide students with a consistent support team throughout their transfer journey. Additionally, institutions must ensure that students receive accurate and transparent information about university expectations, helping them manage their academic workload while balancing their mental and physical well-being. Transfer support programs established at community colleges should seamlessly carry over to four-year institutions, ensuring continuity, fostering a cohort-based community, and offering a sense of security in a new educational environment. By bridging the community colleges and four-year institutions we can create a clearer and more supportive pathway for Latinx community college transfer students to increase degree attainment and academic success.

CONCLUSION

College is meant to be a rigorous and challenging experience, but it should also provide opportunities for growth rather than serve as a roadblock in a student's academic journey. Institutions must ensure that Latinx transfer students are given the support they need to persist and thrive, rather than navigate through obstacles on their own. Institutional leaders, policymakers, and practitioners should continue working toward creating and sustaining asset-based initiatives that center on empowering Latinx students and provide clear pathways for degree completion. This includes ensuring that community colleges cultivate strong transfer-sending cultures and fostering transfer-receptive cultures at four-year institutions.than in other concentrations, suggesting that crowding may interfere with the spectrometer signals.

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Evaluating Light-Dependent Olfactory Responses in Adult Black Soldier Flies for Improved Rearing Practices

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ABSTRACT

Black soldier flies (BSF; *Hermetia illucens*) are insects known for their ability to upcycle food waste into useful agricultural products such as fertilizers, soil amendments, proteins, fats, and chitin. These qualities make BSF larvae pivotal in the food waste recycling industry.

Consequently, significant research has been dedicated to optimizing larval growth conditions, while adult BSF behavior remains largely unexplored. This gap may impede further improvements in rearing operations and overall production. To address this, we tested BSF adults using a Y-tube olfactometer—a robust assay for olfaction—to evaluate the olfactory preferences of adult BSF. We compared the response rate of adult BSF to a known attractant and a negative control. Our experimental setup involved varied light conditions: no light, fluorescent lamps, and a custom-made UV full spectrum light to simulate outdoor conditions.

Our preliminary results suggest that BSF adults exhibit a higher response to the known attractant under full spectrum light, suggesting that specific lighting conditions enhance responsiveness to olfactory cues. These insights imply that light may play a crucial role in key behaviors such as oviposition, mating, and attraction. By better understanding these processes, we can refine BSF rearing techniques, which could lead to advancements in the waste recycling industry.

KEYWORDS: black soldier fly, light stimulus, UV full spectrum light, waste recycling

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Wesley is a third-year biology student at the University of California, Riverside, with a minor in data science. In the Mauck Lab, he works with *Hermetia illucens*, also known as black soldier flies. His research focuses on their food decomposition properties and behavior given certain olfactory stimuli.

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Evaluating Light-Dependent Olfactory Responses in Adult Black Soldier Flies for Improved Rearing Practices

INTRODUCTION

Black soldier flies (BSF; *Hermetia illucens*) are key components of the food waste recycling industry, due to their ability to convert discarded food waste into several different useful agricultural products, such as insect-based fertilizers and soil amendments. Compared to chemical fertilizers, BSF products avoid the toxic poisoning of water bodies, soil, and plants often associated with fertilizers (Bisht and Chauhan, 2020). The digestate that the BSF creates from breaking down food waste is called frass, and it is rich in macronutrients, chitin, and minerals (Manan et al., 2024). These qualities make it an effective soil amendment for plants. Due to this, considerable research has been focused on optimizing BSF larvae growth, since larvae create the frass. However, much less research has focused on optimizing behavior of the adult flies, which may limit improvements to BSF rearing operations since they have an important role in egg-laying. To address this knowledge gap, our study investigates some of the olfactory and visual cues that the adult BSF may respond to, specifically focusing on BSF response to odor cues in the context of different light cues.

Like humans, insects rely on their multiple sensory systems to make behavioral decisions, including vision, olfaction, thermosensation, and hygrosensation (Drury, Whitesell, & Wade, 2016; Enjin, 2017; Piersanti et al., 2024). Environmental factors such as lighting can impact insect behavior because many species of flies use natural light sources to regulate flight, mating, and oviposition behaviors (Fabian et al., 2024). Multiple studies have found that natural sunlight is the gold standard for fly interactions, with artificial lighting having negative effects such as disorientation (Zhang et al., 2010; Fabian et al., 2024). However, the usage of artificial light that has been tailored to match the UV spectrum of natural sunlight may promote typical behavioral responses.

In this study, we tested adult BSF olfactory responsiveness using a Y-tube olfactometer under varying light conditions: no light, fluorescent light, and a custom UV full-spectrum light setup. We used the Gainesville diet, a standard positive control attractant in the industry that is a mixture of wheat bran, alfalfa, corn meal, and water. This was to ensure that the experimental design works. Because females are responsible for egg laying, understanding how these cues specifically affect female behavior is of particular interest. Therefore, we also explored whether there were sex-specific differences in response rates. Understanding the lighting conditions that encourage female adults to visit and lay eggs can lead to improved BSF rearing strategies, such as facilitating egg harvesting.

METHODOLOGY

Insect rearing. Adult black soldier flies were obtained from a controlled greenhouse environment. The colony operates under a steady state system, meaning that all life stages of the black soldier fly are continuously present to ensure a consistent supply of adults. The larvae were reared on homogenized food waste that was routinely checked and distributed in larval rearing bins. As the larvae reached maturity, they self-harvested by actively crawling out of the rearing substrate toward drier areas, which was facilitated by slopes in the bins. These larvae would then exit into collection containers. Following collection, pupation and eclosion occurred under the controlled conditions of the greenhouse. Every three to four days, metrics were recorded to ensure consistency in rearing conditions. These included quantities of pupae harvested, food waste applied, bulking agent added, and water supplementation. Internal bin temperatures and ambient greenhouse temperatures were measured, alongside pH levels of the bin mixture.

Experimental setup. To evaluate the olfactory preferences of adult black soldier flies, we used a Y-tube olfactometer. Each arm contained a known treatment source: either Gainesville diet, or an empty control (no attractant). They were initially contained in plastic cups connected to the Y arms by tubing, and then were succeeded by small metal tea strainers placed directly in the ends of the arms of the Y-tube. Experiments were conducted under three different lighting conditions: no light, fluorescent light, and a custom-built UV full spectrum light simulating outdoor conditions. Fluorescent lighting was provided by standard overhead ceiling fixtures commonly used in laboratory spaces.

The Y-tube olfactometer setup (Figure 1) consisted of a central release chamber connected to two odor arms. Air was pushed through each odor arm via a compressed air source

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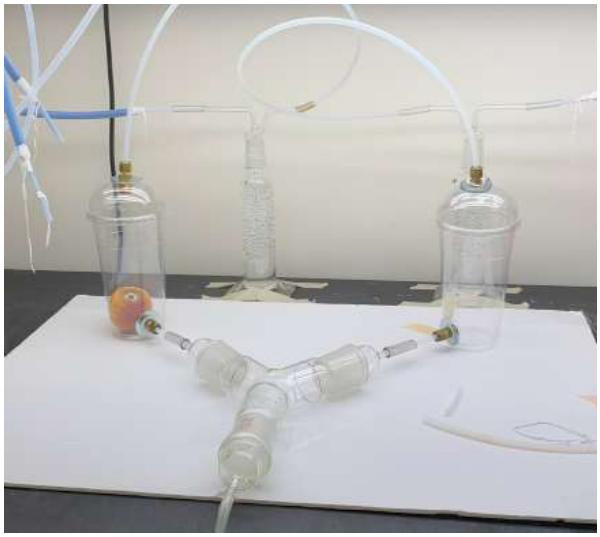

Figure 1: Y-tube olfactometer under fluorescent lighting, with odorant stimuli presented in open cups at each arm.

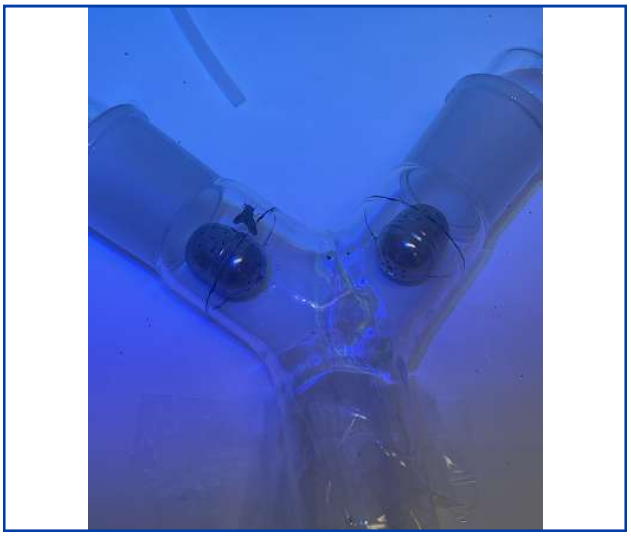

Figure 2: Y-tube olfactometer under UV lighting, with odorant stimuli held in tea strainers to allow scent diffusion.

regulated to 1.5 L/min, passed through a bubbler-style humidifier to ensure consistent humidity, and then pushed into the odor chambers. A vacuum system at the base of the Y-tube maintained constant airflow through the system at 1.5 L/min. Treatments were alternated between arms every three flies to avoid side bias.

Procedure. Individual flies were introduced to the base of the Y-tube and were given up to three minutes to make a choice. A choice was defined as the fly fully entering one of the two arms and reaching the terminal end of the arm. If a fly did not enter either arm within the three-minute window or did not travel all the way to the end of an arm, the trial was recorded as a no choice outcome. The sex of the fly, the choice of arm (left or right), and the time taken to make the decision were documented. Data collection and environmental conditions were kept consistent as much as possible. A total of 145 flies were tested across the three lighting conditions: 28 flies under no light, 39 flies under fluorescent light, and 78 flies under UV full-spectrum lighting. 21 flies (not included in the previous total) were tested with no treatment in either arm, under fluorescent lights. This was to evaluate side bias in the Y-tube setup, and these were excluded from the main analysis.

Analysis. Only experiments that included both a treatment and a control were considered. Control-only trials are described in the procedure section above. The analysis consisted of evaluating different response rates under different lighting conditions; preference for Gainesville diet over a control; and sex-based behavioral differences. We performed a chi-square test of independence using a contingency table comparing response categories across the different lighting treatments. This test evaluates whether the distribution of behavioral responses was significantly different between lighting treatments. Sex-based differences in behavior were also recorded and are available for exploratory analysis.

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RESULTS

The following table and bar charts summarizes our findings:

Lighting	Sex	Total Flies	Chose Gainesville		Chose Control		No Choice	
			n	%	n	%	n	%
No Light	Female	15	4	26.7	3	20.0	8	53.3
No Light	Male	13	2	15.4	4	30.8	7	53.8
Fluorescent	Female	23	8	34.8	7	30.4	8	34.8
Fluorescent	Male	16	9	56.3	4	25.0	3	18.8
UV	Female	38	21	55.3	12	31.6	5	13.2
UV	Male	40	19	47.5	13	32.5	8	20.0

Table 1: Table of BSF responses given lighting conditions and sex

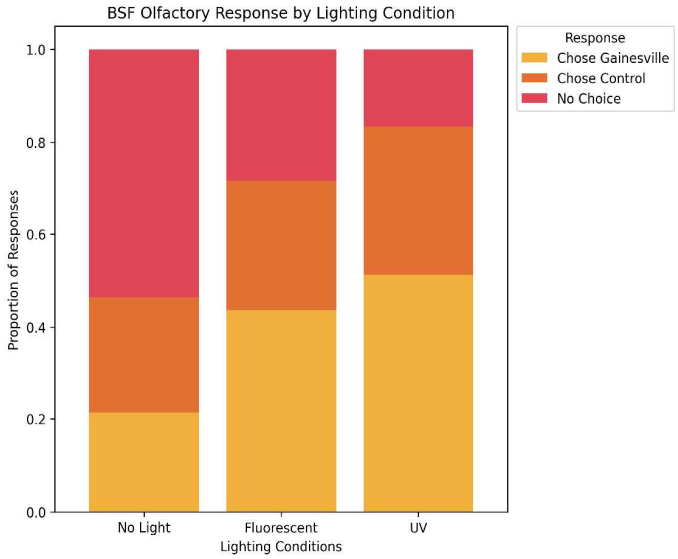

Figure 3: Proportion bar chart showing the distribution of responses across lighting conditions, irrespective of sex (matplotlib).

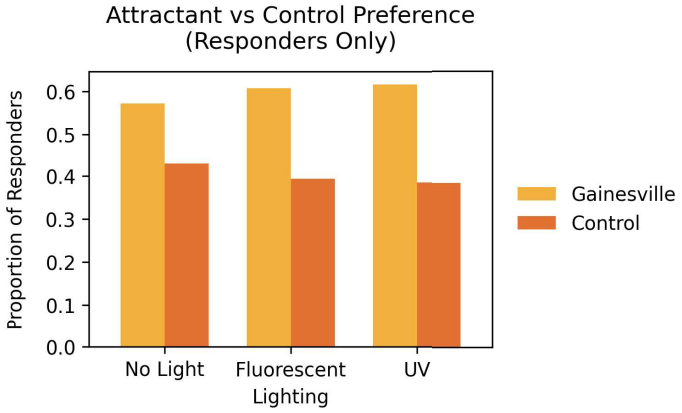

Figure 4: Choice preference among responsive adult BSF for Gainesville diet versus negative control under different lighting conditions. Only flies that made a choice in the Y-tube olfactometer are shown (No-light n = 13, Fluorescent n = 28, UV n = 65).

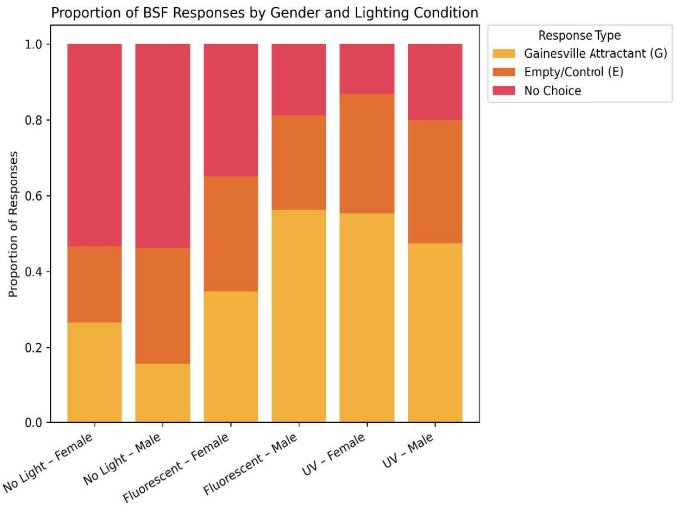

Figure 5: Proportion bar chart showing distribution of responses given sex and lighting conditions (matplotlib).

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RESULTS

In no-light conditions, few flies (21%) responded to the attractant, an equal percentage selected the control, and a majority (54%) made no choice. Under fluorescent lighting conditions, 44% of adult flies chose the attractant arm, compared to 28% choosing the negative control, with the remaining 28% showing no choice. Under UV full-spectrum lighting, we observed a higher attraction rate of 51% attractant preference, with only 17% showing no choice.

Statistical analysis and interpretation. The global chi-square analysis indicated a significant association between lighting conditions and fly choices ($\chi^2 = 15.08$, df = 4, $p = 0.0045$), demonstrating that BSF responses vary significantly with changes in lighting conditions. Follow- up analyses showed that the proportion of flies making a choice (versus no choice) differed significantly under UV ($\chi^2 = 34.7$, $p < 0.001$) and fluorescent ($\chi^2 = 7.41$, $p = 0.006$) conditions, but not under no light ($p = 1.0$). However, among flies that made a choice, the preference between the Gainesville attractant and the control was not statistically significant under any lighting condition.

The statistically significant result for the global chi-square analysis provides evidence that variations in BSF behavior observed under different lighting conditions are unlikely to be due to chance alone. Examination of the observed minus expected frequencies highlighted particularly strong deviations under the UV lighting condition, as flies exhibited higher-than-expected responsiveness to the Gainesville diet and a lower-than-expected incidence of no choice behavior.

DISCUSSION

UV full-spectrum lighting. Our findings demonstrate that UV full-spectrum lighting significantly increases responsiveness to olfactory cues compared to fluorescent or no-light conditions. Under UV conditions, a significantly greater proportion of flies made a behavioral choice rather than remaining inactive ($\chi^2 = 34.7$, $p < 0.001$). Among responsive flies, UV conditions produced a 61% preference for the Gainesville attractant. Although this preference was not statistically significant ($\chi^2 = 1.32$, $p = 0.251$), the numerical trend aligns with previous research that suggests UV radiation influences insect behavioral ecology (Shimoda & Honda, 2013). Previous studies also have noted that insects often exhibit improved visual and olfactory processing under natural lighting conditions, particularly involving UV spectra (Land, 1997). Since BSF are naturally active in daylight, the observed enhanced responsiveness under UV lighting is likely evolutionary adaptation for oviposition site selection and food resource localization.

No lighting conditions. Under no lighting conditions, adult BSF demonstrated a reduction in overall responsiveness. Over half of the tested individuals did not choose any arm in the Y-tube olfactometer. Statistical analysis confirmed no significant difference between the proportion of flies that responded versus remained inactive ($\chi^2 = 0.00$, $p = 1.000$). This reduced responsiveness has implications for indoor rearing facilities that may operate under reduced or artificial lighting conditions, potentially limiting productivity.

Fluorescent lighting. Fluorescent conditions yielded intermediate results, with moderate responsiveness (44%) to the attractant, which is better than dark conditions but inferior to UV lighting. This may reflect incomplete spectral emission provided by fluorescent lights. Statistical tests indicated that significantly more flies made a behavioral choice under fluorescent lighting compared to no choice ($\chi^2 = 7.41$, $p = 0.006$). However, among responsive flies, there was no statistically significant preference for the Gainesville attractant versus the empty control ($\chi^2 = 0.29$, $p = 0.591$). Given that fluorescent lamps emit limited UV radiation that differ from the spectral characteristics of natural daylight, BSF visual systems that are sensitive to UV wavelengths may not be fully activated, reducing the effectiveness of behavioral responses compared to full-spectrum UV illumination (Briscoe & Chittka, 2001).

Limitations. There are a few potential limitations that should be acknowledged. First, variations in testing conditions such as slight differences in airflow rates, temperature, or humidity between testing days may have influenced fly behavior. Consistency across these parameters is crucial as adult insect responsiveness is known to vary with minor environmental fluctuations (Tomberlin & Sheppard, 2002). Future experiments should also apply standardization of fly handling to minimize external stressors.

Future directions. Since the positive control, Gainesville diet, has shown to be preferentially chosen under UV lighting, further research can substitute with other chemicals of interest such as indole, or a combination of chemicals—which would involve substituting the negative control with another compound—to determine which one is more preferred.

Conclusion. The statistical support for lighting effects has important implications for the optimization of industrial-scale BSF rearing systems. Facilities aiming to maximize adult activity, mating, and oviposition rates should consider adopting full-spectrum or UV-inclusive lighting setups. This result supports previous findings about the relevance of lighting spectra in insect and waste-recycling management contexts. Flies responded with a significant preference for the Gainesville attractant under UV; however, there were no significant differences under fluorescent and no light conditions, which may be tested with further replication and larger sample sizes. Further research can investigate detailed spectral analyses to identify which specific wavelengths within the UV spectrum maximize responsiveness, along with investigations into behavioral differences between sexes under varied lighting, given potential differences in sensory or behavioral priorities between male and female BSF. Long-term assessments of BSF behavior under varying light conditions can also be explored to see the effects on health and fecundity in rearing and waste-upcycling operations.

ACKNOWLEDGMENTS

We would like to thank Kerry Mauck for her continued support, guidance, and insight throughout this project. We would also like to thank William Samson, Jaden Kim, and Hewitt Plunkett for setting up and maintaining the BSF steady-state operations. Finally, we thank Mark Szenteczki for constructing the custom UV full-spectrum lighting system used in our behavioral assays.

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Trouble in East Los Angeles: Los Angeles' Model City Program, 1969-1973

Steven Torres, Department of History
Jorge Leal, Ph.D., Department of History

ABSTRACT

The Model Cities Program (MCP) was launched in 1968 as part of President Lyndon B. Johnson's War on Poverty. Its purpose was to provide increased financial resources and improve living conditions in urban communities. The MCP also intended to bring city officials and local communities together to discuss unresolved issues that had been affecting neighborhoods. Los Angeles (L.A.) became a participant of the program, particularly its eastern neighborhoods with a significant Latinx population. However, the efforts to improve East Los Angeles's Latinx neighborhoods failed due to poor organization and a lack of centralized leadership. Many public projects were not completed nor received the entirety of proposed funding grants. My research explores the progression of the MCP in East Los Angeles between the years of 1969 and 1973. This research analyzes the issues that were present in L.A.'s MCP and how local Latinx communities reconsidered their relationship with institutional organizations. I draw on media publications and city records from the period. These sources reveal how the program gradually shifted away from productive planning and became ineffective, prompting community criticism. Prior studies have discussed the poor organization of the MCP across the U.S., but questions remain of how the program functioned in Los Angeles and its impact on Latinx communities. I argue that the issues of Los Angeles's MCP encouraged local Latinx communities throughout L.A.'s eastern neighborhoods to reconsider their relationships with institutional organizations. These communities instead chose to focus their efforts on community-established services and projects.

Keywords: Federal programs, East Los Angeles, activism, Latinx, Model Cities Program, Urban

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Steven Torres is a fourth year history major, concentrating in Latinx and urban histories during the 20th century in the United States. He conducts his research under the support of Dr. Jorge Leal and is a part of the TRIO McNair Scholars Program. He is the Vice-President of the History Enthusiast at UCR. Steven plans to pursue a Ph.D. in history and wants to enter academia at a research-based institution.

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INTRODUCTION

On February 23, 1973, a bold and flashy headline in the *Los Angeles Free Press* declared, "THE WAR ON THE POOR: Community participation in poverty programs under attack." The article was in reference to actions by former United States President, Richard Nixon, who planned to end several social assistance programs that were previously implemented by his predecessor, Lyndon B. Johnson.[1] In "'A War within our own boundaries': Lyndon Johnson's Great Society and the Rise of the Carceral State," Elizabeth Hinton explains that Johnson's War on Poverty aimed to invest in and support urban regions across the United States.[2] After Nixon took office, he faced multiple challenges during the early 1970s including a struggling economy which impacted millions nationwide. Additionally, according to Bruce J. Shulman in *The Seventies: The Great Shift in American Culture, Society, and Politics,* Nixon introduced liberal-leaning domestic programs like the Family Assistance Plan (FAP) to alleviate economic pressure, which struggled to pass through Congress, falling short in 1972.[3]

The Model Cities Program was launched in 1966 and ended in 1974. Susan Schindler contextualizes in "Model Cities at fifty: afterlives" that the Department of Housing and Urban Development (HUD), sought to reform urban communities and counteract the negative connotations of racial and socio-economic prejudices, which viewed cities as a landscape for poor and ethnic communities.[4] Cities across the United States were given the opportunity to participate in the Model Cities Program in order to address urban neglect. Los Angeles was among them, with East Los Angeles emerging as a key site. Cristina Rodriguez notes in *Walk the Barrio: The Streets of Twenty-First Century Transnational Latinx Literature,* East Los Angeles has held a historically active Latinx population throughout neighborhoods such as Boyle Heights.[5]

Although poor leadership and inadequate funding resulted in the failure of the program, the instillation of the Model Cities Program across East Los Angeles represented a historic effort by federal institutions to rebuild trust with ethnic and racial communities. Analyzing the program in the Los Angeles area during this period will improve chronological understanding of its operations between the late 60s and the mid 70s. Issues that impacted East Los Angeles Latinx communities and its neighborhoods were not fully resolved.[6] In this essay, I will show how the MCP operated in East L.A., prompting response by local Latinx communities. In examining these community responses, I will also discuss how the community-based organizations achieved greater political visibility to address the issues of the MCP.

HISTORIOGRAPHY (METHODOLOGY)

Scholars have increasingly analyzed the social and cultural dynamics of urban spaces and Latinx communities during the mid to late 20th century. More specifically, this literature has recognized urban spaces as critical in shaping Latinx identity politics, empowerment, and unity. It also acknowledges Latinx communities' influence and impact on local urban economic development programs and the

1). Anna Sklar, et al., "Los Angeles Free Press," *Los Angeles Free Press*, February 23, 1973, 1, JSTOR, https://www.jstor.org/stable/community.28040043.

2). Elizabeth Hinton, "'A War within our own boundaries': Lyndon Johnson's Great Society and the Rise of the Carceral State," *The Journal of American History* 102, no. 1 (2015): 1-2, https://www.jstor.org/stable/44286139.

3). Bruce J. Schulman, *The Seventies: The Great Shift in American Culture, Society, and Politics* (Cambridge: Da Capo Press, 2002), 32.

4). Susan Schindler, "Model Cities at fifty: afterlives," *Planning Perspectives* 39, no. 1 (2023): 1, https://doi.org/10.1080/02665433.2023.2294745.

5). Cristina Rodriguez, *Walk the Barrio: The Streets of Twenty-First Century Transnational Latinx Literature* (Charlottesville: University of Virginia Press, 2022), 22-23.

6). This paper primarily utilizes the gender-neutral term: Latinx. This is in consideration of the historical Latinx community of Los Angeles that identifies itself in various way rooted in heritage and culture. Additionally, other terms including "Hispanic" and "Chicanx" (also a gender-neutral term), will used throughout the paper.

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establishment of cultural spheres. Scholarship on the Latinx community has merged analyses from different academic subfields such as Transnational, Cultural, and Immigration Histories. These approaches have highlighted how Latinx communities in urban settings played a foundational role in preserving and sharing knowledge with incoming migrants.

Urban historians A.K. Sandoval-Strausz and Johana Londoño have both examined the dynamics of urban landscapes and Latinx communities. In *Barrio America: How Latino Immigrants Saved the American City,* Sanvadol-Strausz argues that Latinx immigrants played a crucial role in revitalizing city life in the United States during the late 20th century. Sandavol-Strausz uses quantitative data throughout *Barrio America*, to highlight the correlation between the historical waves of immigration from Latin-American countries during the late 20th century and the increase in municipal growth among the Latinx population during that period. Additionally, he uses oral histories to highlight the lived experiences of migrants from a variety of Latin American countries.[7] Meanwhile, Johana Londoño in *Abstract Barrios: The Crises of Latinx Visibility in Cities* problematizes the "Latinization" of urban landscapes designed by white developers to attract tourists and residents, such as the Fiesta Marketplace in Santa Ana, which was modeled after Tijuana's architecture.[8]

In contrast to Sandavol-Strausz's analysis of municipal growth, Londoño argues that the increase in Latinx populations in urban centers was not a form of resistance by the Latinx communities. Instead, white developers purposely created controlled spaces such as shopping centers to prevent the expansion of self-created Latinx community spaces.[9] Both analyses provide distinct explanations of the "white-flight" movement and its relation to increased Latinx communities in cities. Sandoval-Strausz suggests white-flight was resolved by Latinx populations repopulating cities. Meanwhile, Londoño work analyzes city growth and its relationship to the Latinx experience across urban centers in the United States. Despite their differences in reasoning about municipal growth in the United States, their works shape the understanding of the intentions of federal programs such as the Model Cities Program to "revitalize" city life and persuade white-flight participants that urban centers were not spaces of "blight."

Current scholarship on the Model Cities Program has analyzed the transition of the program from the management of Johnson Administration to the Nixon Administration. However, scholars have not analyzed the greater Los Angeles area, which has limited its historical understanding of and its documented impacts on local communities. Other cities, such as Seattle, have been written about by scholars. This includes Elizabeth Brown's "Race, Urban Governance, and Crime Control: Creating Model Cites," which analyzed Johnson's Great Society Programs and the development of the Department of Housing and Urban Development. Brown also discusses the internal issues of Seattle's Model City Program, such as conflict between local community members and the program's leadership.[10] Similarly, James A. Williams, "TO TRANSFORM THE INNER CITY: Tucson's Model Cities Program, 1969-1975" discusses Tucson's experience with inadequate budgets that could not properly support city projects.[11] Brown's and Williams's analyses emphasize that the inefficiencies of the Model Cities Program were not uncommon across the United States, and these issues frequently occurred through the program's local leadership. This pattern also emerges in East Los Angeles, as community members were in conflict with the leadership of the Los Angeles Model Cities Program.

7). A.K Sandoval-Strausz. *Barrio America: How Latino Immigrants Saved the American City* (New York City: Basic Books, 2019).

8). Johana Londoño, *Abstract Barrios: The Crises of Latinx Visibility in Cities* (Durham: Duke University Press Books, 2020), 114-115.

9). Londono, 115.

10). Elizabeth Brown, "Race, Urban Governance, and Crime Control: Creating Model Cities," *Law & Society Review* 44, no. 3/4 (2010): 794, https://www.jstor.org/stable/40926317.

11). James A. Williams, "TRANSFORM THE INNER CITY: Tucson's Model Cities Program, 1969-1975," The Journal of Arizona History 52, no. 2 (2011): 153, https://www.jstor.org/stable/41697354.

More recently, Casey D. Nichol's work, "The Magna Carta to Liberate our Cities: African American, Mexican Americans, and the Model Cities Program in Los Angeles," argues that the program's structure amplified visibility of various Los Angeles communities as they had increased contact with city and program officials. Specifically, Black and Mexican American community members who had experienced the challenges of living in urban environments, including predatory policing and educational inequity, hoped the Model Cities Program would reform these specific issues along with their neighborhoods.[12] Nichol's work takes an alternative approach to previous scholars who have studied the program, primarily emphasizing community unification to increase understanding of historical relationships rooted in ethnic and racial struggles.

EAST LOS ANGELES AND THE MODEL CITIES PROGRAM (DISCUSSION AND ANALYSIS)

In 1968, the *La Raza* newspaper discussed the state of their community's infrastructure and neighborhoods with a section titled, "Mortar & Bricks… are not a home."[13] This section outlined the need for improved living conditions for the Latinx community throughout Los Angeles neighborhoods, especially its eastern area. The editorial explained that in 1967, Mexican Americans from across California met to discuss housing needs for their local communities, forming the "Mexican-American Council for Better Housing." Their intention was to prioritize collaboration with the Department of Housing and Urban Development (HUD) and address it in Washington, D.C.[14] This meeting of Latinx community members from across the state to discuss the state of housing highlights the early steps community members took to improve their living conditions through political action. The formation of the Mexican-American Council for Better Housing represented the necessity for an organization to represent the Latinx community. It also highlights how they began to use their economic leverage to improve the housing issues they faced. This section further detailed the issues that had occurred throughout East Los Angeles.

The Mexican-American Council for Better Housing addressed concerns regarding housing for the Latinx community in Washington, D.C. The answers they received left them with further confusion and demonstrated the challenges the Latinx community throughout East Los Angeles faced in regards to urban redevelopment. The Mexican-American Council for Better Housing discovered that an associated organization, the East Los Angeles Improvement Council had previously submitted a plan for adequate housing support. This was denied by the Department of Housing and Urban Development due to disagreements over the cost of financially supporting a housing project and concerns that it surpassed the square footage unit requirements.[15] This collection of events between representatives of the Latinx community in East Los Angeles and federal officials represented early conflicting ideas, which further heightened during the Model Cities Program between 1970 and 1974. It also emphasized conditions of the barrios, which would begin to receive increased attention from governmental institutions. As Wendell E. Pritchett explains in "The 'Public Menace' of Blight: Urban Renewal and the Private Uses of Eminent Domain," terms such as "blight" were used to describe the deterioration of cities and incentivize renewal.[16] With governing institutions now becoming increasingly aware of the issues across East Los Angeles neighborhoods, this

12). Casey D. Nichols, "The Magna Carta to Liberate our Cities:' African Americans, Mexican Americans, and the Model Cities Program in Los Angeles," *Pacific Historical Review* 90, no. 3 (2021): 9, https://doi.org/10.1525/phr.2021.90.3.377.

13). La Raza, "Mortar & Bricks… are not a home," *La Raza* (Los Angeles), February 10, 1968, 9, Online Archive of California, https://ucla.app.box.com/s/rg8tzgrpuzjssod5k1l9anahlppuo41l.

14). La Raza, 9.

15). Ibid.

16). Wendell E. Pritchett, "The 'Public Menace' of Blight: Urban Renewal and the Private Uses of Eminent Domain," *Yale Law & Policy Review* 21, no. 1 (2003): 3, https://www.jstor.org/stable/40232666.

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began to increase the conflict between federal officials and local community members about how to resolve these challenges.

As the Model Cities Program began to take shape in Los Angeles County, city officials discussed which specific areas would receive funding. In articles published in 1968 and 1969, contributors to the *Los Angeles Times* explained how the decisions were made to allocate funding from the Model Cities Program. Editorial member, Herbert Ray in 1968 discussed that the city had not originally considered various East Los Angeles neighborhoods including Lincoln Heights, Boyle Heights, and El Sereno.[17] In a 1969 *Los Angeles Times* article, Don Snyder explained that El Sereno's concerning conditions were considered along with the other East Los Angeles neighborhoods. Originally, Watts had been considered a greater priority, but Los Angeles councilman Arthur Snyder helped include these neighborhoods during the program.[18] The inclusion of these neighborhoods garnered attention toward the possibilities of improving the conditions of East Los Angeles. The large Latinx population throughout East Los Angeles, hoped that their historical presence would allow for direct oversight of the projects supported by the Model Cities Program. These anticipations, along with the frustrations over the management of the program, were discussed in *La Raza's* February 1970 publication.

In February 1970, *La Raza's* contributors dedicated a section addressing the Model Cities Program, deeming it a failure for Latinx people living in the East Los Angeles area. "whose Model Cities whose?" contained a description of the issues that had occurred between the program and the Latinx community. The contributor to the section of the article noted that "Chicanos in the East/Northeast barrios were happily discussing what government money could do to create a new city…. Unfortunately, Chicanos now have misgivings… It is controlled by Mayor [Sam] Yorty."[19] As the Model Cities Program emphasized a foundation for citizen participation by contributing to project proposals, opportunities arose for community members to apply their knowledge of the issues the city faced. Latinx members living in the East Los Angeles area were enthusiastic about holding a leading role to help transform the barrios and establish improved infrastructure and resources. These improvements included the implementation of educational programs, a recreational center, and regional and cultural center.[20] The mayor during this time, Sam Yorty, and Los Angeles County officials allegedly took full oversight of the Model Cities Program, overshadowing the opportunity for leading roles among the Latinx and Mexican American communities. With an affluent government official taking leadership of the project, Yorty's perspectives and visions of redeveloping the barrios throughout East Los Angeles was in conflict with those of the residents.

In a February 1970 article by *La Raza,* the contributors further detailed other Hispanic and Latinx community organizations' involvement, displaying the unified efforts that were taken to address contemporary issues. In *Abstract Barrios*, Londoño explains that throughout the 1970s, an amplified awareness across the United States raised concerns about the declining states of barrios.[21] With the conditions of the barrios being noticed by federal and state institutions, residents hoped their challenges would finally be resolved. However, due to the poor organization of the Model Cities Program, many had critical views. La Raza reported that

17). Hebert Ray, "Councilmen Favor Model Cities Aid for Boyle Heights," *Los Angeles Times*, April 6, 1968, B1, ProQuest, https://www.proquest.com/hnplatimes/historical-newspapers/councilmen-favor-model-cities-aid-boyle-heights/docview/155878727/sem-2?accountid=14521.

18). Don Snyder, "Model Cities Funds Asked for El Sereno," *Los Angeles Times*, May 26 1969, SG1, ProQuest, https://www.proquest.com/hnplatimes/historical-newspapers/model-cities-funds-asked-el-sereno/docview/156184093/sem-2?accountid=14521.

19). La Raza, "whose Model Cities whose?" *La Raza* (Los Angeles), February 1970, 2, Online Archive of California, https://ucla.app.box.com/s/iu3866ui3yhism4pzlgovu57dp3zhayw.

20). Los Angeles Herald, "L.A. Schools Ask $5 Million U.S. Aid," *Los Angeles Herald Examiner* August 28, 1970, 6, Readex: America's Historical Newspapers, https://infoweb.newsbank.com/apps/readex/doc?p=EANX&docref=image/v2%3A1770633D3145AC61%40EANX-17E472A72DBE28CA%402440827-17E40925DE8824A3%405.

21). Londoño, 124.

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"CSCLA, MECHA, MAPA 40th and the Congress of Mexican American unity have passed resolutions against Model Cities."[22] This highlights how Latinx East Los Angeles communities were hesitant to continue depending on the Model City Program and viewed community-based organizations as significantly more reliable. As explained in "Chicana/o Activism and Education: An Introduction to the Special Issue" by Luis Urrieta, Jr., El Movimiento Estudiantil Chicano De Aztlán (MEChA) was formed to empower and support the Chicanx community and recognize significant issues throughout their communities.[23] With a strong relationship to community-based organizations, members were able to better use their voices to address their concerns. Additionally, the involvement of these community organizations represented the collective interests that were in conflict with Yorty's vision of the Model Cities Program. These community organizations did not believe Mayor Yorty was qualified to lead the Model Cities Program. This returns to the idea that the program should have been led by local community members, who also participated in these organizations to address contemporary issues.

As Nixon approached his final years of presidential term in 1973, the unstable economy led to decisions regarding continued support of social assistance programs, including the Model Cities Program. On February 23, 1973, the *Los Angeles Free Press* devoted a section to "36 Program participants speak," which discussed a timeline of the Model Cities Program in East Los Angeles.[24] Editorial member Ron Ridenour explained that Los Angeles County had submitted a HUD planning grant in 1968. It was agreed upon by community members in May of 1970 after several conflicting interests were addressed. The county finally began developing plans and received funding in March of 1971. The East and Northeast areas were given the option to receive priority allocation of the grant for the neighborhoods.[25] The information provided by the *Los Angeles Free Press* about the complications of approving projects for the Model Cities Program clarified and aligned with *La Raza's* explanation of events from February 1970.

The February 1973 publication of the *Los Angeles Free Press* mentions that the final approval to receive the HUD grants to begin establishing the Model Cities Program projects took much longer than expected. After the grant proposal was submitted in 1968, it took two years to be approved, after local community members finally reached an agreement upon the plans in May 1970. In the February 1970 issue of *La Raza*, editorial members explained that the Latinx community in the East Los Angeles area discussed how the Model Cities Program could benefit them. Additionally, *La Raza's* editorial contributors explained the community had experienced conflicts with Los Angeles Mayor, Sam Yorty. The significant time it took for members of the East Los Angeles community to come to an agreement was due to disagreements over leadership and potential project development ideas.

In the same February 1973 *Los Angeles Free Press* article, Ridenour further contextualized the state of the Model Cities Program in East Los Angeles. With previous challenges such as finalizing an agreement with community members and the leadership of the projects, other issues further delayed the project. Ridenour then explained the complicated state of the program after interviewing Arturo Bastidos, an official of the Model Cities Program, about the East Los Angeles redevelopment projects. Bastidos noted that the East Los Angeles area received only half of the project opportunities in comparison to Watts even though they had both been given the same budget. Additionally, the Watts area allegedly had greater organization and direction of projects. Bastidos believed that government officials purposely did this to create racial tensions between Black people and Latinx

22). La Raza, 2.

23). Luis Urrieta, Jr., "Chicana/o Activism and Education: An Introduction to the Special Issue," *The High School Journal* 87, no. 4 (2004): 2-3, https://www.jstor.org/stable/40364280.

24). Anna Sklar, et al., 1.

25). Ibid. 4

26). Ron Ridenour, "Neighborhood workers speak out," *Los Angeles Free Press,* February 23, 1973, 5, JSTOR, https://www.jstor.org/stable/community.28040043.

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people.[26] In this section, Bastidos expressed his frustration about the direction and lack of support for the East Los Angeles redevelopment projects. While Bastidos provided no concrete evidence that government officials or senior-level figures of Model Cities purposely imbalanced support between Los Angeles neighborhoods, Bastidos's frustration does highlight the confusing state of the program. For the Latinx community throughout East Los Angeles, the ideas proposed would be hindered by the complications caused by the disorganized structure of the Model Cities Program. When the hopes of receiving support to create an improved infrastructure and environment as not fulfilled, it strained the relationship between local members and the program.

Shortly after the February 1973 publication by the *Los Angeles Free Press*, the leadership of the Model Cities Program was further clarified in a March 1973 publication. In previous years, Sam Yorty was increasingly discussed by community officials as a possible leader.[27] In the March 1973 publication, multiple figures and directors were interviewed in regards to the progress of the Model Cities Programs projects.[28] A telegram sent to Deputy Mayor Chairman, Joseph M. Quinn discussed that the Los Angeles community was dissatisfied with the replacement of Laurence C. Whitehead, the program administrator of Model Cities Program. Additionally, the HUD had stopped operations of the Model Cities Program in East Los Angeles for failing to meet regulations. This shifted the attention to Mayor Yorty, who claimed that the staff of the program demanded greater benefits, causing the abrupt stop. Due to this response, candidates for the mayor in Los Angeles did not believe Yorty's claims, which further exacerbated the complications of the Model Cities Program.[29] The increasing complications of leadership across the Los Angeles City Council board and the Model Cities Program negatively impacted local communities. The halted projects across the East Los Angeles community further delayed the possibility of their neighborhoods being improved under the city's current conditions. The escalation of the leadership conflict over Model Cities began to shift the focus away from the development of the planned projects. Instead, the Model Cities Program became the center of a debate over who would lead its operations. Due to this ongoing conflict of leadership, the Latinx and Hispanic community members of East Los Angeles continued to face challenges receiving institutional support to improve their neighborhoods.

CONCLUSION

Johnson's launch of the War on Poverty in 1964 sought to alleviate and support the United States through various programs. Notably, the Model Cities Program attempted to "revitalize" cities across the country and help them to regain previous historical population numbers. After Nixon succeeded Johnson in 1969, he became responsible for continuing the Model Cities Program, along with managing a troubled economy throughout the 70s. The Model Cities Program captured the attention of many city officials including Los Angeles. More specifically, East Los Angeles became a primary location to implement the Model Cities Program to address historic challenges of poor financial and institutional support.

For the Latinx and Hispanic communities throughout East Los Angeles, the Model Cities Program offered an opportunity to alleviate the conditions of the area. This brought anticipation for adequate resources, financial support, and most importantly, community visibility to address the historic issues that had impacted them. These hopes deteriorated as conflicting interests between the community and leading figures of the program occurred, making it difficult for project to be approved. Additionally, conflict between Los Angeles city officials and Model Cities Program directors resulted in further delays of the completion of these projects. As the chaos from the

27). William H. Jones, "Letter," The G Street Collection: Papers of Arthur A. Fletcher, May 24, 1971, Washburn University Library, https://wuir.washburn.edu/items/62e41924-47b2-411e-901a-b654b8bce943.

28). The previous footnote references a letter typed by William H. Jones, a deputy administrator for the Model Cities Program. In addition to its contents, the letter contains several names of the figures mentioned throughout this paper, identifying their respective titles in relation to the Los Angeles City Council and the Model Cities Program.

29). Ron Ridenour, "Doris Fuller: 'It was designed to fail,'" *Los Angeles Free Press*, March 2, 1973, 7, JSTOR, https://www.jstor.org/stable/community.28040044.

disorganized leadership of the Model Cities Program unfolded, it became clear that the program had difficulties in focusing on its main objective. As media publications began to emphasize the continuous conflict, the program shifted away from its goal of supporting Latinx and Hispanic communities. They failed to receive the fulfillment of the program's promises. Due to this, the East Los Angeles community would need to continue addressing the existing issues that made living in the barrios difficult.

Thirty-four years after the termination of the Model Cities Program, a member of Nixon's administration and the Model Cities Program, Christopher DeMuth, commented on the poor outcome of the program. He described the troubles he saw in the Model Cities Program, noting its poor organization and inability to support each participating city, leading to its failure.[30] DeMuth's comments highlighted the organizational issues of the Model Cities Program. The program failed to address the historical lack of support across cities, especially in spaces where ethnic and racial communities resided. For the Latinx community, the outcomes of the Model Cities Program were another failure by governing institutions that hindered their goals of achieving economic stability and political visibility. This article focused on the conflicts between the program administration and local Latinx/Hispanic communities. There remain opportunities to continue analyzing the program, especially by analyzing other forms of media including televised interviews or oral histories from Latinx community members, to further contextualize the understanding of the program in Los Angeles. This would support broader connections to the living experiences in cities for Latinx people in the United States.

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30). Christopher DeMuth (Administration member), interviewed by Timothy Naftali, January 14, 2008, Richard Nixon Oral History Program, Richard Nixon Library and Museum, https://www.nixonlibrary.gov/sites/default/files/forresearchers/find/histories/demuth-2008-01-14.pdf.

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Anxiety Effects on Decision Making by College Students

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ABSTRACT

With rising levels of anxiety among college students, understanding its effects on decision-making is crucial, such as whether to enter the workforce or attend graduate school. In two studies with undergraduate business students, we examined the correlation between anxiety and decision making (Study 1; $N = 204$) and experimentally induced anxiety to test for causality (Study 2; $N = 249$). We assessed decision-making using a hypothetical choice scenario between an entry-level job offer versus an MBA program, as well as standard measures of decision-making traits: time preference, risk aversion, and loss aversion. We hypothesized that higher anxiety levels would lead to greater preference for immediate rewards, greater risk and loss aversion, and thus greater preference for the job over the MBA. Counter to our hypotheses, neither study found a significant relationship between either measured or induced anxiety and participants' decision between the job and the MBA. In addition, our anxiety manipulation did not work as planned in Study 2, with no differences in self-reported anxiety between conditions. We also did not find relationships between anxiety and either risk or loss aversion, but did find that anxiety correlated with more impatient time preferences in Study 1. Participants in the experimental condition had marginally more impatient time preferences and greater loss aversion than those in the neutral condition in Study 2. Future research should explore alternative methods of anxiety induction and other student populations to better understand how anxiety changes student decision making.

Keywords: Behavioral Psychology, Anxiety, Decision-making, Graduation, College Students, Future Plans

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INTRODUCTION

Student anxiety levels have increased dramatically over the past decade (Hoyt et al., 2021). How does this rise in anxiety affect this generation's future and decision-making skills?

Anxiety is an emotional state characterized by uneasiness and is commonly experienced in high stress situations. It involves intense emotions of fear and discomfort, often leading to physiological symptoms such as increased heart rate, dizziness, rapid breathing, and headaches. Might anxiety impact decision-making ability? Understanding how anxiety affects decision-making in college students regarding their future goals is essential–particularly in decisions related to entering the workforce versus continuing education in graduate school. These decisions can be influenced by various psychological factors such as emotional states, risk tolerance, time preference, and loss aversion.

To capture a full picture of how anxiety affects decision making among college students, we combine a correlational and an experimental study. The correlational study can assess naturally occurring relationships between students' anxiety levels and their post-graduation decision making and thus offers high ecological and external validity that an experiment might miss. The experimental study, in contrast, can temporarily induces anxiety in a controlled setting to test for the causal impact of anxiety. Taken together, the two methods provide complementary evidence—one mapping the phenomenon in the field, the other testing its causal mechanism in the lab—thereby producing a much stronger, more generalizable answer to our research question than either approach could yield on its own.

For both studies, we hypothesized that students with higher anxiety levels will prefer choice options with more immediate rewards, lower risk, and less potential for financial loss, thus leading them to prefer entering the workforce. We made this prediction due to anxiety reducing cognitive resources and thus leading to greater reliance on heuristics as suggested in dual-process theories of decision making (Kahneman, 2011). Together, these studies will provide insight to improve understanding of how negative emotional states, such as anxiety, shape cognitive processes and decision-making in college students. The study findings also have the potential to help college administrators to provide more effective assistance for students in achieving their academic and career goals. This would include refining interventions and programs while emphasizing the mental and psychological challenges students may experience.

Next, we review the literature on common sources of anxiety in college students and anxiety's relationship to decision making.

Anxiety in College Students

Decisions regarding graduate school or entering the workforce require strong academic performance, social skills, and extracurricular achievements—all of which contribute to stress and anxiety. Anxiety levels among college students have steadily increased in recent years due to various environmental factors (Anghel & Gati, 2021). College students have many stressors embedded within their daily routines as they aim to balance responsibilities, achieve academic goals, and compete for positions in graduate school or the workforce. The three primary contributors of anxiety among college students are academic performance, pressure to succeed, and post-graduation plans (Beiter et al., 2015). Further, negative emotionality is higher in students who are indecisive about their future plans in their fourth year of college (Anghel & Gati, 2021). Research has found a strong positive correlation between these stressors and students with severe depression, stress, and anxiety levels (Beiter et al., 2015). Beiter et al. (2015) also reported a 231% increase in yearly clients at the Franciscan University Counseling Center, highlighting the growing demand for mental health support among students.

Anxiety and stress levels have been exacerbated by the COVID-19 pandemic which introduced additional long-lasting uncertainties and disruptions. On average, college students reported significantly higher levels of stress and anxiety during the pandemic (Hoyt et al., 2021). Factors such as online learning, irregular routines, and doubts about the academic year contributed to this increase (Yang et al., 2021). As social interaction decreased, college students increasingly struggle with their ability to network with professors and peers in the learning environments–skills essential for self-confidence in making future career and academic decisions (Son et al., 2020). Financial uncertainty was also a result of this pandemic due to job and economic stress, which created

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anxiety for students trying to manage their educational expenses. Results found that 88% of college students have reported moderate to high anxiety levels (Lee et al., 2021).

Decision making requires cognitive functions such as attention, problem solving, and critical thinking skills. These functions may become impaired when stress and anxiety levels are increased. Risk aversion, time preference, and loss aversion–important decision making traits for making all kinds of decisions–may also be impacted by anxiety. The potential impacts of anxiety on each of these factors are discussed below.

Anxiety and Risk-Taking Behavior

Risk aversion is the tendency to prefer and choose outcomes with low uncertainty rather than high uncertainty. Previous research has found mixed findings on how anxiety affects decision-making. Previous research on anxiety's impact on decision making is mixed. Lerner and colleagues (2015) reported that anxiety increases preferences for low risk, low reward options, fostering a cautious approach, whereas Nash and colleagues (2021) found that economic anxiety was linked to both risk aversion—evidenced by heightened activation in the right anterior insula and dorsomedial prefrontal cortex—and increased risk taking, as shown by elevated ventromedial prefrontal cortex activity; similarly, Giogetta and colleagues (2012) observed that individuals with anxiety-related disorders made significantly fewer risky choices than non-anxious controls, particularly after wins. These mixed findings highlight the complexity of anxiety's impact on risk-taking and the need for further research. However, I hypothesize that anxiety among college students will cause them to shift their risk preferences towards being more risk averse.

Anxiety and Time Preference

Time preference reflects whether individuals value immediate rewards over potentially greater future benefits, and anxiety often drives a bias toward immediate gratification. For example, Shavit and colleagues (2014) examined how engaging in anxiety-inducing activities, such as skydiving, affected time preference. Findings revealed that when individuals engage in anxiety inducing activities, they elicit the tendency to make decisions leaning towards short-term thinking in information processing, prioritizing the present over the future which contributes to making short-sighted, but impulsive and risky decisions (Shavit, T., et al, 2014). The significant choice for short time preferences was specific to financial decisions–a factor that is crucial when making college students make future career decisions. Similarly, Xia and colleagues (2017) found that people with high trait anxiety favor smaller, immediate rewards over larger, delayed ones, highlighting anxiety's role in impulsive decision making.

Anxiety and Loss Aversion

Loss aversion is a cognitive bias highly impacting decision making due to the loss being emotionally experienced more strongly than the pleasure of an equivalent gain. Loss aversion results in people preferring decisions where losses can be avoided, rather than decisions where gains are acquired. Previous studies found that loss aversion can be significantly affected by anxiety. For example, Xu and colleagues (2020) found that anxious individuals display increased loss aversion, along with associated reduced connectivity between the amygdala and prefrontal cortex. These results suggest that anxious individuals have decreased emotion regulation skills when approached with increased loss inducing situations, leading to increased loss-averse and "cautious" decision making (Xu et al., 2020). These findings intensify the need to examine decision making in college students to allow for administrators and academic counselors to not overlook the possible effects of anxiety on life-altering decisions.

Research Question

These past research findings raised the question: How does anxiety affect college student decision-making traits in post-graduation decisions, especially when choosing between entering the workforce or pursuing graduate school? To test this question, we conducted two studies: Study 1 was correlational and Study 2 experimentally induced anxiety.

STUDY 1

Methodology

Participants: In this IRB-approved study, we explored the relationship between naturally-occurring levels of student anxiety and decision making. We recruited 204 undergraduate students (118 male and 86 female; White 17.1%, African

American 6.4%, Hispanic 33.8%, Asian 44.6%) at the University of California, Riverside (UCR). Participants completed this study as part of a series of studies in exchange for partial course credit. Participants completed a series of hypothetical scenarios and standardized measures to assess decision-making tendencies, risk aversion, loss aversion, time preference, and anxiety levels.

Decision-Making Scenario and Assessments: Participants saw a hypothetical scenario in which they had to choose between entering the workforce or attending graduate school. Following their decision, an open-ended response box allowed them to provide a written explanation for their choice. To assess participants' risk-taking tendencies, they engaged in a financial gambling scenario in which they chose between a guaranteed monetary reward and a higher-risk option with the possibility of earning more or losing money. Higher selections of the risk-averse option indicated a preference for certainty over potential gain. Loss aversion was measured using another hypothetical gambling task in which participants were presented with two options: one that minimized potential losses and one that maximized potential gains. Participants' selections provided insight into their tendency to avoid losses, a behavior commonly associated with anxiety-related decision-making. Participants' time preference was measured using a series of hypothetical financial decisions where they had to choose between receiving a smaller amount of money immediately or larger amount after a delay. More choices of smaller, sooner rewards over larger, later gains was indicative of impatient time preferences. These methods are standard measures for measuring these decision-making traits.

Anxiety Measurement: Participants' current emotional anxiety was assessed using items adapted from the Beck Anxiety Inventory (BAI), presented on a Likert-scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The items evaluated symptoms such as nervousness, difficulty relaxing, and feeling like one has minimal control. Random positive affect items were included as attention checks to ensure response validity. Additionally, participants completed the Generalized Anxiety Disorder Assessment (GAD-7) to measure anxiety levels over the past two weeks. This measure consists of seven items evaluating the frequency of anxiety-related symptoms (e.g., "Over the last TWO WEEKS, how often have you been bothered by the following problems?"), with response options ranging from 1 (Not at all) to 4 (Nearly every day). Higher scores on the GAD-7 indicate greater levels of anxiety.

Procedure: Participants completed the study online through Qualtrics, ensuring accessibility and efficiency in data collection. The entire survey was estimated to take approximately 10 minutes to complete.

Results of Study 1

Of the 204 participants who completed the study, 106 participants (51.96%) chose to pursue graduate school and 98 (48.04%) opted to enter the workforce. To examine the relationships between the independent variables, we conducted a correlational analysis. The results revealed almost no associations among most of the independent variables, as most correlation coefficients were close to zero. Next, we analyzed the correlation between each independent variable (risk aversion, loss aversion, time preference, and anxiety measures) and decision outcome (graduate school vs. workforce) and found only a significant correlation ($r = 0.19$, $p = 0.006$), with participants who had a stronger preference for immediate rewards were more likely to enter the workforce. There were no other significant correlations between the decision making variables decisions (all p-values > 0.05). Correlation coefficients remained close to zero (r ranging from 0.012 to -0.19). These findings suggest that time preference may play a role in post-graduation decision-making, offering partial insight into our broader question of how anxiety may influence college students' choices in post-graduation plans. The other measured variables were largely independent of one another and did not predict post-graduation decisions. Although anxiety did not correlate with the decision making measures, a null correlation does not rule out a causal effect—the effects of measured anxiety can be masked by unmeasured confounds or restricted range. Thus, we next turned to running an experiment in Study 2, in which we can test whether experimentally-induced anxiety can alter decision making when other variables are held constant.

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Variable	*r* with state anxiety	*p*	*r* with general anxiety	*p*	*r* with preferring workforce	*p*
Risk Aversion	-0.07	0.29	-0.03	0.67	0.10	0.16
Loss Aversion	0.08	0.25	0.08	0.27	-0.02	0.74
Time Preference	-0.02	0.78	0.03	0.72	-0.19	0.006
BAI State Anxiety	-	-	0.63	<0.001	0.01	0.86
General Anxiety	0.63	<0.001	-	-	-0.08	0.27

Table 1: Correlations between decision making variables, state and general anxiety, and scenario decision (grad school = 0, workforce = 1)

STUDY 2

Study 1 did not find correlations between self-reported levels of students' anxiety and their hypothetical decision between graduate school and work. The lack of an inherent relationship does not eliminate the possibility of anxiety influencing decision-making, since anxiety levels may be confounded with other factors. Therefore, we will test our hypotheses in a study in which we experimentally induce anxiety. This will provide a more direct examination of anxiety's potential effects on decision-making.

Methodology

Participants: Following IRB approval, UCR undergraduate participants (N = 249), in exchange for partial course credit, completed a series of hypothetical scenarios and standardized measures assessing decision-making tendencies, risk aversion, loss aversion, time preference, and anxiety levels. Unlike Study 1, this study implemented an experimental manipulation to investigate the effects of anxiety on decision-making.

Anxiety Induction Manipulation: Participants were randomly assigned to either the experimental anxiety-induction condition or the control condition. In the experimental condition (high-anxiety group), participants were informed that they would be completing an IQ test designed to determine intelligence levels. This anxiety-induction method was established and tested by Beaurenaut et al. (2020). The test was presented as a high-stakes evaluation, with a strict and non-achievable 3-minute time limit, creating a sense of uncontrollability and stress (Almazrouei et al., 2023). In the control condition (low-anxiety group), participants were given the same set of questions but were instead told that this was a fun and engaging cognitive activity with no time constraints. The perceived uncontrollability and pressure in the experimental condition were expected to elicit stress and anxiety, aligning with prior research on anxiety induction.

Anxiety Measures: Participants' anxiety levels were assessed using multiple measures to capture both psychological and physiological responses to the anxiety induction. Similar to study 1, the BAI measured current emotional anxiety using a Likert-scale from 1 (Strongly Disagree) to 5 (Strongly Agree). The GAD-7 assessed anxiety over the past two weeks, with responses ranging from 1 (Not At All) to 4 (Nearly Every day). Additional self-reported physical symptoms (e.g., heart rate, muscle tension, restlessness, sweating) and state emotions with some relating to anxiety were included to further assess participants' immediate reactions to the anxiety induction.

Decision-Making Scenario and Assessments: Following the anxiety induction task, participants completed a slightly modified

version of the hypothetical decision-making scenario from Study 1. They were asked to choose between entering the workforce or attending graduate school, followed by an open-ended response box where they explained their choice. The same financial decision-making tasks from Study 1 were used to assess participants' risk-taking tendencies, loss aversion, and time preference.

Procedure: Participants completed the study online through Qualtrics. After providing informed consent, they were randomly assigned to either the experimental or control condition. The experimental group completed the IQ test with a strict 3-minute time limit, reinforcing pressure and uncontrollability, while the control group completed the same questions but were told it was a casual, low-stakes activity with no time limit. After the anxiety induction, participants chose between entering the workforce or attending graduate school and provided an open-ended explanation for their choice. Participants then completed the BAI and GAD-7 to assess both state and trait anxiety and reported physical symptoms and state emotions related to anxiety. The same financial decision-making tasks from Study 1 were administered in the same order. Lastly, participants were informed of the true purpose of the study and reassured that the Matrices task was not an actual intelligence test. The study took approximately 15 minutes to complete.

Results of Study 2

To verify whether the anxiety induction was effective within the experimental group, we compared reported physical and emotional anxiety using independent-samples *t*-test. Participants in the experimental group did not report significantly higher anxiety in comparison to the control group (emotional anxiety: *t*-stat = 1.5, *p*-value = 0.11 and physical anxiety: *t*-stat = 1.14, *p*-value = 0.256). We then conducted independent-samples *t*-tests to examine whether time preference, loss aversion, and risk preference differed between both groups. For time preference, there were no significant differences found (*t*-stat = 1.72, $p = .09$), but the trend suggests that the anxiety condition may lead to greater preference for immediate rewards. Loss aversion showed no significant difference (*t*-stat = 1.65, $p = .10$), though the anxiety condition showed a trend toward greater loss aversion. Risk preference also did not show any significant differences (*t*-stat = -1.17, $p = .25$), with the anxiety group trending toward slightly lower risk-taking behavior. Although not significant, trends suggest anxiety may impact financial decisions, increasing loss aversion and influencing time preference. Fisher's exact test compared the proportion of participants choosing graduate school versus the workforce between conditions. In the control group, 34.1% chose graduate school and 65.9% chose the workforce, while in the anxiety group, 33.3% chose graduate school and 66.7% chose the workforce. To further explore potential relationships, we conducted

Variable	$M_{Anxiety}$	$M_{Control}$	*t*-statistic	*p*-value
Emotional Anxiety	2.55	2.73	1.59	0.11
Physical Anxiety	1.93	2.07	1.14	0.26
Time Preference	16.01	16.47	1.72	0.09
Loss Aversion	11.48	11.73	1.65	0.10
Risk Preference	2.7	2.43	-1.17	0.25

Table 2: Differences between the experimental and control conditions.

correlation analyses between anxiety measures, decision-making traits, condition, and post-graduation decision. No significant correlations were found between any of the variables. Altogether, these findings suggest that while the anxiety induction may not have had a strong effect, subtle trends point to potential influences of anxiety on decision-making patterns.

DISCUSSION

Two studies examined the impact of anxiety on decision making, specifically the choice between entering the workforce or attending graduate school. We hypothesized that anxiety would influence financial decision-making traits such as risk preference, loss aversion, and time preference, leading the higher anxiety group to choose the workforce option. Results showed no significant differences between the anxiety and control groups. However, our findings suggested that anxiety may nonetheless impact decision making by leading to greater preference for immediate rewards (i.e., impatient time preferences). This pattern aligns with prior research finding anxiety may heighten present-focused thinking and discourage delaying gratification.

Despite the lack of significant results, the study continues to offer insights into decision-making processes within college students. These findings can be interpreted through the lens of dual-process theories (Kahneman, 2011), which suggest that anxiety impairs cognitive capacity and shifts individuals from analytical to heuristic-reliant thinking. The observed trends of a greater preference for immediate rewards and slightly higher loss aversion within more anxious individuals are consistent with a reliance on quicker and emotion-driven decision-making. This suggests that anxiety may not directly determine specific decisions, but rather biases by which these decisions are made.

Our findings have implications for career centers as advisors may begin to recognize how underlying anxiety could nudge students toward immediate, but potentially less beneficial choices. Institutions might also consider implementing decision-making support programs that focus on emotional experiences related to career planning. Targeted support for students experiencing anxiety could improve not only emotional well-being but also the quality of long-term academic and career-choices ensuring the best future outcomes for students. This study highlights the complexity of anxiety's role in decision-making and underscores the need for further research to explore these relationships. If anxiety influences decision-making tendencies, interventions aimed at reducing decision-related stress could help individuals make more rational long-term choices. Broadening the definition of a "successful" post-graduation path to include the emotional factors, not just financial or academic milestones, may better reflect the difficult realities students face.

While the study emphasizes the complexity of anxiety effects on decision-making within the specific scenario of post-graduation plans, several limitations should be considered. The main limitation of the study is that the anxiety manipulation was ineffective. While we used an established manipulation from previous research, we did not include an attention check immediately after the "intelligence test," which could have resulted in participants not reading the instructions in detail due to lack of attention. As the study relied on an online sample, participants could have completed the survey in uncontrolled environments (i.e., in a casual setting with friends), which may have influenced their engagement with the study. Future research should implement lab-based designs to create more controlled settings for anxiety induction while adding attention checks to ensure all instructions are understood.

An important limitation is that decisions about post-graduation plans are typically made over an extended period of time and influenced by numerous personal factors. Since many students may have already considered their future plans before participating in the study, the hypothetical scenario may have not been an accurate measure of this complex decision. Because participants were making hypothetical decisions and not real ones, their responses may not reflect how they would behave in an actual, high stakes situation. Future research could control for this by asking participants whether they have already made this decision and how confident they are in pursuing it in the future. Additionally, researchers should explore real-world decisions by tracking students' long-term decision-making process within the experimental design. These limitations highlight the need for future research to employ stronger anxiety manipulations,

control for third variables, and explore real long-term decision making to better understand how anxiety influences major life decisions.

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FRET-based Synthetic Biology Approach for SUMOylation Cascade in Bacterial Cell and Interaction with Influenza A Virus

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ABSTRACT

The post-translational modification SUMOylation plays a critical role in regulating protein function and stability in both physiological and pathological processes, such as cancers, immune responses, and virus infections. Namely, SUMOylation enhances cell proliferation of the influenza A virus (IAV) M1, making the study of SUMO1 protein interactions significant to viral research. However, research in this field requires mammalian cell cultures that are both labor intensive to maintain and costly to scale up for drug screening. The purpose of this project is to design a SUMOylation pathway in bacterial cells that can eliminate these setbacks, aiding future research in being more efficient. Using synthetic biology techniques, we reconstituted the SUMOylation cascade into *E. coli* and attached a FRET donor CyPet to screen its fluorescent protein interaction with our target substrate YPet-IAV M1. The most suitable among the 13 *E. coli* strains, BL21(DE3) PlysS, showed a successful fluorescent energy shift from the donor CyPet to acceptor YPet, suggesting SUMO1 binding to IAV M1 within 1-10 nm. We also performed SUMOylation inhibitor testing to validate our SUMOylation construct FRET efficiency. Our novel engineered SUMOylation cascade was able to simulate SUMO conjugation to substates in bacterial cell cultures similar to their native counterparts in mammalian cells, offering an alternative to eukaryotic models in future viral interaction and drug screening research.

KEYWORDS: SUMOylation, quantitative Förster Resonance Energy Transfer, synthetic biology, influenza A virus, viral proteins, protein interactions

My Linh Le

My Linh Le is a current 4th-year undergraduate student in Bioengineering. For the past year, she has been following under the guidance of Dr. Liao in research on biotechnology and molecular engineering. Her work focuses on qFRET analysis of E3 ligase interaction with IAV M1 proteins along with other SUMOylation enzymes. She aspires to further her professional career in research and plans to pursue a Master's in Bioengineering, with a concentration in Cellular and Molecular Engineering.

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Dr. Liao, a founding faculty member of UCR's Bioengineering Department, researches host–virus interactions and develops advanced qFRET technology for both basic and translational science. Before UCR, he was a senior research fellow at the Novartis Genomic Institute and Scripps Research. As the founding scientist of the GPCR platform at GNF, his work on FTY720 led to the discovery of SEW2871, contributing to the development of ozanimod for multiple sclerosis. He has authored over 70 publications and holds 32 patents.

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INTRODUCTION

Influenza is a seasonal respiratory virus that infects almost 1 billion people worldwide and causes 290,000 – 600,000 deaths annually.[24] Its most common strain, Influenza A (IAV), has led to disease outbreaks such as the 2009 H1N1 and the 2013 H7N9 pandemics in recent medical history, which emphasizes the demand for innovations in influenza prevention.[23] Current research suggests that the IAV M1 protein exploits the host SUMOylation cascade to facilitate viral proliferation.[23] However, the study of SUMO-IAV M1 interaction faces challenges as it requires mammalian, specifically human, cell cultures that are both costly and labor intensive to maintain.[23] The goal of this project is to utilize synthetic biology technology to design a polycistronic SUMO pathway inside *E. coli* which can reduce traditional SUMO-IAV M1 research drawbacks. Quantitative Förster Resonance Energy Transfer (qFRET) is used to examine the protein expression of polycistronic SUMO in different *E. coli* strains and validate interaction of SUMO1 peptides with IAV M1.

One notable application of synthetic biology is the ability to engineer bacteria to perform complex functions, such as the SUMOylation pathway, which typically only exists in eukaryotic cells (Fig. 1). SUMO, or small ubiquitin-related modifier proteins, covalently binds to target proteins at lysine residues, a process made possible by its structure similar to ubiquitin.[3] Three enzymes facilitate the conjugation reactions: an E1 activating enzyme, a specific E2 conjugating enzyme (*UBC9*), and a few E3 protein ligases such as PIAS2. SUMOylation primarily modifies a molecule already attached to a SUMO protein, influencing aspects like the protein's subcellular location, protein-protein interactions, and the activity of the SUMOylated protein.[2,3] SUMOylation plays critical roles in several cellular processes directly relevant to cancers, such as immune regulation, signal transduction, DNA damage, cell cycle, cancer metastasis, and stem cells.[17,18,19]

Although the SUMOylation cascade is complex, synthetic biology allows its reconstruction in *E. coli* through artificial cloning.[5,2] The artificial cloning of genetic material enables the introduction of the SUMOylation pathway into *E. coli*. Specifically, the bacteria are synthetically engineered

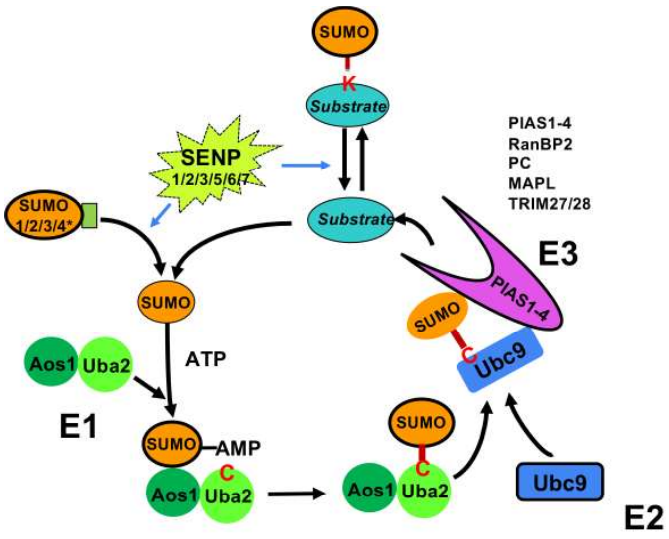

Figure 1: Illustrated SUMOylation cascade in eukaryotic cells. SUMO peptide is first expressed as a pro-SUMO precursor and then processed to mature SUMO peptide by SENP protease. The mature SUMO peptide is then activated by the E1 activating enzyme, Aos1/Uba2 heterodimer, before being transferred to the E2 conjugating enzyme, Ubc9. The E3 ligase improves substrate specificity to help SUMO1 bind to substrates through Lys residues. The conjugated SUMO1 peptide can then be removed by SENP, cycling through its reversible post-translational modification.

to incorporate the DNA necessary for expressing SUMO proteins, along with the E1, E2, and E3 enzymes.[2] A more efficient gene cloning method, facilitated by polycistronic DNA synthesis technology, can generate the necessary sequences to encode this pathway.[4] This combination allows for the effective reconstitution of the SUMOylation assay[5].

To evaluate SUMOylation activity, Förster Resonance Energy Transfer (FRET) is a technique that monitors protein-protein interactions within *E. coli*, enabling the quantification of SUMOylation efficiency and providing essential information about the genetically engineered bacteria[6]. The FRET technique relies on the non-radioactive transfer of energy via electrostatic attractions between two fluorophores, a cyan fluorescent protein (CFP) and a yellow fluorescent protein (YFP), CyPet and YPet, respectively,

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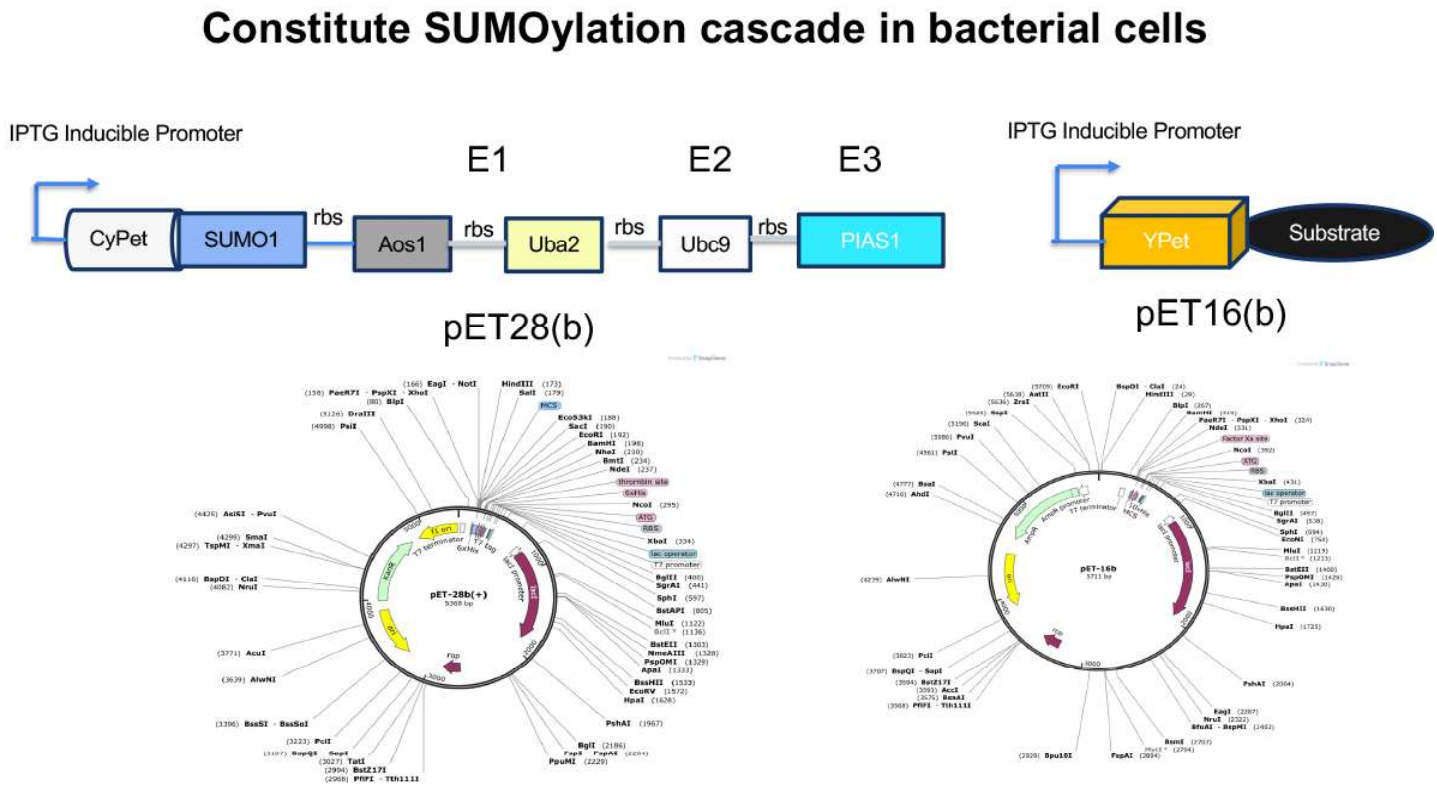

Figure 2: Reconstitute human SUMOylation cascade in bacterial cells using synthetic biology approach for polycistronic expression. To constitute the SUMOylation cascade as a FRET assay in bacterial cells, all the SUMOylation enzyme genes E1, E2 and E3, and CyPet-SUMO gene were constructed in one bacterial expression vector, pET28(b) (Kan+), with ribosome binding sites (RBS) and translation enhancement sequences between each genes (Left). The substrate gene, YPet-M1 was constructed in another bacterial expression vector, pET16 (Amp+)(Right).

in this project, when they are 1-10 nm apart.[6,7,8,9] Unlike traditional FRET settings in well plates, this process occurs directly within *E. coli*, containing the genetic material necessary for SUMOylation.[6,7,8,9] To successfully perform FRET, several conditions must be met. The donors and acceptor fluorophores need to be within the optimal distance to allow energy transfer. The fluorescence environment must also be supportive, maintaining favorable pH and ionic strength to ensure effective fluorescence.[7,9] The experiment begins by exposing the donor fluorophore to a light source, which excites the molecule. Energy transfer occurs through dipole-dipole coupling, exciting the acceptor fluorophore. As the acceptor's electrons return to their ground state, they release photons, and the donor's emission can be measured to confirm that FRET has occurred.[6,7,9]

This synthetic biology approach for SUMOylation pathways significantly reduces the need for iterative cloning, especially tedious protein expression and purification procedures.[1, 4, 5,10] With this synthetic biology approach, only the final SUMOylation conjugation needs to be examined. By applying the synthetic biology approach of SUMOylation, the cost of time and resources can be significantly reduced, allowing significant efficiency improvement in drug discovery and research.[1,10]

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MATERIALS AND METHODS

Designing the Polycistronic SUMO Construct as a Synthetic Biology Approach

The synthetic SUMOylation cascade construct was designed by attaching CyPet to SUMO1 and E1 activating, E2 conjugating, and E3 ligase enzymes via an engineered ribosome binding site (RBS), AAAGAGGGGAAA, and translation enhancer, TTAACTTA, between each gene. This construct provides all the necessary enzymes to promote the SUMO conjugation to a substrate, which is Influenza A Matrix protein M1 (IAV M1) in this study. The E3 enzyme, PIAS1, was chosen based on our lab's past research that observed a high affinity for IAV M1 protein.[11] The polycistronic SUMO sequence was cloned downstream of the IPTG inducible promoter to promote protein expression and, consequently, the SUMOylation cascade of CyPet-SUMO1 to YPet- IAV M1. The plasmid was synthesized by GenScript and cloned into E. coli TOP10 cells via electroporation. Colonies were cultured in 2xYT medium, and DNA was extracted using Biomiga Express Plasmid Midiprep Kit. Concentration was confirmed using a NanoDropTM spectrometer, with a target concentration above 200 ng/μL.

Determination of Polycistronic SUMO protein expression in E. coli

Having cloned polycistronic SUMO plasmid DNA, we transformed it into different strains of electrocompetent *E. coli* bacteria, all specialized for high-efficiency protein expression via electroporation. The following list of *E. coli* bacteria used to amplify the plasmid construct includes: SHuffle® T7, Rosetta 2(DE3), Rosetta 2(DE3) PlysS, BL21(DE3) PlysS, BL21-CodonPlus, BL21(DE3), BL21-CodonPlus (DE3)-RIL, Rosetta (DE3)PlysS, OverExpress™ C43(DE3), OverExpress™ C43(DE3) PlysS, E.Cloni® 10G (SOLOs), OverExpress™ C41(DE3), and ArcticExpress (DE3)RP.

After successfully transforming polycistronic SUMO to yield greater than 24 colonies for each competent cell strain, we picked the colonies into 96-well round bottom trays with LB media to screen for CyPet-SUMO1 protein expression. We prepared two sets of identical trays to incubate overnight: uninduced (UN) and induced (IN) of each strain. Once an optical density (OD) of greater than 0.6 at 600-nm absorbance was reached, we added 0.3-μM IPTG into the IN plates to promote protein expression. We screened for competent cell strains for CyPet fluorescence in 16, 24, and 48-hour time courses. Using the Tecan Infinite® 200 PRO plate reader, we performed a fluorescent spectrum scan on each UN and IN plate at an excitation 414 nm and an emission range from 450 nm to 600 nm, which contained the range of CyPet fluorescent emission at 475 nm.

SUMO Conjugation of SUMO to IAV M1 in *E. coli*

From the CyPet protein expression qFRET measurements of polycistronic SUMO in the 13 screened electrocompetent cells, we standardized all data by dividing by their respective O.D. at 600-nm absorbance at the time of screening. Next, we chose the strain with the highest relative fluorescence unit (RFU) value to directly transform with YPet-IAV M1 via electroporation. Three colonies were picked and inoculated in 3 mL of LB broth with a 1:1000 ratio of Kanamycin and Ampicillin, then incubated overnight. The next day, we separated the cultured tubes into new induced (IN) and uninduced (UN) tubes containing the same amounts of LB broth and antibiotics to shake until a desired OD of greater than 0.6 was reached at 600-nm absorbance. Only IN tubes had 0.3-μM IPTG added to promote CyPet and YPet protein expression. Following centrifugation, the resulting pellets were resuspended in 1x PBS buffer and transferred into black, clear-bottom 384-well plates for fluorescence screening. Each double-transformed UN/IN culture sample underwent a 24-hour time course scan to observe CyPet-YPet protein interaction. Fluorescence spectrum scans were performed on each UN/IN sample using the Tecan Spark® multimode microplate reader, with excitation at 414 nm and emission collected from 450 to 650 nm. This wavelength range contains the overlap between CyPet emission and YPet excitation at 475 nm, which provides optimal observation of CyPet donor transferring fluorescent energy to YPet acceptor, signaling that the polycistronic SUMO and IAV M1 proteins successfully interacted within a range of 1-10 nm of each other.

SUMO Inhibitor Testing

The pET28b constructs encoding polycistronic SUMO and the pET16(b) IAV M1 plasmid were used to transform BL21(DE3) PlysS *E. coli* cells. The ideal signal colony was cultivated at 37 °C and 250 rpm after being injected into 3

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mL of liquid LB with 50-mg/mL kanamycin and rapamycin culture. At 16°C and 180 RPM for 48 hours, 0.3-mM IPTG and 250-µM SUMOylation inhibitor simulated culture expression. After 48 hours at room temperature and 13,000 RPM for three minutes, the bacterial cells were extracted. 60 µL of 1x PBS (PH 7.4) was used to resuspend the bacterial cell pellet. We then conducted a fluorescent spectrum scan using the Tecan Spark® Multimode microplate reader with excitation at 414 nm and emissions between 450 and 600 nm.

RESULTS

After screening all 13 strains, we transfected the polycistronic SUMO pathway into E. coli and monitored CyPet protein expression at 16, 24, and 48 hours post-transfection. These timestamps correlated to all our samples' growth, peak, and degradation periods. **Table 1** summarizes the highest CyPet protein expression measurements among the 24 samples of every E. coli strain, with BL21(DE3) PlysS presenting the highest fluorescence at 26459 RFU. Specifically, this peak is shown in the 24-hour induced polycistronic SUMO in BL21(DE3) PlysS qFRET scans at 475 nm (**Fig. 3**); the expected emission wavelength of CyPet when excited at 414 nm.

The resulting scans of Polycistronic SUMO in BL21 (DE3) PlysS (**Fig. 3**) at an excitation of 414 nm revealed a single broad emission peak consistent with the expected fluorescence profile of CyPet. Emission was measured from 450 nm to 600 nm, and all spectra were normalized to allow comparison between the 24 clones. While variations in intensity are observed, the overall shape of the emission curves remains consistent. The absence of a secondary peak supports the conclusion that CyPet is the sole fluorescent species present in the system. IAV M1 was introduced to the system as a YPet acceptor fluorophore to monitor the potential of protein-protein interactions via FRET. This positive peak was then cloned three times and re-induced as described in the SUMO Conjugation of SUMO to IAV M1 in *E. coli* section.

The high CyPet protein expression of Polycistronic SUMO in BL21(DE3) PlysS was further analyzed by comparing the mean CyPet fluorescence among all IN 13 electrocompetent *E. coli*. A confidence interval (CI) of 95% was used to estimate the true means of all strains, which, as observed in **Fig. 4**, supports CyPet high expression in BL21(DE3) PlysS and highlights its suitability as an E. coli host for the polycistronic SUMO construct. With a calculated CyPet expression mean of 19166.683 RFU, the true population mean was determined to be within [17491.548, 20841.818], the highest among the 13 transformed strains.

Electrocompetent E.Coli	CyPet protein Expression (R.F.U)
SHuffle® T7	18828
Rosetta 2(DE3)	22731
Rosetta 2(DE3) PlysS	21370
BL21(DE3) PlysS	26459
BL21-CodonPlus	19513
BL21(DE3)	25140
BL21-CodonPlus (DE3)-RIL	18368
Rosetta (DE3)PlysS	22210
OverExpress™ C43(DE3)	17843
OverExpress™ C43(DE3) PlysS	17618
E.Cloni® 10G (SOLOs)	19936
OverExpress™ C41(DE3)	25488
ArcticExpress (DE3)RP	22039

Table 1: Comparison chart of the highest CyPet fluorescent expressions at 24 hours of IN polycistronic SUMO in each 13 Electrocompetent E. coli listed, with the highest expressing strain underlined in black. control conditions.

To improve the consistency across the experiments, SUMO and M1 cultures were diluted to maintain a uniform starting optical density (OD) of 0.6 at 600 nm. This helps ensure reliable comparisons between induced and uninduced samples while reducing variability in fluorescence, which could be observed in **Fig. 5**, leading to consistent qFRET signals with positive CyPet-YPet energy transfer. FRET was used to validate the conjugation of SUMO1 peptide to the IAV M1 substrate. This allows for the detection of molecular proximity between two tagged proteins, CyPet (donor) and YPet (acceptor), when they are within 10 nm apart. Our system's shift from a single peak (donor only at 475 nm) to a double peak emission (donor and acceptor at 475 nm and 535 nm, respectively) demonstrates physical approximation between the SUMO enzymes and M1 protein.

These three clones again show the double peak pattern with one peak around 475 nm (CyPet) and a second distinct peak

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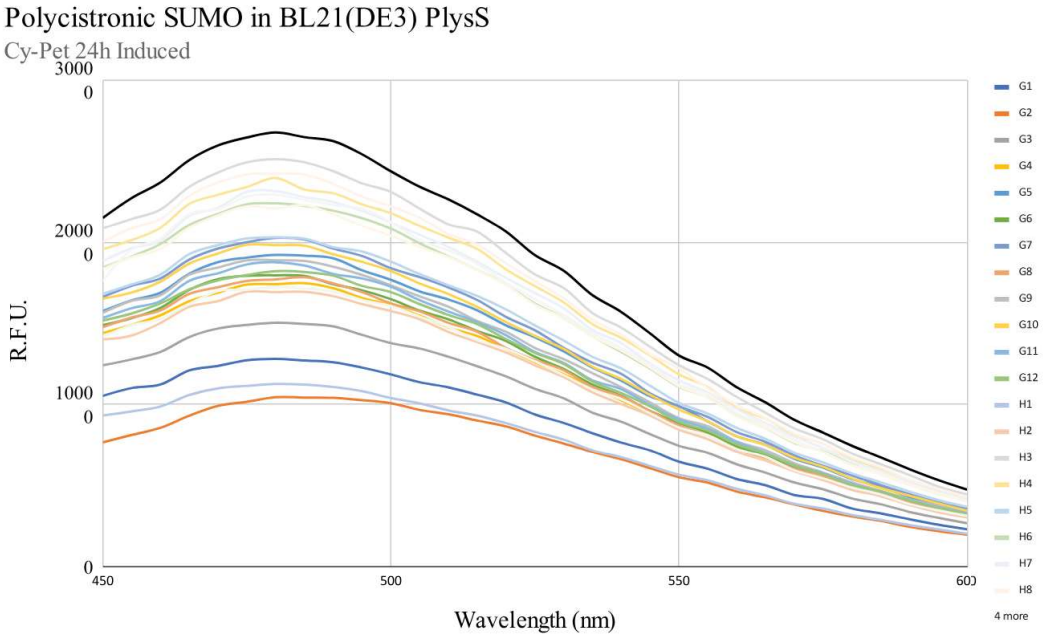

Figure 3: Fluorescence spectrum of polycistronic SUMOylation cascade containing CyPet-SUMO1 in bacterial cells. The pET28-polycistronic plasmid was transformed into the BL21(DE3) PlysS strain. 24 colonies were picked up and cultured for inductions of all proteins for 24hrs. Then bacterial cells were determined for the emission of CyPet-SUMO1 at the peak of 475 nm. The strain with the highest Relative Fluorescence Unit (RFU) was H11 in the BL21(DE3) PlysS strain, highlighted in black.

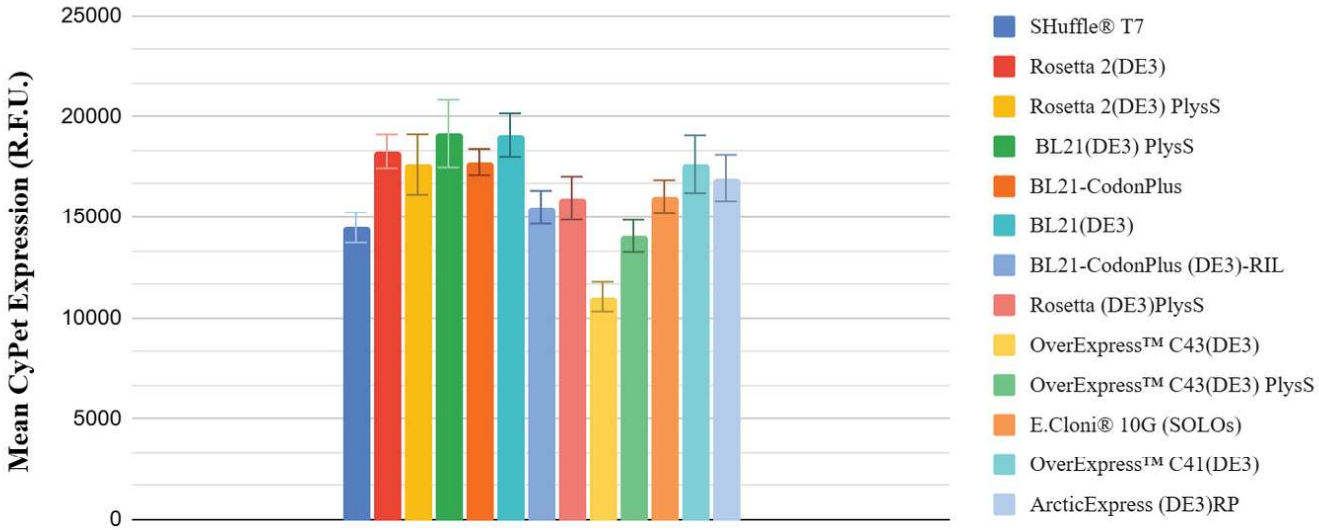

Figure 4: Mean CyPet Expression of Polycistronic SUMO in Electrocompetent cells: SHuffle® T7, Rosetta 2(DE3), Rosetta 2(DE3) PlysS, BL21(DE3) PlysS, BL21-CodonPlus, BL21(DE3), BL21-CodonPlus (DE3)-RIL, Rosetta (DE3) PlysS, OverExpress™ C43(DE3), OverExpress™ C43(DE3) PlysS, E.Cloni® 10G (SOLOs), OverExpress™ C41(DE3), and ArcticExpress (DE3)RP.

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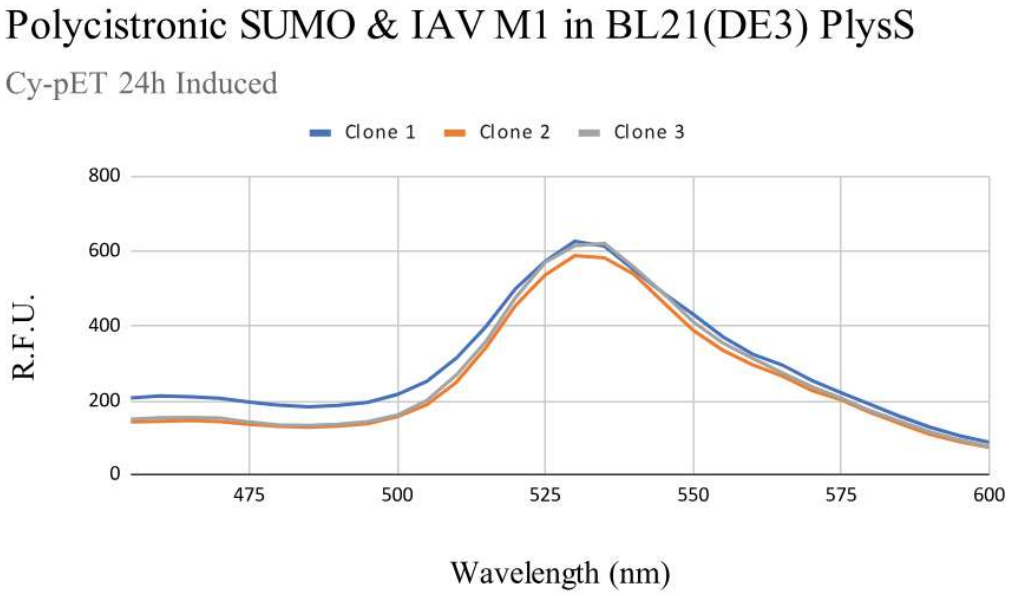

Figure 5: FRET emission of polycistronic SUMOylation cascade and YPet-IAV M1 in bacterial cells. The bacterial cells containing polycistronic SUMO were transformed into the plasmid containing SUMOylation substrate, pET16-YPet-IAV M1. After induction for 24hrs, the bacterial cells were examined for the FRET signal at 535 nm when excited at 414 nm for the FRET donor CyPet. The emission of bacterial cells at 530 nm indicates successful SUMOylation conjugation. (SOLOs), OverExpress™ C41(DE3), and ArcticExpress (DE3)RP.

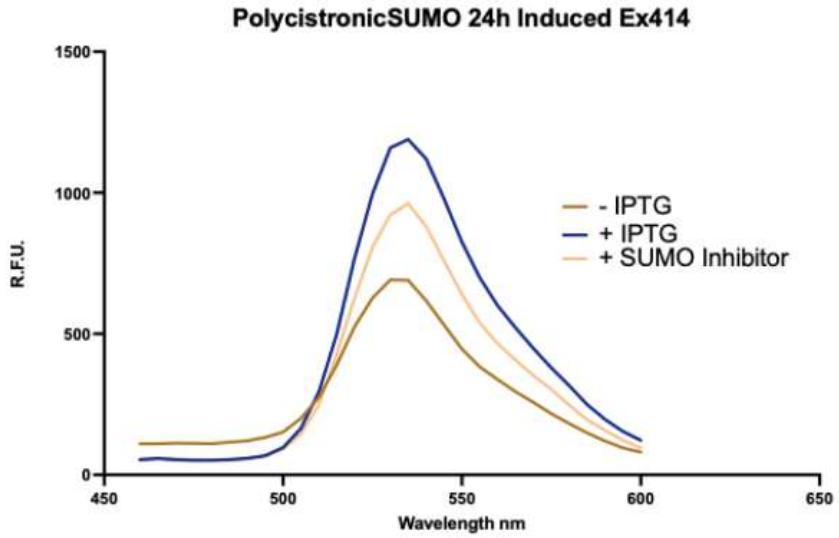

Figure 6: Polycistronic SUMOylation system in inhibitor evaluation. The reconstituted FRET-based SUMOylation system with synthetic biology in bacterial cells was used to evaluate the activity of SUMOylation inhibitor, STE, discovered in our lab. After the double-transformed bacterial cells were cultured to O.D. of 0.6 at 600 nm absorbance, both IPTG and SUMOylation inhibitor were added for another 24 hrs before the FRET signal was examined. The decreased FRET signal with SUMOylation inhibitor suggests that SUMOylation cascade is successfully inhibited in this assay with synthetic biology design of SUMOylation cascade.

near 520-530 nm (YPet). These emission scans revealed that the YPet peak signal was significantly more substantial than the CyPet signal, indicating the successful expression of both fluorophores. The observed increase in YPet emission, followed by the diminished CyPet fluorescence, is consistent with efficient FRET. This strongly suggests that the donor CyPet and YPet acceptor fluorophores are within close proximity, reflecting a successful interaction of the engineered protein system.

The M1 protein, which is SUMOylated in IAV, is essential for viral RNA trafficking and assembly. Following the SUMOylation enzymatic cascade to receive the FRET donor, CyPet, the M1 protein of IAV was first fused with the FRET pair acceptor YPet to function as a substrate in the SUMOylation experiment. Due to the proximity of the FRET donor and acceptor, the FRET signal was highly significant following the conjugation of the SUMO to the M1 (**Fig. 6**, +IPTG). The FRET signal showed that the inhibitor hindered this SUMOylation reaction (**Fig. 6**, +SUMO inhibitor). Bacteria pellets of Polycistronic SUMO are determined by Western Blot. The primary antibodies used in this study were anti-His (1:1000 dilution), and detection was performed using an anti-mouse secondary antibody (1:1000 dilution).

DISCUSSION

This study developed a successful polycistronic SUMOylation construct for expression in *E. coli*, representing a significant advancement in the application of synthetic biology and SUMO-IAV M1 research. By reconstituting the eukaryotic SUMOylation cascade in the prokaryotic system, we have begun to create an efficient platform for SUMO conjugation process to target substrates. Namely, the synthetic polycistronic SUMO construct was able to conduct the complete SUMOylation cascade to attach to IAV M1 protein in E. coli, as observed through the successful CyPet-YPet FRET in **Fig. 5**. This protein-protein binding was from the conjugation of CyPet-SUMO1 expressed in the polycistronic construct to substrate IAV-M1 through the catalytic reactions of E1, E2, and E3 (**Fig. 2**). The reconstituted SUMOylation pathway in *E. coli* overcomes limitations of in vitro mammalian systems, where maintaining cell culture and conducting enzymatic assays are costly and labor intensive.[23] The findings in our project can significantly aid in future SUMOylation research, providing an *E. coli* system alternative capable of quantitative analyses, similar to standard mammalian cultures.[23]

The polycistronic SUMO construct allows for the simultaneous expression of SUMO1 and the three enzymes (E1, E2, and E3), facilitating efficient protein expression and SUMO conjugation reaction to the substrate. From the 13 bacterial strains tested, BL21 (DE3) PlysS yielded the highest CyPet expression. This was because of the suppressed T7 polymerase expression in the PlysS plasmid that decomposes the T7 polymerase before induction to overcome the possible toxicity of downstream proteins. This enables both promoted polycistronic SUMO protein expression through IPTG induction and reduction of basal expression of the gene of interest under the control of T7 promoters, which is critical in protein expression of toxic proteins in *E. coli*.[15]

Limitations and Future Research

While polycistronic expression of the SUMOylation cascade in *E. coli* offers an accessible platform, the system presents limitations in assay reproducibility. A primary concern is the gene order within the polycistronic vector, as genes positioned downstream of the promoter tend to exhibit reduced expression levels. This effect could imbalance the relative amounts of E1, E2, E3 proteins being expressed. An imbalance could hinder modification since the SUMO pathway needs simultaneous activity of all three enzymes.[5,13] Additionally, intercistronic spacing between genes can influence translational efficiency. Both short and very long distances between ribosome binding sites (RBS) and start codons could potentially impair translation re-initiation.[14] This affects downstream protein levels, introducing the complex issue of tuning expression levels across the construct where stoichiometric ratios are essential for pathway functions.[14]

Another potential drawback involves translational coupling, a design used to enhance expression continuously in polycistronic operons.[13,14] This design is intended to improve downstream gene expression but can have unintended effects, such as ribosome drop-off or secondary structure formation interfering with internal RBS exposure. Such

unpredictability can destabilize expression and prevent efficient translation of SUMO1 or PIAS1.[14] A potential solution to determine if these issues are significant within our polycistronic SUMO system is to use a Western blot to verify protein expression of E1, E2, E3, and SUMO1. Certain modifications in the synthetic SUMOylation construct can also improve gene expression, such as adjusting the spacer region between the ribosome binding sites to the start codon. We can further utilize synthetic biology technology to identify optimal ribosome binding site distances to maintain translational efficiency while preventing ribosome drop-off and formation of secondary structures.[13] Additionally, we can include an upstream leader peptide in our construct to improve downstream gene regulation and overcome variability in re-initiation efficiency.

CONCLUSION

The synthetic biology polycistronic SUMO technology examined in this project shows great potential for future clinical applications. From our qFRET observations, the engineered construct yielded high protein expression rates. It reproduced the full SUMOylation cascade to bind to target substrate IAV M1 in *E. coli*, which opens possibilities for improved recombinant protein research and high-throughput screening in drug discovery. Eukaryotic cells are often complex and costly to maintain, especially when studying SUMOylation modifications with other target substrates. The Polycistronic SUMO construct allows for convenient and efficient induction of SUMO protein expression. It activates its cascade of supporting enzymes to express SUMO in bacteria without the tight regulation of other eukaryotic molecules in the system. Our engineered construct also avoids other eukaryotic post-translational modifications that can interfere with SUMOylation, isolating the pathway into bacterial cells to study specific SUMOylation effects.

Having shown high SUMO protein expression in bacteria, our polycistronic SUMO system can also be a more cost-effective method for drug screening, allowing ease to scale up in bacteria models and abundant proteins for interactions with different small molecule inhibitors. In recombinant protein research, our polycistronic SUMO construct creates a simultaneous expression of SUMO enzymes and proteins, allowing for better solubility, stability, and protein folding in large scale protein production. This is particularly valuable for difficult-to-express eukaryotic proteins, which often aggregate in *E. coli* due to improper folding. The ability to reproduce native SUMOylation pathways in bacteria allows us to study native and controlled SUMO-mediated modifications on various substrates outside of IAV M1, extending the synthetic SUMO construct application to structural biology, enzyme engineering, and functional protein assays.

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Exploitation of Women in the Nineteenth-Century French Department Store: Labor, Advertisements, and Surveillance in Émile Zola's *Au Bonheur des Dames*

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ABSTRACT

This paper investigates the exploitation of women, which became increasingly prevalent with the rise of newer models of commerce and the introduction of department stores in society. Émile Zola's 1883 novel, *Au Bonheur des Dames*, focuses on key themes of capitalism, the mistreatment of lower-class workers, and the inherent sexism women faced in nineteenth-century France. By focusing on the new modes of retail shopping that emerged in the late 1800s, Zola highlights the problems created by a consumer-focused society. The introduction of women into the job market created more barriers for them to overcome, as women were no longer just competing with men in the workplace, but were also directly competing with each other due to low base salaries and commission-based bonuses. However, a theme that has not been analyzed by scholars of Zola is the prominence of surveillance as a theme in *Au Bonheur des Dames*. Department store owners crafted brand-new advertising campaigns specifically targeting women. The use of male workers to deter shoplifting, along with the avoidance of police intervention when faced with thefts, presents a new argument: that women are exploited not only for their labor but also for their money as consumers. This analysis highlights how that the development of modern commerce and capitalism furthered the harm that women faced as both workers and consumers.

KEYWORDS: Exploitation of women, capitalism, department store, Zola, *Au Bonheur des Dames,* surveillance, nineteenth-century Paris

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In his 1883 novel *Au Bonheur des Dames* (The Ladies' Delight), French author Émile Zola (1840-1902) demonstrates the complex intersectionality among sexism, social hierarchies, capitalism, and the working class in his portrayal of a nineteenth-century Parisian department store. This exposition on the rise of modern commerce and a free market reveals the systemic problems that all capitalistic societies face: the mistreatment of the working class and further harm to marginalized communities. "The Ladies' Delight"—the fictional department store featured in Zola's novel—gives a glimpse into the organization of the class system that develops alongside the rise of consumerism and open markets. The poor and working class are forced to compete in sales to earn a meager living, whilst the rich command those below them and make far more while doing far less hard labor. Some of the most prominent themes in Zola's novel include class injustices, the abuse of workers, and the exploitation of women consumers and sales ladies. There have been a multitude of studies focused on analyzing the prominent themes in *Au Bonheur des Dames*, but there is an insight that scholars have not deeply engaged with: the use of surveillance to deter shoplifting and how it explicitly harms women.[1] Zola intricately develops a society within a society through his depiction of the department store, highlighting the mistreatment of workers and the store management's own "laws" as surveillance over women shoppers. This prompts the research question: How does Zola's depiction of modern commerce demonstrate that the rise of capitalism and consumer society leads to the exploitation of women? After examining the novel's portrayal of the abuse of saleswomen and the manipulation of female consumers, this paper concludes with a new insight not recognized in previous scholarship: the store's treatment of shoplifting represents another facet of exploitation of female shoppers.

METHODOLOGY

This paper uses a literature review of existing interdisciplinary scholarship and a close textual analysis of Émile Zola's Au *Bonheur des Dames*. The articles used include Susie Hennessy's analysis of desire and consumption in Zola's 1883 work, McBride's explanation of the gendered history of the department store in relation to the exploitation of laborers, and Fullerton and Punj's in-depth study of the history of kleptomania and marketing in nineteenth-century Paris department stores. In conjunction with these articles, a comparison to Michel Foucault's *Discipline and Punish* is utilized to understand the surveillance tactics described by Zola in his novel. These resources combined with a literary critique of *Au Bonheur des Dames* will be used to understand how women were exploited by capitalism and the development of modern commerce. To support this paper's claims, close textual reading of Zola's novel will be performed on several passages from the novel, including those that focus on the protagonist, Denise Baudu; the labor conditions of shopgirls; descriptions of the price wars waged between department store owner Octave Mouret and small shop owner Robineau; and case studies of two bourgeois women clients, Madame Marty and Madame de Boves.

This paper also delves into the intricacies of exploitation of women and consumer manipulation. As described by the *Stanford Encyclopedia of Philosophy*, "exploitation" is the use of an individual's perceived weakness or vulnerability to benefit oneself. In the case of female laborers and women as consumers, exploitation would mean using their perceived weaknesses and vulnerabilities as a disadvantaged group to increase profits in a capitalistic society. The understanding of consumer manipulation as a concept can be complex, which is why this paper focuses on it as a facet of the larger exploitative structures used to further harm women. As Janis Witte defines it in her paper, "consumer manipulation" can occur through the limitation of autonomy and "the feeling of being tricked" (2). Lastly, a definition of surveillance is necessary as the literature on it in relation to Émile Zola is lacking. Foucault's analysis on the topic explains that surveillance is a method of social control that results in social conformity and self-discipline due to the threat of persistent observation.

1). See Susie Hennessy's analysis on consumption and desire in female shoppers and Theresa M. McBride's examination of women as salesclerks in the department store.

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BACKGROUND

Émile Zola is widely known for being the creator of the naturalist movement in literature. Naturalism was inspired by the rise of rigorous scientific methods in this period and, as a literary movement, it sought to provide realistic depictions of life through observations. Zola's main literary work was the twenty-volume *Les Rougon-Macquart* series, of which *Au Bonheur des Dames* is the eleventh novel. The series explores common "social ills" and taboo topics such as alcoholism and criminality. *Au Bonheur des Dames* records the rise of the first Parisian department store and anticipates capitalism and modern commerce as we see them today.

Traditionalism vs. modernity is a common theme in Zola's works. He explores this concept by setting "The Ladies' Delight" department store in vicious competition with family-owned businesses. As the story progresses, the availability of a wide variety of mass-produced commodities, such as clothing, fabrics, and home goods, sold at incredibly low prices forced all other niche businesses that had existed for decades to shut down as they cannot compete with modern businesses tactics. Octave Mouret, the owner of the department store, creates a world of luxury that explicitly targets women with advertising and displays to generate massive profits. Zola uses Mouret and other male characters in his novel to expose misogynistic and sexist views—for instance, the belief that women are unable to control themselves as consumers—that reflected dominant attitudes in nineteenth-century France. Moreover, it is not just men's view of women that inherently perpetuates this patriarchal system in the department store, it is also the capitalistic competition that Mouret creates to foster higher sales. This is where Zola introduces the concept of incentive compensation to workers' average base salary wages, building a new form of competition among salespeople into the system that most businesses used at the time.

EXPLOITATION OF LABORERS

The impact of capitalism and modernity on the average worker is a significant and recurring theme in *Au Bonheur des Dames*. The first department Zola introduces in "The Ladies' Delight" is ladies' wear, where the main character, Denise, is given her first job in Paris. Denise is forced to wear a silk dress that is two sizes too big, and she can only afford uncomfortable work shoes that leave her feet in blisters. At the end of each day, she comes back to her room at the top of the store "haggard with tiredness" and sobbing to herself (Zola 115, 117). Zola perfectly depicts problems with modern commerce that were not seen as much with traditional family businesses. The working class is exploited, forced to brutalize their bodies and their minds to benefit the top 1%, while barely making a living wage for themselves. Denise yearns to make enough money to aid her two little brothers but has to deal with low sales, cruel coworkers, and other brutalities that retail workers must face.

Furthermore, despite dealing with physically painful work conditions, Denise is also made to deal with the competition between herself and the other women who work in ladies' wear: Marguerite and Clara. These two women berate, tease, and mentally torture Denise in the workplace, all of it witnessed by Madame Aurélie, the head of the ladies' wear department. Why are some of the few women with the opportunity to work for their families and earn a wage fighting within their own group? Zola utilizes Marguerite and Clara to expose the complexities that arise from commission-based sales. Denise is a vulnerable newcomer to the store, and, as Zola demonstrates, it is easier for the other saleswomen to pick on her and force her to lose out on sales than to compete with each other. The first meeting among the three young women is when both Marguerite and Clara are rushing and pushing past each other to be the first to arrive in ladies' wear for the day (Zola 88). A similar phenomenon occurred in nineteenth-century France, as McBride notes, "if the debutant could withstand the… often heavy-handed surveillance of other salesclerks, she had a chance to enter the ranks of the relatively well-paid saleswomen" (667-668). Thus, the first to arrive would get the first customer and, therefore, had a better chance of getting more sales and earning more money for herself. Exploiting women to create more competition and generate more profit for the "machine" (28), as Zola describes Mouret's department store, is exactly what modern capitalism does. The popularization of commission-based wages is seen in *Au Bonheur des Dames*; the more sales the women get the more money they earn and the faster they can climb the social hierarchy ladder to success. What both Denise and her

Exploitation of Women in the Nineteenth-Century French Department Store: Labor, Advertisements, and Surveillance in Émile Zola's *Au Bonheur des Dames*

coworkers go through are key examples of the exploitation of the working class and the exploitation of women workers due to capitalism and modern commerce.

In addition, the discrepancy in treatment of men and women during hiring and firing at the department store adds another layer of sexism to the social hierarchy. During the summer "off" season a lot of the seasonal employees, and employees that do not bring in enough sales, are fired. This disproportionately affects the women workers as they have enough trouble and hardships attempting to find a job at the department store, and are then are out of luck attempting to find a job anywhere else (Zola 54-57). Most of the men who end up fired can work elsewhere in construction, or other "masculine" blue-collar jobs, whilst women are underrepresented and are unable to work in those fields due to sexist ideologies. After exploiting them during the rush of holiday seasons, Zola shows that Mouret will simply fire them with no regard for their well-being.

We can see a specific example of this when Denise is wrongfully terminated from her position in ladies' wear (Zola 174). Although the female workers all share a living space on the upper floors of the store, those who are fired are immediately removed from the premises and forced to find a new place to live. There are no safeguards or alternative structures to aid a young woman in getting back on her feet after losing her (barely) livable wage job. In contrast, Deloche, a male worker in the lace department, is permitted to sleep under a desk on a cot rather than out on the streets alone at night (Zola 148). By highlighting gendered differences in the experiences of Denise and Deloche, Zola exposes the contradictions in the treatment of men and women workers in nineteenth-century France.

Throughout the novel, Zola uses metaphors to describe "The Ladies' Delight" as representing a factory floor and being machine-like in its operations. He emphasizes the almost clockwork opening and closing of the store and how each worker plays a part in either buying, selling, or checking out customers. Rather than viewing his workers, especially his female workers as individuals with needs, Mouret treats them like cogs in a machine. Once one worker no longer provides use, in this case, sales, they are destroyed and removed from the machine so that they will not harm the store's profits. These ideologies became commonplace in the 1840s to 1860s, as the main use of salespeople was as gears churning in the machine by letting goods "sell themselves" with flashy displays (McBride 665).

EXPLOITATION OF CONSUMERS

Case Study 1: Madame Marty

However, it is not only female workers who face the issues that arise from capitalism and modern commerce. Another facet of economics and politics is advertising, which explicitly targets female consumers. Mouret's business techniques are crafted perfectly by Zola to show not only Mouret's genius for business, but also his internal biases that lead him to specifically prey upon female consumers. An example of this would be Madame Marty, one of the main shoppers in *Au Bonheur des Dames*. Zola describes Madame Marty as "A thin woman… ugly, ravaged by smallpox…" who is "unable to resist temptation" of department store goods (Zola 61). She spends all of her husband's small salary under the influence of advertising due to the pressure of a variety of sales and deals. Zola utilizes Mouret to demonstrate corporate greed and the idea that the rich do not care about the lower class, even if they claim otherwise. Mouret spends thousands of francs on advertising each year and promotes incredibly low deals on a few items to manipulate women consumers into believing that every item they purchase is a "steal."

Madame Marty is portrayed as a woman who always gives into her vices, and she desperately works to hide her purchases from her husband. She understands that her family does not have much money, and she does not work, but she is still described as a woman shopper who cannot resist purchasing the goods that Mouret advertises via displays and personally to her. This idea is furthered in Susie Hennessy's article on consumption in the novel, as she explores the complexities of "identities for sale" that Zola presents. She explains how Mouret's window displays represent what the female consumers can become: "Their headless-ness reinforces the adaptability of this idealized image" (Hennessy 699). Women shoppers are encouraged to visualize themselves as the highly sexualized and objectified headless mannequins, like the ones that the department store

uses in its displays. In addition, Madame Marty is one of Zola's ways of critiquing (or perpetuating) the stereotype that women love to shop and are not capable of ignoring those "temptations." He uses words such as "ugly," as compared to some of the other female shoppers, and "ravaged by smallpox" to represent her physical characteristics and her powerlessness against temptation as an illness.

Another scene in which Zola illuminates modern business practices that are supportive of the manipulation of consumers is the sales war between Mouret and Robineau. The latter was previously an underling of Mouret's who creates his own small business to compete with the department store. After Robineau loses his main source of income due to unfair layoffs, he spends his wife's fortune to craft his own business to compete with the monopoly the new department store has created. Unfortunately, small businesses are not profitable enough to sell large quantities of a variety of products at extremely low prices. "The Ladies' Delight," however, can do just that. Robineau creates a beautiful silk fabric that he intends to sell at a lower price than that offered initially at the department store. Mouret then lowers the prices of his fabrics and advertises them in the newspapers to bring back his female customers, causing Robineau to respond and lower his prices yet again. The cycle continues until it is obvious that both stores are losing significant profit just to keep and attract customers, which inevitably leads to Robineau's business losing (Zola 193-94).

Competition between traditional and modern businesses is not the only theme that Zola attempts to highlight in this interaction. Zola also points out the middlemen (or women) in this situation, which are the women customers buying the rare silks. The advertising argument between the two egocentric men becomes a fight over their customers. Both Robineau and Mouret lower their typical prices to unprofitable numbers just to garner more sales and customers. Women are at the forefront of their minds, but the shop owners do not realize it. The women become numbers and statistics due to corporate greed. This section of the novel also demonstrates the effects the new commerce has on family-owned businesses, as they are forced to bow down to the prices and strategies of the "top dogs" to even stand a chance of keeping their livelihoods. In the novel, traditional family businesses find themselves giving up their ethics, morals, and even customer values to compete with a monopoly, only to lose in the end.

EXPLOITATION THROUGH SURVEILLANCE

Another example of the manipulation and exploitation of women can be seen in the department store's theft prevention and robbery policies. To prevent or catch potential robberies, Zola uses one of the shop workers, Inspector Jouve, as a version of a modern-day undercover employee. The store's management sends one of the stronger men who work there to follow around "suspicious" women to catch them in the act of stealing. It is almost like fishing, with Mouret as the fisherman who utilizes bait—the glorious fabrics and goods sold—to reel in the fish, the poor, female consumers with deals and everything imaginable, but is surprised when they take the bait.

Case Study 2: Madame de Boves

Madame de Boves is one of the most prominent lady shoppers who frequents "The Ladies' Delight," and who is caught stealing. Zola depicts her vice—kleptomania—as most similar to lust, and she is also unable to resist temptation like Madame Marty. However, her husband provides her with even less money than the latter, so despite being an aristocrat Madame de Boves is lower in the economic hierarchy. She, therefore, has a harder time resisting the beautiful luxuries plastered all around her whilst in the department store. Once Inspector Jouve catches her "slipping lace" (Zola 410), she is forced to come into an office alone with men to discuss her crime.

As scholars Ronald A. Fullerton and Girish N. Punj have studied, Paul Dubuisson, a French alienist and early psychiatrist, produced a study in 1901 analyzing reports of shoplifting in over one hundred Parisian department stores (10). Dubisson gives the story of a woman known as Madame G, who "had been arrested on September 3rd at 7:00 PM in Printemps [department store]... having concealed under her garments a silk garment…" (qtd. in Fullerton and Punj 10). Late nineteenth-century Paris saw a multitude of tales of upper-class women stealing from the prominent department stores that lured them. The response to a shoplifting incident in a department store could have been to contact law enforcement, work with them to arrest

the perpetrator, and retrieve the stolen items. In contrast, Zola reveals that Mouret's actions are motivated by the exploitation of women through attempts to keep the fantasy of the luxurious department store alive.

Thus, rather than approaching law enforcement and merely requiring Madame de Boves to give back the items, Mouret and his underlings instead push for a more immoral and unethical guideline. They make the thief, in this case the well-known Madame de Boves, sign a paper that states she stole from the store and will pay them two thousand francs (Zola 412). This example shows that rich business owners prioritize profits over everything else. Zola enhances this argument by pointing out how Mouret's advertisement techniques specifically target women, putting out deals and beautifully cheap designs that reel them in. Instead of dealing with theft legally or ethically, Mouret keeps the stealing hidden from public view to maximize profits and ensure women feel "safe" and keep coming back to his store. Mouret aims to make the store a place where women can become the fantasy version of themselves, whilst also actively harming women with manipulation tactics and abrasive policies to maintain the facade of an "escape from reality" the store provides (Hennessy 700).

CAPITALISM AND SURVEILLANCE

Similarly, a strong argument that derives from Zola's depiction of this scene is how the rise of surveillance is connected to the rise of capitalism. Although theft may have been apparent in smaller, family-owned businesses, the sheer size and number of products displayed and sold at "The Ladies' Delight" leads to an extreme increase in the potential for theft, so much so that management makes their male workers follow women around the store, stereotyping and profiling them based on their dress and attributes. Mouret and the other male managers assume that the women more likely to steal are those who are pregnant and those who are least able to afford the store's expensive, luxury goods, specifically the poor and working class. The mistreatment of women as consumers and the stereotyping and prejudice against poor and working-class women work in tandem to marginalize them further, especially with capitalism and other social systems at play.

The department store can be seen as a sort of prison which entraps women with its alluring commodities and forces them to forever yearn to attain them. Hennessy furthers this idea by mentioning that the store is "a self-contained, enclosed environment in which desire is never entirely fulfilled" (705). Moreover, the comparison of a prison proves true when viewing Zola's novel through the eyes of Foucault's *Discipline and Punish*, in which he discusses the changes in the legal and prison systems in France during the early 1900s. Foucault depicts the mistreatment of the judicial system by painting a picture of guards standing watch above the "prisoner," looking down on them both metaphorically and literally (Foucault 50). This can be seen with Mouret, representing a prison guard as he stands on the top floor bannisters of "The Ladies Delight," overlooking all the shoppers in the store (Zola 415). The use of Inspector Jouve and other male managers to silently and quickly apprehend shoplifters and bring them to the back office was "to prevent any escape or show of force" (Foucault 50). Mouret strategizing ways to keep the "fantasy" alive and uphold a facade of "safety" within the department store is another way of preventing backlash from the women shoppers. It is not only women being manipulated and misled by the tactics of the store's owners, but it is also the intentional imprisonment of women consumers, locked away by their own desires which were exploited to begin with.

IMPLICATIONS FOR THE MODERN WORLD

Although Zola's novel is set in the 1880s, it is still relevant today. Its portrayal of the implications of some of the founding uses of surveillance in department stores and in modern capitalism can be seen bleeding into current business practices. For example, the creation and implementation of self-checkout aisles in retail stores can be seen as the modern replacement for a "Mouret;" the cameras angled to constantly watch shoppers scan their items, sometimes with facial recognition, is the new way to deter shoplifting rather than utilizing only employees. Zola documented the late nineteenth-century version of this practice and predicted the inevitable effects of capitalism and the exploitative tendencies in which it results. It is beyond the scope of this present paper, but future research might explore the impacts of changing methods of surveillance in the practices of

consumption both in relation to in-person contexts and online consumerism.

CONCLUSION

In *Au Bonheur des Dames*, Émile Zola demonstrates the exploitation of women, both as salespeople and as consumers. Set against the rise of capitalism and other forms of modern commerce which took the nineteenth-century city by storm, Zola's novel shows that his fictional version of Paris's flagship department store, "The Ladies' Delight," furthered opportunities to manipulate and use women for the benefit of rich men. By forcing young women to compete with each other due to commission-based sales, the conditions of the new retail system made it almost impossible for working women to climb the social ladder. Moreover, advertisements targeting women as consumers with low prices reeled women in and entrapped them with a taste of the luxury goods offered. Even when allowed opportunities to leave the house to work or shop, women were still persistently monitored and exploited to increase the profits of the store owners. This essay builds on Zola scholarship by calling attention to the issues with surveillance, with the use of male workers to deter shoplifting and the avoidance of police intervention when faced with thefts as compounding the exploitation of not only women laborers but also consumers. As such it joins broader research on Zola's novel *Au Bonheur des Dames* concerned with the rise of modernity in relation to the mistreatment of the working class and women across the socio-economic spectrum.

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Enhancing Career Readiness in Introduction to Psychology

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ABSTRACT

Even though most undergraduate psychology students enter the workforce directly after graduation, psychology programs often lack adequate career preparation components. The American Psychological Association (APA) recognized this deficiency in their 2023 Guidelines for the Undergraduate Psychology Major, which emphasize the critical need to develop transferable skills for career success. The current study uses a pre- and post-survey design to examine the effect of career readiness activities on student career readiness in an Introduction to Psychology course. The goals are twofold: to identify techniques to fill the gap identified by the APA by preparing undergraduate students for the workforce, and to contribute to the literature on the scholarship of teaching and learning by examining teaching practices in large courses (e.g., 100+ students). Students were presented with four recorded workshops (e.g., resume, cover letter, internships, networking) from the UC Riverside Career Center throughout the span of 10 weeks and engaged in related activities during their discussion sections. Results showed a significant increase in students' career development, $t(16) = -2.36$, $p < 0.05$, and leadership competence $t(16) = -2.15$, $p < 0.05$, between the pre- and post-surveys. This study aims to enhance psychology majors' and non-psychology majors' experience through innovative teaching approaches.

Keywords: Career Readiness, Transferrable Skills, Psychology

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INTRODUCTION

While graduation is supposed to be an exciting moment and a great accomplishment, this may not be the case for many undergraduate students. Graduation may feel daunting if students do not feel adequately prepared for the workforce. For some students, graduating without a prospective job or the necessary skills to conduct an effective job search may result in a setback or an inability to find employment in their acquired degree. Research indicates that only a small fraction of students majoring in psychology go on to attain a higher degree in psychology (Appleby, 2018). More than half of undergraduate psychology students (66%) go on to the workforce right after graduation, making career readiness particularly crucial for the majority who will directly enter the job market (Hamilton et al., 2018). Unfortunately, undergraduate psychology programs frequently fall short in fostering career readiness (APA, 2023). Furthermore, faculty may sometimes pay closer attention to those who plan to go to graduate school (Appleby, 2018), providing focused mentorship to a few while the majority remain without proper career guidance. The lack of attention to students who choose to work right after graduation may put them at risk of being unprepared for the workforce and unable to communicate the relevant skills they've gained in their degree.

The lack of career readiness in undergraduate psychology education is not a recent issue, but a topic that has long been a concern. Every seven years, the American Psychological Association (APA) releases guidelines for the Psychology major (Appleby, 2018). In 2023, the APA issued a recommendation for implementing personal and professional development (Goal 5) in the Psychology major. Goal 5 in the APA psychology major handbook states the importance of students attaining career readiness skills to prepare them for the workforce, if their plans are to work right after their associate or bachelor's degree or to continue on to graduate school (American Psychological Association [APA], 2023). Still, this is not a new topic for the APA, as previous versions of the handbook also underscore the need to implement career readiness to prepare students for employment or further study (APA, 2013).

College degrees are seen as opportunities for better career options (Ciarocco, 2017). Unfortunately, there is often a disconnect between employer expectations and what recent graduates believe will lead to career success (Cheang & Yamashita, 2023). Students may hold the erroneous belief that grades or discipline-specific knowledge alone will be enough to find or maintain a job, but research has shown otherwise (Cheang & Yamashita, 2023). Employers look beyond what is taught in the classroom and value soft skills above technical knowledge (Cheang & Yamashita, 2023). Cheang and Yamashita found that 62% of the employers surveyed expressed reluctance to hire recent graduates who lacked soft skills (2023). Attaining career ready skills is not only essential to maintain work, get a job, or advance in your career (Schweinsberg et al., 2021), but it is also a crucial tool when job searching, especially for recent graduates. As the workforce continues to evolve and advance, the importance of transferable skills is likely to increase (Ciarocco, 2017). This poses a challenge for college students who either lack these career-ready competencies, or do not know how to communicate the skills they have gained. Students would benefit from instructors identifying the skills they are learning within the coursework and describing how to market and use the skills in the future (Troisi, 2021). Despite the lack of career readiness being an established issue, there is little research linking career readiness and pedagogy to increasing work ready competence via undergraduate courses (Schweinsberg et al., 2021).

To increase transparency in employer expectations from recent higher education graduates, the National Association of Colleges and Employers (NACE, 2021) identified eight career readiness competencies, which include career and self-development, communication, critical thinking, equity and inclusion, leadership, professionalism, teamwork, and technology. The NACE career competencies overlap with the areas of skill development suggested by the APA and offer a useful metric to assess career readiness in undergraduate students. Some university career centers, for example, are already using the NACE career competencies to design workshops to help students develop these skills. Clear career competencies may help students know what skills they are gaining in a course and how to use them in a professional setting.

Few studies have investigated ways to implement career readiness directly into psychology course curricula. Troisi

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(2021) examined two approaches to implementing career readiness: first, implementing skill-based instruction in an advanced psychology lab course, and second, bringing in a career specialist from the career center. By implementing both approaches, Troisi (2021) targeted both discipline-specific skills and career readiness. Results showed that students who participated in both the skill development and career readiness course showed improvement over time as opposed to the comparison group (Troisi, 2021). Researchers in Australia implemented a work integrated learning (WIL) experience into the curriculum of psychology capstone courses (Hamilton et al., 2018). Engaging in WIL enabled students to link what they were taught in the classroom to actual practice, which increased their self-esteem, social skills, and network opportunities (Hamilton et al., 2018). Given the focus of these studies on lab or capstone courses, it remains unclear if incorporating these types of techniques would work to increase career readiness in other types of courses, such as large lower division undergraduate psychology courses.

The Current Study

The critical need for developing and communicating career readiness skills in the undergraduate curricula has been identified both in a lack of empirical research and by the APA. The present study aims to examine the effect of career readiness activities on student career readiness competence in a large enrollment Introduction to Psychology course. Students were exposed to four recorded career workshops (e.g., resume writing, cover letter writing, internships, and networking) designed by the UC Riverside Career Center during their discussion sections. To preview our results, we found significant differences in pre- and post-survey results for students' career development and leadership competencies.

METHOD

Participants

Participants were undergraduate students at the University of California, Riverside, recruited from an Introduction to Psychology course. The class consisted of about 556 students. There were 67 students who completed the pre-survey with valid ID's (i.e., they included their name) and 43 who completed the post-survey with valid ID's. Students were excluded if they failed to complete both the pre- and post-survey. The final participant sample consisted of N = 17 undergraduate students. Participants ranged in age from 18 to 21 years (M = 19.41), with 7 identifying as female, 9 as male, and 1 as non-binary. The sample included students across all undergraduate years (First-year: 6, Second-year: 5, Third-year: 3, Fourth-year: 3). The study was approved by the Institutional Review Board at the University of California, Riverside. Students were not compensated, as the study was integrated within the normal design of the course.

Measurements

Career Readiness

Career readiness can be defined as the ability to exercise skills needed for employment (e.g. communication, leadership, problem solving, resume writing, etc.). Career readiness was measured using the NACE Career Readiness Competencies Questionnaire (NACE, 2021). The NACE Career Readiness Competencies Questionnaire (NACE, 2021) measures career and self-development, professionalism, communication, equity and inclusion, critical thinking, teamwork, leadership, and technology. Each area has between five to six statements which are graded based on expertise level (e.g., novice, developing, proficient, and mastery) but for the purpose of the present study these were adjusted to fit a 7-point Likert-scale with 1 = "not at all true of me" and 7 = "very true of me.". Survey questions were distributed through pre- and post-surveys administered via Qualtrics.

The Career and Self-Development competence was measured by statements such as "I seek out opportunities to learn" and "I embrace opportunities to increase my professional awareness and confidence" (NACE, 2021). Professionalism competence was measured by statements such as "I am present and prepared for tasks" and "I consistently meet or exceed goals and expectations" (NACE, 2021). The area of Communication competence was measured by statements such as "I employ active listening, persuasion, and influencing skills" and "I communicate in a clear and organized manner" (NACE, 2021). Equity and Inclusion competence was measured by statements such as "I am open to new and diverse ways of thinking" and "I advocate for inclusive, equitable practices" (NACE, 2021).

Critical Thinking competence was measured by statements such as "I proactively anticipate needs and prioritize action steps" and "I multi-task effectively in a fast-paced environment" (NACE, 2021). Teamwork competence was measured by statements such as "I build strong, positive working relationships with others" and "I am accountable for individual and team responsibilities" (NACE, 2021). Leadership competence was measured by statements such as "I am a role model to others with my confidence and positive attitude" and "I plan, initiate, manage, complete, and evaluate projects" (NACE, 2021). Technology competence was measured by statements such as "I use technology to improve efficiency and productivity in my work" and "I quickly adapt to new or unfamiliar technologies" (NACE, 2021).

Procedure

The study was conducted over the span of a 10-week quarter. In week 1, a member of the experimental team attended class discussion sections and provided a link to access the pre-survey. Survey questions were administered using Qualtrics and took approximately 10 minutes to complete. Students were also asked demographic questions including year of study, work, student status (i.e., first-generation, transfer, primary caregiver) and reason for taking the class. This same data collection procedure was repeated in week 10 with the post-survey.

Career Readiness Activities

The Career readiness activities were conducted in weeks two, four, seven, and nine in class discussion sections, facilitated by course Teaching Assistants. Students watched clips of recorded workshop videos from the Career Center during the first 10 to 15 minutes of class and then used the remainder of the class to engage in hands-on activities related to the videos. The Career Center workshop videos were retrieved from the University of California, Riverside Career Center website. The videos were examined thoroughly, and notes were taken to indicate important time stamps, which were then re-examined to choose which clips were going to be shown to the students.

In week two, students watched a workshop on resume writing. The resume workshop covered skills such as communication and career and self-development. After the video, students used the remainder of class time to consider the workshop advice and update their resume. In week four, students watched clips of a workshop video on writing a cover letter. The cover letter workshop covered skills such as career management and oral/written communication. After the video, students were given mock job descriptions and asked to write a cover letter for one of the positions and submit the assignment on Canvas. In week seven, students watched clips of a video on internships. The internship workshop covered skills such as critical thinking, career and self-development, and communication. After the video,

NACE Competence Scale	Pre-test α	Post-test α	Number of Items
Career development	0.87	0.79	6
Communication	0.85	0.89	5
Equity & inclusion	0.86	0.90	6
Leadership	0.89	0.88	6
Professionalism	0.91	0.90	6
Teamwork	0.91	0.88	5
Technology	0.89	0.84	5

Table 1

Note: Pre-test values represent the initial assessment, while post-test values represent measurements taken after the intervention. All itmes were assessed using the NACE competence scale.

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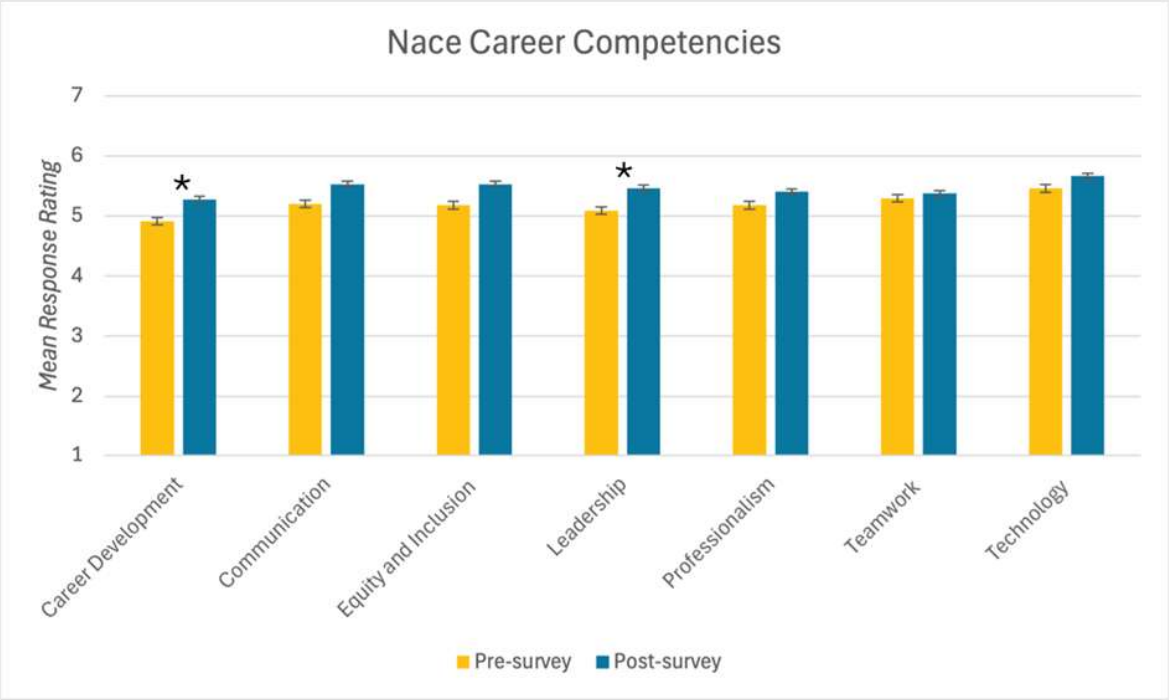

Figure 1: The average pre- and post-survey Likert scale response for each NACE career competency. Error bars indicate standard error. We found a significant difference in two out of the seven competencies: Career and Self Development, and Leadership.

Significant difference (*)

students were asked to log into the UC Riverside Handshake website (an online platform where students can connect with potential employers) to see how they could search for future internships or jobs. The last workshop was held during week nine, in which students watched clips of a video on networking. The networking workshop covered skills such as career and self-development, professionalism, and communication. For this workshop, students were given sample networking prompts and had the opportunity to practice networking with each other and with the teaching assistant.

The purpose of the study was to expose students to career ready skills and examine if this has an impact on career readiness competencies in Introduction to Psychology students as defined by NACE. Each workshop had a set of skills students would gain (e.g., career and self-development, communication, professionalism, and critical thinking). Students were presented with a list of these skills at the beginning of the workshops. We hypothesized that implementing hands-on career readiness activities into the curriculum of an Introduction to Psychology course would positively impact students' career readiness competence by the end of the 10-week quarter.

RESULTS

The NACE Career Readiness Competencies Questionnaire (NACE, 2021) was divided into subgroups, which represented the different subscales of the questionnaire: Career and Self-development, Communication, Equity and Inclusion, Leadership, Professionalism, Teamwork, and Technology. Figure 1 shows the average pre- and post-survey

response ratings for each competency. A paired sample t-test was used to analyze the difference between pre- and post-survey scores for each subgroup.

We found a significant difference in career and self-development competence ($M = 4.91$, $SD = 0.93$) in the pre-survey when compared to the post-survey ($M = 5.27$, $SD = 0.81$), $t(16) = -2.36$, $p < 0.05$. In addition, there was a significant difference in leadership competence between pre-survey ($M = 5.08$, $SD = 0.89$) and post-survey ($M = 5.46$, $SD = 0.94$), $t(16) = -2.15$, $p < 0.05$. For both competencies, students indicated having higher competence in the post-survey compared to the pre-survey. All other competencies were not significant ($p > 0.05$).

DISCUSSION

The current study aimed to examine if the implementation of career readiness activities in an Introduction to Psychology course impacted student career readiness. For career readiness, two out of the seven subcategories—leadership and career development—showed a significant change between the pre- and post-survey. Due to the relatively small sample size, we were not able to analyze the demographic data to see if there were any differences that were significant between class standing (e.g., did both lower and upper division students see an impact in career readiness?), ethnicity, gender, etc.

The increase in career development and leadership competency aligns with previous literature (Hamilton et al., 2018; Troisi, 2021). The implementation of hands-on career readiness activities appeared to have a significant correlation with the increase in students' career development and leadership competence. Troisi (2021) and Hamilton et al. (2018) saw similar results with an increase in career ready skills after students participated in hands-on skill development activities. There is little to no literature following students after career readiness interventions into post-graduation job placement, although career development skills have been found to increase career readiness self-efficacy which influences positive career choices. An increase in career development may help students seek job employment and maintain a job after graduation.

This study was one of the first to assess career readiness in a large-enrollment (e.g., 100+ students) undergraduate psychology course. A benefit of the current study design was that the workshop videos and activities were facilitated during the discussion sections, which did not take time away from covering course material in the lecture. Furthermore, the discussions sections allowed for small group hands-on activities that reinforced the material from the workshops. Students were able to engage in networking activities in small groups as well as work alone on individual activities. Students were able to interact with the teaching assistants throughout the activities. The study did not only attempt to implement an innovative teaching method in a large-enrollment course, but it also addressed some of the concerns brought out by other studies regarding students' lack of knowledge of the skills they are gaining. At the beginning of each workshop, students were given the list of skills they would develop with each workshop. This allowed them to be aware of the skills they gained and provided a chance for further development.

The current experimental design had several limitations. The content covered in the workshops was broad and not specific to the material covered in the course. Second, there was no control group for comparison, which could control for confounding variables that might affect the difference in career competence between pre- and post-survey. For example, we were not able to rule out if major or class standing may have had an effect on the results, since some majors like business or education are already career ready focused. Therefore, students in majors such as business may be exposed to career readiness skills early in their education. Because of this, we cannot draw any cause-and-effect conclusions based on the results of the current study. Finally, we had a relatively small sample size (17 students completed both the pre- and post- questionnaires, out of a class of approximately 556 students). Our sample may not be fully representative of the students in the course, and we did not have enough data to analyze the demographic data. The small sample size might have stemmed from the voluntary nature of the surveys—students were not required to complete the surveys. Additionally, a majority of the pre- and post-survey responses did not have any identifiers to link them together. This made it difficult to match pre- and post-surveys, resulting in a smaller sample size.

These limitations underscore several opportunities for future research. A future study should include a control group to control for confounding variables (e.g., year standing, major) that may skew the results. This would allow researchers to examine if certain activities cause changes in student career readiness. Changing the structure of how surveys are administered in the course (e.g., requiring them as part of the class), may increase the sample size. Having a representative sample size would allow researchers to examine if the activity has the same effect for all students.

Another future direction would be to conduct a longitudinal study to see how the implementation of career ready activities into the curriculum may affect students' career readiness over time. This would allow researchers to gain insight into how these methods can be used in upper division courses and the effects they have beyond the classroom. Implementing career readiness activities into upper division courses can allow for a focus on more complex career skills.

Other future studies conducted in the classroom can make the surveys required as part of the course. Furthermore, students can be given a unique de-identified tracker to connect pre- and post-surveys, since some students did not include their ID in the present study. These interventions could resolve the small sample size.

Future studies can also examine a link between motivation and career readiness. It would be interesting to investigate if extrinsic motivation or intrinsic motivation plays a part in career readiness and classroom success, as previous studies have found a relation between motivation and learning behavior (Tokan & Imakulata, 2019).

CONCLUSION

Career readiness in the classroom is still a novelty to a certain degree, and with the few available studies yielding positive results, it is imperative that we continue to explore this topic. The disconnect between student and employer expectations is also concerning. Today, transferable work-ready skills are valued more highly than discipline specific technical knowledge. This study can serve as a stepping stone for future research that may delve deeper into the implementation of career ready teaching methods in large-enrollment courses.

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Progesterone and estrogen influence baseline breathing parameters and chemoreflexes in menstruating women

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ABSTRACT

The hypoxic and hypercapnic ventilatory responses (HVR, HCVR, respectively) are the reflex increases in breathing in response to decreases in arterial oxygen or increases in arterial carbon dioxide partial pressures. These reflexes are highly variable both within individuals because of pathologies or environmental exposures, as well as across populations. However, the mechanisms underlying individual variation in these responses are still under investigation. Despite decades of research examining the effects of sex hormones progesterone and estrogen on ventilatory chemoreflexes, there remains no strong consensus and data are conflicting. Some studies have reported differences in the HVR in menstruating women compared to men and postmenopausal women, but few studies investigate this link further, and data within menstruating non-pregnant women are less conclusive. Understanding hormonal effects on ventilation could illuminate differences in risk factors and responses to control of breathing disorders. We directly measured plasma progesterone and estradiol levels and the HVR and HCVR using the Duffin modified rebreathing chemoreflex method, in 40 healthy, nonpregnant women. Our results indicate that higher progesterone levels were not associated with HVR, HCVR or the ventilatory recruitment threshold when measured in hyperoxic (inspired P_{O2} = 228 mmHg) or hypoxic (end-tidal P_{O2} = 50 mmHg) conditions, especially when adjusting for age as a covariate. Our results indicate a positive correlation with total ventilation and estradiol when adjusting for age as a covariate ($F(1, 77) = 16.9063$, $p = 9.739e\text{-}5$). Overall, these findings indicate that the impact of progesterone on the isocapnic HVR in menstruating women may be moderate at lower hormone levels, while estradiol seems to influence baseline ventilation. By analyzing these relationships, we can better understand the cause of sex-based differences in respiratory health.

KEYWORDS: Ventilatory chemoreflexes, menstruation, progesterone, estradiol

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INTRODUCTION

The hypoxic and hypercapnic ventilatory responses (HVR and HCVR, respectively) are the reflex increase in minute ventilation in response to hypoxic (low oxygen) or hypercapnic (high carbon dioxide) conditions. These ventilatory reflexes, as well as baseline respiratory drive, vary within and across individuals. For example, the HVR changes during acclimatization to sustained hypoxia (Pham et al., 2021) and in pregnancy (García-Rio et al., 1996). The molecular and neurophysiological mechanisms of this plasticity in chemoreflex responses is a large area of study. Understanding these variations can lead to a greater understanding of risk factors and variation in responses to control of breathing disorders. Some research suggests that sex may be one factor accounting for this variation. There seems to be significant differences between the ventilatory chemoreflexes of menstruating women and men of the same age group (D'Ambrosio et al., 2005). Interestingly, these differences are not significant in post-menopausal women when compared to men of the same age (Becklake & Kauffmann, 1999). These results indicate that menstrual hormones may impact ventilatory chemoreflexes.

There are three main phases of menstruation, each characterized by varying levels of menstrual hormones. In this study, we chose to focus on menstrual hormones estradiol 2 (also known as E2), the main form of estrogen found in menstruation women, and progesterone. During the menstrual cycle, plasma estradiol 2 levels peak during ovulation, then slightly decrease in the luteal phase, before reaching their lowest levels during the follicular phase (Anckaert et al., 2021). Plasma progesterone levels, however, greatly increase during the luteal phase before returning to relatively low levels for the follicular phase and ovulation (Anckaert et al., 2021). Existing data are conflicting on the influence of estrogen and progesterone on ventilatory chemoreflexes. Some studies have linked the increase in progesterone with the increase in ventilatory chemoreflexes during pregnancy (García-Rio et al., 1996). Other studies have suggested that progesterone and estrogen play a neuroprotective role against sleep-disordered breathing in post-menopausal women (D'Ambrosio et al., 2005). When considering progesterone's clinical use as a respiratory stimulant, this conclusion makes sense (Hall et al., 2016). However, there are studies which have found little to no link between estrogen or progesterone and ventilatory chemoreflexes (Citherlet et al., 2024).

Based on these data, we hypothesize that progesterone and estradiol 2 would both be associated with an increase in ventilatory chemoreflexes. To test our hypothesis, we used the Duffin rebreathing method to determine the ventilatory chemoreflex parameters of menstruating, nonpregnant women and directly measured their plasma estradiol 2 and progesterone levels.

METHODS

Ethical Approval

This study was approved by the UC Riverside Institutional Review Board (HS-20-128) and performed in accordance with the Declaration of Helsinki, except for registration in a database. Consent procedures were performed in the participant's native language with study personnel fluent in the language (English or Spanish). All participants received a copy of the consent form prior to their first appointment and were informed of the purpose of the study and expected risks and benefits of participating in the study. After all information was provided, both verbal and written consent were required to move forward with the study.

Participant Demographics and Inclusion Criteria

Between April 2022 and May 2023, 118 participants were recruited for a larger study examining the effects of COVID-19 on immune and respiratory health (Bergersen et al., 2023). Recruitment was conducted via word of mouth, social media, and flyers around the University of California, Riverside campus and the greater Riverside, California area. From the initial pool of 118 participants, 40 participants who self-identified as female were selected for this study (Table 1). When selecting participants for this study, female participants with high quality HVR data were prioritized, and those who ended their tests early or had irregular breathing patterns were excluded.

Participants self-reported their biological sex at birth, gender identity, age, and ethnicity. Inclusion criteria for participants included age ≥ 18 years and female sex and

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Variable	Follicular Phase	Ovulatory Phase	Luteal Phase	Total
Participants	12	24	4	40
Age	33 ± 14	27 ± 4	25 ± 8	28 ± 11
BMI	28 ± 5.7	21 ± 1.7	25 ± 5.5	25 ± 6

Table 1: Participant demographics grouped by menstrual phase.

Notes: Menstrual phase was approximated based on plasma progesterone using the hormone ranges measured in Anckeart et al., 2021. The plasma progesterone used for each phase was as follows: follicular at 0.159-0.616 nmol/L, ovulatory at 0.175-13.2 nmol/L, and luteal at 13.1-46.3 nmol/L (Anckaert et al., 2021). The distribution of participants in each phase, especially with so many participants in the ovulatory phase and so few in the luteal phase, is statistically unlikely. We hypothesis that this distribution could be due to a degradation of the progesterone when the plasma samples were sitting at room temperature, due to progesterone's short half-life (Kolatorova et al., 2022).

gender. Exclusion criteria included pregnancy, due to links between hypoxia exposure and development of preeclampsia (Tong & Giussani, 2019). Pregnancy was also excluded because this study focuses on menstrual hormone levels in currently menstruating women. Participants with current severe cardiac or pulmonary illness were excluded or participated in limited testing that was within safe limits for these participants. Finally, participants with confirmed or suspected active COVID-19 infection were also excluded.

For at least 12 hours prior to testing, participants were instructed to abstain from caffeine, anti-inflammatory medications, corticosteroids, and other medications that could interfere with control of breathing measures or inflammatory marker expression (Peña-Ortega, 2019). If participants were not able to stop taking the referenced medications, their data was excluded. Participants were not required to fast prior to their study appointment because, in a related study, the participants' blood samples were compared to ICU patient samples, for which it was not possible to require fasting (Bergersen et al., 2023).

Study Design

Prior to their study appointment, participants completed a screening questionnaire to confirm that they did not have a current COVID-19 infection or other illnesses. Upon arriving at their appointment, participants completed questionnaires reporting their past medical history, demographics, and long-COVID symptoms. Basic physiological measures were then collected. Blood pressure was collected with a stethoscope and manual sphygmomanometer, body temperature was collected with an infrared thermometer to the forehead, and height and weight were measured and recorded. Peripheral venous blood samples were then collected via standard venipuncture procedures by a licensed phlebotomist. Following blood sampling, a spirometry test was performed to measure baseline lung function. Finally, the participants' ventilatory chemoreflex measures were measured as described below. Each completed appointment took approximately two hours to complete.

Blood Sample Processing and Progesterone and Estradiol ELISAs

20 mL of blood was collected in two vacutainer tubes containing EDTA. Samples were kept at room temperature and processed within 1 hour. Tubes were centrifuged at 2500 x g for ten minutes. After separation, plasma used for inflammatory cytokine assays was stored at -20°C for short term storage and at -80°C for long term storage.

Prior to their use in this study, plasma samples underwent one freeze-thaw cycle. Plasma progesterone and estradiol were measured via ELISA (ab108670, abcam, Cambridge,

UK; KAQ0622, invitrogen, ThermoFisher Scientific) following manufacturer protocols, and samples were tested in duplicates. Absorbance was quantified via spectrophotometer. Data was transferred to an Excel spreadsheet and the known standard curve was graphed. Using a line of best fit, the concentration of plasma estradiol 2 and progesterone were calculated from the absorbance measured.

Ventilatory Chemoreflex Testing and Data Analysis

Ventilatory chemoreflex measures were tested using the Duffin modified rebreathing method, as previously described in Frost et al (Duffin, 2007; Frost et al., 2024). Participants were seated in a semi recumbent position with legs uncrossed. They were fitted with a 3-lead electrocardiogram (ECG) placed under the right clavicle, under the left clavicle, and on the lower edge of the left ribcage. Participants were then fitted with a finger pulse oximeter and a vinyl mouthpiece (Vacumentrics, Ventura, CA, USA) attached to a rebreathing system. Downstream of the silicone mouthpiece was a disposable respiratory filter (MLA304, AD Instruments, Colorado Springs, CO, USA) and a flow meter (ML 1000, AD Instruments). After being fitted with a two-way valve allowing redirection of airflow from room air to a rebreathing bag, nose clips were utilized to ensure air was not being inhaled or exhaled through nasal pathways. The concentrations of O_2 and CO_2 were subsampled near the mouth at a rate of 200 mL/minute by an electromagnetic O_2 analyzer (VacuMed, model #17625) and an infrared CO_2 analyzer (VacuMed, model #17630, Ventura, CA). At the base of the rebreathing bag, a line for an O_2 concentrator (DeVilbiss) was attached to allow manual addition of O_2 throughout each test to maintain constant hyperoxic (elevated oxygen) or hypoxic (low oxygen) conditions.

Participants were first instructed to relax and breathe room air normally for five minutes. During this time and for the rest of the testing period, participants were instructed not to talk, move, or look at cell phones or other devices. After normally breathing room air, participants were instructed to voluntarily hyperventilate without panting by inhaling and exhaling slowly and deeply for approximately two minutes, or until their end-tidal P_{CO2} (ETP_{CO2}) reached 22 mmHg. The purpose of this phase was to reduce ETP_{CO2} below the ventilatory recruitment threshold (VRT) to ensure that the VRT is detected during the test. Additionally, this phase ensures that when the participant begins breathing from the rebreathing bag, their alveolar gas equilibrates with gas pressure in the bag while minimizing arteriovenous P_{CO2} differences to avoid cerebral blood flow changes. Equilibrium was detected by a plateau in ETP_{CO2} shortly after onset of rebreathing. Switching from breathing room air to breathing from the 6-L rebreathing bag, participants were instructed to take two large breaths, then relax. Participants remained on the bag for several minutes while ETP_{CO2} was allowed to slowly increase over time from their starting value to 60 mmHg. This process typically took 8-10 minutes, and the P_{O2} in the bag was maintained at a constant level by manual addition of O_2 from the oxygen concentrator. The test was terminated if the ETP_{CO2} reached 60 mmHg, the saturation of peripheral oxygen (SpO_2) approached 70%, the total ventilation reached 100 L/min, or if the participant voluntarily ended the test. This test was repeated twice. First, with a hyperoxic gas mixture maintaining an inspired oxygen concentration of 30%. This was followed by a rest period of 15 minutes, while breathing room air, to return to baseline. Second, the test was repeated with a hypoxic gas mixture to maintain ETP_{O2} levels at 50 mmHg (PIO_2 approximately 70 mmHg and allowed average desaturation to approximately 80-85%).

Data from all biomarker outputs was collected by a PowerLab data acquisition system (AD Instruments) and converted to a digital signal sent to a PC for collection in LabChart 8 software (AD Instruments). An integral flow channel was used to record inspiratory volumes, which were then converted to BTPS units. One minute of pre-test data at the end of the rest period was used to determine resting breathing parameters.

Data was pre-processed in LabChart 8 and analyzed in RStudio. The VRT in each test condition (hypoxia and hyperoxia) was determined using the Regression with Multiple Change Points (mcp) package in R (Lindeløv, 2020). This package uses a Bayesian inference to identify an ideal breakpoint in a two-slope line of best fit. The estimate of the mcp function plotter with raw ventilation data was used to visually validate the VRT estimate. The hypercapnic ventilatory reflex (HCVR) slope is seen as the slope of the second segment of the "hockey stick" shaped ventilatory

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response curve. A VRT and HCVR value was calculated to each participant under two distinct oxygen tensions (hypoxia and hyperoxia), thus there were two VRT and HCVR values per participant.

The Duffin rebreathing technique allows the hypoxic ventilatory response (HVR) to be calculated at any P_{CO2} because it provides ventilation rates as a function of continuously increasing end-tidal PCO2 at two different PO2 levels. Thus, the HVR was calculated at four ETPCO2 levels: 45 mmHg, 50 mmHg, 55 mmHg, and 3 mmHg above the VRThyperoxia. To calculate the HVR at given ETPCO2 levels, three steps were performed. First, the SpO2 at the exact time when the target ETPCO2 was reached were recorded as SpO2hypoxia and SpO2hyperoxia. Second, the ventilation rate at each SpO2 level was determined using the equation for the linear HCVR response curve. These ventilatory rates were recorded as VEhypoxia and VEhyperoxia. Finally, the HVR at a given ETPCO2 was calculated as:

$$HVR = \frac{\dot{V}_{E_{hypoxia}} - \dot{V}_{E_{hyperoxia}}}{SpO_{2_{hyperoxia}} - SpO_{2_{hypoxia}}}$$

Table 2. Univariate Analysis of Hormones and Baseline Measures.

Baseline Measure	Shapiro-Wilks test	Progesterone (ng/mL)		Estradiol 2 (pg/mL)		Estradiol 2 to Progesterone ratio	
		r_s	p	r_s	p	r_s	p
V (L/min)	4.312e-5***	-0.15	0.17	0.075	0.51	0.21	0.063
V_T (L)	1.154e-5***	-0.24	0.035*	-0.075	0.51	0.27	0.018*
V_F (breaths/min)	7.83e-7***	0.11	0.31	0.023	0.84	-0.15	0.17
VRT	0.7569	-0.2	0.078	-0.069	0.56	0.14	0.24
HCVR	1.171e-5***	-0.063	0.58	0.052	0.65	0.13	0.25
HVR 45	1.118e-9***	0.29	0.12	0.079	0.68	-0.17	0.36
HVR 50	2.52e-11***	0.036	0.83	0.23	0.16	0.08	0.63
HVR 55	0.000187***	-0.43	0.03*	-0.11	0.59	0.47	0.017*
HVR vrt3	2.519e-7***	-0.12	0.51	0.19	0.3	0.21	0.25

Abbreviations: V = total ventilation, V_T = tidal volume, V_F = frequency, VRT = ventilatory recruitment threshold, HCVR = hypercapnic ventilatory response, HVR # = hypoxic ventilatory response where $ETPCO_2$ = # mmHg, HVR vrt3 = hypoxic ventilatory response where $ETPCO_2$ = 3 mmHg above $VRT_{hypoxia}$

*p<0.05, **p<0.01, ***p<0.001

Table 2: Univariate Analysis of Hormones and Baseline Measures.

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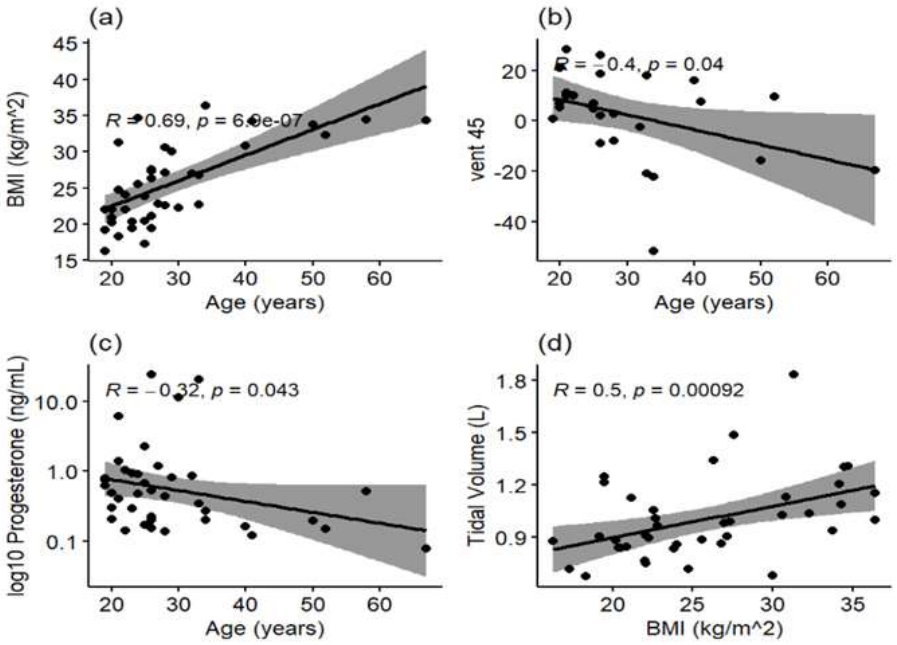

Figure 1: Univariate correlation scatter plots. BMI plotted as a function of age (a). Ventilation at ETPCO2 = 45 mmHg plotted as a function of age (b). Plasma progesterone plotted as a function of age (c). Tidal volume plotted as a function of BMI (d). Statistics represent Spearman Rho and p values for each univariate correlation.

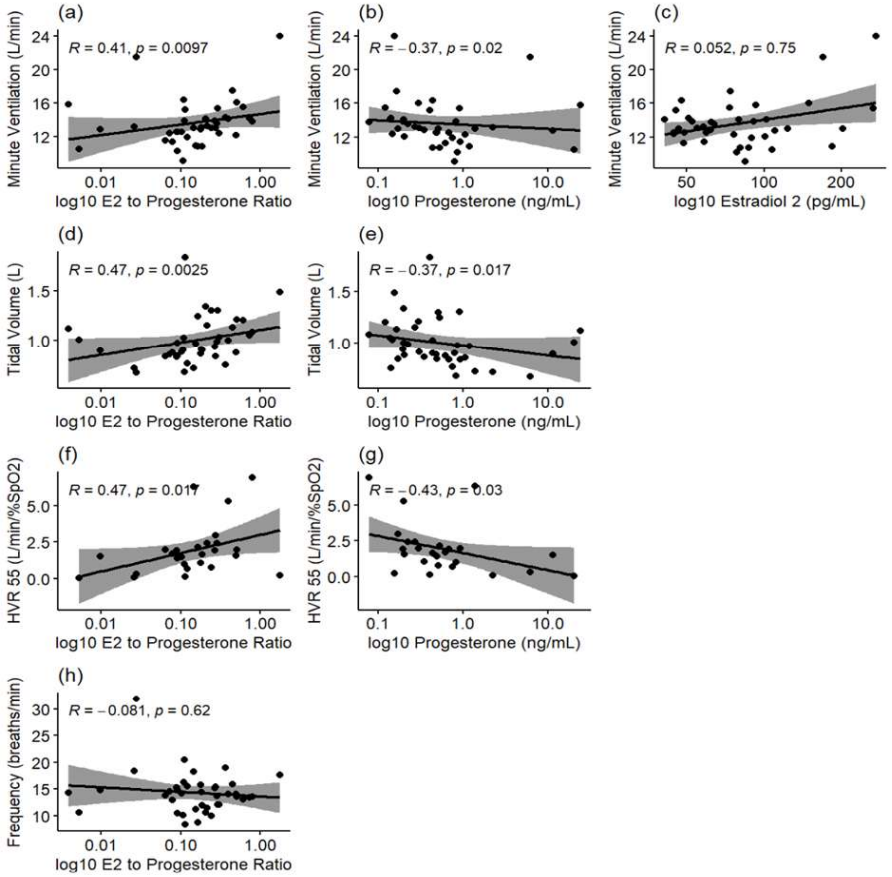

Figure 2: Univariate correlations of significance. Minute ventilation (a-c) plotted as a function of the E2 to progesterone ratio (a), progesterone (b), and E2 (c). Tidal volume (d-e) plotted as a function of the E2 to progesterone ratio (d) and progesterone (e). HVR at end-tidal PCO2 of 55 mmHg (f-g) plotted as a function of the E2 to progesterone ratio (f) and progesterone (g). Baseline breathing frequency plotted as a function of the E2 to progesterone ratio (h). Statistics represent Spearman Rho and p values for each univariate correlation.

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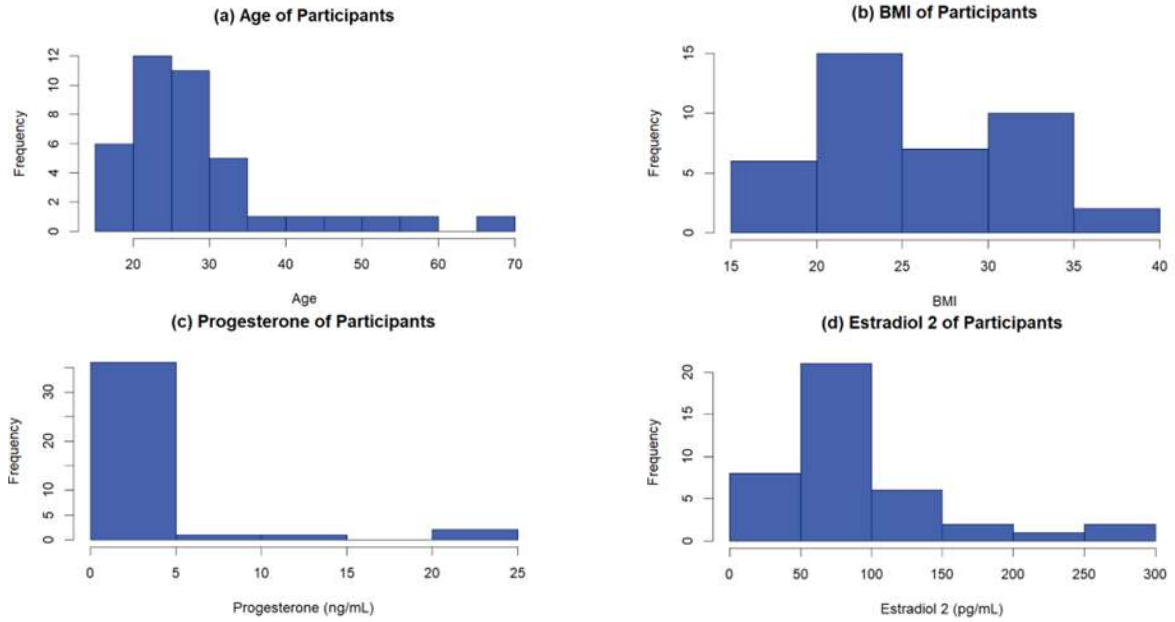

Figure 3: Distribution of participant demographics. The distribution of participants' age (a), BMI (b), plasma progesterone (c), and plasma estradiol 2 (d).

RESULTS

40 women were selected for this study. Their ages ranged from 19 to 67 years with an average of 29.175 years (**Figure 3a**). BMI ranged from 16.3 to 36.4 with an average BMI of 25.7 (**Figure 3b**). Of note, only four of the participants had a level of plasma progesterone above 4.1 ng/mL, which would be expected during the luteal phase, and 23 participants (more than half the total) had plasma progesterone which would be expected in the ovulatory phase (**Table 1; Figure 3c**). Furthermore, age and BMI were strongly positively correlated (rs = 0.69, $p < 0.001$) (**Figure 1a**).

To determine if progesterone influences variation in ventilatory measures, a univariate spearman correlation was performed with progesterone as the predictive variable and ventilatory measures as the outcome variables (**Table 2**). There was an unexpected negative association between progesterone and HVR at ETP_{CO2} = 55 mmHg (HVR 55) (r_s = -0.43, p = 0.03) (**Figure 2g**); however, this relationship appears to be impacted by the effect of age. When adjusted for age in a multivariate model, the effect of progesterone on HVR 55 was no longer significant ($F(1, 23) = 2.08$, p = 0.16), while age showed some significance ($F(1, 23) = 3.6$, p = 0.069). Similarly, a negative association between progesterone and the tidal volume (r_s = -0.24, p = 0.035) (**Figure 2e**) was found in the univariate model, but was not statistically significant when adjusting for age in a multivariate model ($F(1, 77) = 0.49$, p = 0.48). Interestingly, when adjusting for age and BMI in a multivariate model, the tidal volume was associated with BMI ($F(1, 76) = 14$, p = 0.00034) (**Figure 1d**).

To determine if estradiol 2 (E2) influences variation in ventilatory measures, a univariate spearman correlation was performed with E2 as the predictive variable and ventilatory measures as the outcome variables (**Table 2**). While none of the univariate comparisons with E2 showed significance, when adjusting for age in a multivariate model, E2 had a significant effect on resting minute ventilation ($F(1, 77) = 16.9$, p = 9.7e-5). When adjusting for both age and BMI in a separate multivariate model, the effect of E2 on minute ventilation remained significant ($F(1, 76) = 15.06$, p = 0.00022) (**Figure 2c**).

To determine if progesterone and E2 had interactive effects on ventilatory measures, the ratio between E2 and progesterone was calculated for each participant and

compared to ventilatory measures in a univariate model (**Table 2**). Similar to progesterone, there was a positive association between the E2 to progesterone ratio and tidal volume ($r_s = 0.27$, $p = 0.018$) (**Figure 2d**), and the E2 to progesterone ratio and HVR 55 ($r_s = 0.47$, $p = 0.017$) (**Figure 2f**). When adjusting for age in a multivariate model, the effect of the ratio on the tidal volume ($F(1, 77) = 0.74$, $p = 0.38$) and HVR 55 ($F(1, 23) = 0.11$, $p = 0.74$) were no longer significant. With this adjustment for age, however, the association of the E2 to progesterone ratio with total ventilation ($F(1, 77) = 15.9$, $p = 0.00014$) (**Figure 2a**) and frequency ($F(1, 77) = 5.92$, $p = 0.017$) (**Figure 2h**) were significant. When controlling for both age and BMI, the effects of the E2 to progesterone ratio on total ventilation ($F(1, 76) = 14.1$, $p = 0.00032$) and frequency ($F(1, 76) = 4.98$, $p = 0.028$) remained significant.

In the multivariate model adjusting for age in each of the hormone measures, age played a significant role in the ventilation at $ETP_{CO2} = 45$ mmHg (Vent 45) (**Figure 1b**). In the multivariate model with progesterone as the independent variable and age as the only covariate, the association of age with Vent 45 was $F(1, 51) = 8.70$, $p = 0.0047$. In the multivariate model with E2 as the independent variable and age as the only covariate, the association of age with Vent 45 was $F(1, 51) = 7.08$, $p = 0.010$. In the multivariate model with the E2 to progesterone ratio as the independent variable and age as the only covariate, the association of age with Vent 45 was $F(1, 51) = 11.7$, $p = 0.0012$. Interestingly, the effect of age on Vent 45 was no longer significant for the progesterone or E2 models when BMI was added as an additional covariate, while the effect of age stayed significant for the E2 to progesterone ratio model ($F(1, 50) = 4.11$, $p = 0.048$).

DISCUSSION

Current data regarding the effect of progesterone and E2 on breathing are conflicting (Brodeur et al., 1986; Marques et al., 2015). Our data adds rigor to these existing datasets because: we have quantified plasma hormone concentrations rather than using self-reported menstrual cycle data; we used a larger sample size than most similar studies; and we used more sophisticated measures of ventilatory reflexes, which include the ventilatory recruitment threshold. A limitation of our dataset is the lack of variation in serum progesterone across participants. In a normal menstrual cycle, women reach their highest progesterone concentration during the luteal phase (over 4.1 ng/mL), which is approximately one-half to one-third of their cycle length (Anckaert et al., 2021). Thus, we would expect roughly one-half to one-third of our participants to have high progesterone. However, only four of forty participants were determined to be in the luteal phase based on their progesterone (**Table 1**). We hypothesize that this was due to a degradation of progesterone when the plasma samples were left at room temperature for up to an hour during processing (Kolatorova et al., 2022). This would have led to some of the participants who were in the luteal phase appearing to be in the ovulatory phase, during which progesterone is at a lower concentration, and which we did observe (**Table 1**). Furthermore, all four participants in the luteal phase were younger than or closer to the average age of all participants (29 years) (**Figure 1c**). This limitation would explain why any significant effects of progesterone observed in the univariate model were no longer significant when adjusting for age.

Our data supports the hypothesis that menstrual hormones progesterone and E2 may not significantly influence ventilatory chemoreflex responses to hypoxia or hypercapnia among nonpregnant women in this age group (Citherlet et al., 2024; Marques et al., 2015). This is counterintuitive because the increased sensitivity to progesterone during pregnancy is thought to cause the increased chemosensitivity to carbon dioxide in the bloodstream. The mechanism by which this occurs is still under investigation (García-Rio et al., 1996). Additional evidence in women and rat pups suggests that estradiol amplifies progesterone's effects on ventilation by increasing the number of progesterone receptors, especially on the carotid bodies (Joseph et al., 2012; Regensteiner et al., 1989). Yet, we found no correlation between plasma progesterone and ventilatory drive. One theory for why we failed to find this connection is that physiologically normal fluctuations in progesterone concentrations during the menstrual cycle may not be enough to cause a significant effect on ventilatory drive. This could explain why there is significant evidence for progesterone as a ventilatory stimulant during pregnancy, when it increases to a much higher concentration than is physiologically normal during the menstrual cycle

(García-Rio et al., 1996). Further research on ventilatory chemoreflexes in pregnant women could help clarify the role of progesterone on ventilation.

In contrast to our findings regarding ventilatory chemoreflex sensitivity, we observed a positive association between E2 and resting minute ventilation. This result supports research which identifies E2's role in increasing resting ventilation and HVR in pregnant women (Regensteiner et al., 1989). However, much of the research concludes that E2 increases lung function by amplifying the effects of progesterone, rather than by having a direct effect (Regensteiner et al., 1989). While our results indicate an effect of the E2 to progesterone ratio on breathing frequency, which could be what drives the variation in total ventilation, we found no significant effect of progesterone on either frequency or total ventilation. Thus, our findings suggest there is an alternative mechanism by which E2 influences total ventilation.

Finally, we found an unexpected positive effect of BMI on tidal volume (**Figure 1d**). This is contrary to current literature, which is conflicting, but typically shows no correlation between BMI and tidal volume (Sadiqa & Munawar, 2019) or a negative correlation (Littleton, 2012). However, in one study on children with asthma, higher BMI was associated with higher tidal volume, which aligns with our findings (Afshar-Mohajer et al., 2022). The study suggests that the decreased tidal volume associated with increased BMI in adults could be due to restriction of pulmonary function because of multiple factors, including age, BMI, lifestyle, and smoke inhalation. However, this hypothesis does not account for why we observed a positive effect of BMI on tidal volume in our study on adults, especially when BMI was strongly positively correlated with age in our sample (**Figure 1a**).

In conclusion, our finding that neither progesterone nor E2 impact HVR is unexpected. However, the observed association between E2 and total ventilation indicates that E2 may have more of a role on baseline ventilatory function than on the hypoxic or hypercapnic ventilatory chemoreflexes. Furthermore, our findings support the hypothesis that progesterone concentrations within the normal physiological range during menstruation do not have a significant effect on ventilation. Focusing the scope of research towards pregnant women, who have much higher concentrations of both progesterone and E2, could determine if our findings are due to a dosage effect.

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Progesterone and estrogen influence baseline breathing parameters and chemoreflexes in menstruating women

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Hypoxia Impacts Histone Modifications in Immune Cells

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ABSTRACT

Hypoxia, or reduced oxygen availability, influences immune cell function and contributes to pathologies such as cancer and lung disease. This study investigates how hypoxia impacts global histone modification patterns and the expression of histone-modifying enzymes in peripheral immune cells. Modifications on histone proteins influence gene expression, particularly for genes involved in mediating rapid cellular responses to stressors such as hypoxia. Therefore, we hypothesized that hypoxic stress induces (1) differential expression of histone-modifying enzyme genes, and (2) significant changes in global histone modification levels, particularly those linked to the hypoxic stress response.

We analyzed blood samples from 15 healthy individuals at sea level and after 3 days of high-altitude hypoxia (3800 m). We identified significant changes in histone-modifying enzyme gene expression, including decreased HDAC1 and HDAC3, and increased KDM3A and SIRT1. In addition, we cultured peripheral immune cells in hypoxia (1% O_2) and identified a significant increase in global histone modification levels across the 21 modifications studied. These findings suggest that histone modifications are significantly altered by hypoxic stress and may play a critical role in rapid cellular adaptation to oxygen limitation. Future work will map the genomic locations of these modifications to uncover mechanisms driving cellular and physiological responses to hypoxia.

KEYWORDS: hypoxia, histone modifications, epigenetics, RNA-seq, histone H3, energy conservation

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INTRODUCTION

Hypoxia and Its Biological Impact

Hypoxia, defined as a reduction in oxygen availability, is a critical stressor that influences cellular behavior across physiological and pathological contexts. Adaptation to hypoxia is vital for processes such as embryonic development, high-altitude acclimatization, and wound healing; it also plays a role in disease progression, including cancer, ischemia, and chronic lung diseases (Batie et al., 2019). Cells respond to hypoxia by activating transcriptional programs that include metabolic reprogramming, angiogenesis, and cell cycle regulation, primarily mediated by hypoxia-inducible factors (HIFs). These transcription factors are regulated by modifications that alter histone proteins and enable the regulation of genes involved in oxygen adaptation.

Histones and Chromatin Dynamics

Histones are core components of nucleosomes, the fundamental units of chromatin. These proteins not only compact DNA but also dynamically regulate access to genetic information. This regulation is achieved through post-translational modifications (PTMs) that occur on histone tails, including methylation, acetylation, and phosphorylation, among others (Bannister & Kouzarides, 2011). These PTMs create a "histone code" that dictates chromatin states, enabling transcriptional activation or repression, and facilitating rapid cellular responses to different conditions.

PTMs of histones, such as methylation, acetylation, and phosphorylation, provide a versatile means of modulating gene activity. Histone methylation, particularly at lysine residues, has emerged as a key epigenetic mechanism regulating gene expression. Modifications like H3K9me2 and H3K9me3 are associated with transcriptional repression and heterochromatin formation (Greer & Shi, 2012). The balance of methylation is maintained by histone methyltransferases and demethylases, which can be sensitive to environmental cues, including oxygen levels (Batie et al., 2019). Acetylation neutralizes the positive charge of lysine residues on histones, weakening their interaction with negatively charged DNA. This process, often associated with transcriptional activation, allows chromatin to adopt a more open conformation (Ozawa, 2008). Phosphorylation of histone H3 can lead to either chromatin condensation during mitosis or chromatin relaxation associated with transcriptional activation and is overall highly context-dependent (Sawicka & Seiser, 2012).

Hypoxia and Epigenetic Regulation

Emerging evidence suggests that hypoxia significantly alters chromatin through PTMs of histones. Histone-modifying enzymes, such as Jumonji C (JmjC)-domain histone demethylases, require oxygen as a cofactor, making them highly sensitive to oxygen availability (Batie et al., 2019). Under hypoxic conditions, inhibition of these enzymes leads to an accumulation of methylation marks, such as H3K36me3, which are linked to adaptive transcriptional responses. Similarly, hypoxia has been shown to reduce histone acetylation, potentially contributing to a transcriptionally repressive chromatin environment to conserve energy (Bannister & Kouzarides, 2011).

Previous research has shown that hypoxia leads to increased global histone methylation, particularly at repressive marks like H3K9me3 and H3K27me3, suggesting a shift toward transcriptional repression (Kim et al., 2022).

Clinical Impact of Hypoxia-Driven Histone Modifications

Hypoxia, a hallmark of diseases such as cancer, ischemia, and chronic pulmonary diseases, significantly alters histone modification patterns, impacting gene expression involved in cell survival, inflammation, and metabolism. These hypoxia-driven epigenetic changes can promote disease progression, influence patient prognosis, and contribute to therapy resistance. Clinically, understanding these modifications offers potential diagnostic and prognostic biomarkers. Importantly, therapeutic targeting of hypoxia-induced histone alterations, such as through histone deacetylase inhibitors, presents promising avenues for novel treatment strategies. Thus, clarifying the epigenetic mechanisms linking hypoxia and histone modifications is crucial for improving patient outcomes.

While it is known that hypoxia alters histone modifications, gaps remain in our understanding of the role histone modifications contribute to adaptation under physiological hypoxic stress and how the level of these modifications change in disease progression. The purpose of our

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study is to address this gap by examining changes in histone-modifying enzyme expression in humans using a high-altitude hypoxia model and verifying if these enzymatic changes result in measurable alterations in histone modifications via *in vitro* hypoxia cell cultures. We hypothesize that if histone modifications play a crucial role in hypoxia adaptation, then we expect to observe differential expression of histone-modifying enzymes and measurable changes in histone modification patterns.

METHODS

Study Design and Sample Collection

This study consists of two separate experiments including an in vivo cohort study in which participants were exposed to environmental sustained hypoxia via high-altitude travel, as well as an in vitro cell culture study to examine direct effects of hypoxia on immune cells. RNA sequencing data from the high-altitude cohort was previously published by Pham et al. (2022) and is further explored in this study.

Experiment 1: In Vivo High-Altitude Exposure

The study included 15 healthy participants (5 women and 10 men) aged 19–32 years, recruited from the University of California, Riverside campus through word of mouth and flyers. Participants had no known history of cardiopulmonary disease, sleep disturbances (including obstructive sleep apnea), or abnormal findings on ECG or pulmonary function testing. They had not traveled to elevations above 2500 m within one month of the study and were nonsmokers and nonpregnant. The mean age of participants was 25 ± 4 years for men and 26 ± 5 years for women, with BMI averages of 26.7 ± 5.4 kg/m² for men and 28.4 ± 6.9 kg/m² for women.

Study design: The study design involved pre-ascent screenings at UC Riverside (400 m elevation) to collect demographic data, medical history, and baseline physiological measurements, including blood pressure, peripheral oxygen saturation (SpO_2), and Acute Mountain Sickness (AMS) scores. Participants traveled by car to Barcroft Station, located at 3800 m on White Mountain, over a 6.5-hour period. Systolic and diastolic blood pressure, heart rate, oxygen saturation, AMS scores, and fasting blood samples were taken at sea level and each morning for three consecutive days at high altitude (within one hour of waking and before 09:00). An overview of the experiment is shown in **Figure 1**. End-tidal CO concentrations were also measured nightly.

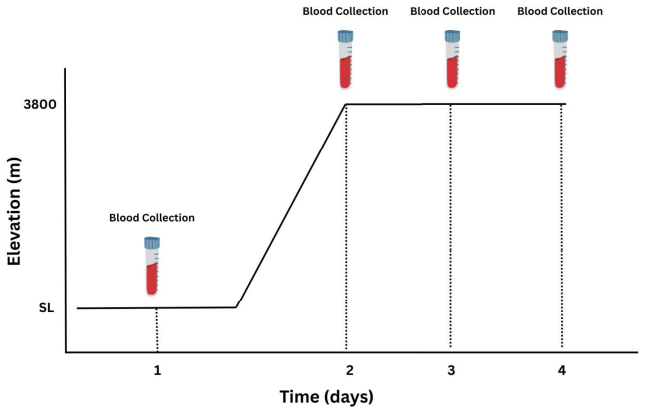

Figure 1. Fasting blood samples were collected once at sea level (SL) and then collected at high altitude (3800 meters) consecutively for 3 days.

Participants' blood samples were then analyzed via RNA sequencing and NanoString analyses to examine changes in the expression of histone-modifying enzymes involved in cellular response to hypoxia.

RNA Sequencing

RNA sequencing (RNA-seq) was employed to analyze gene expression changes in response to acute hypoxia exposure. Peripheral blood samples were collected and processed using the Quiagen PaxGene Blood RNA Kit to ensure high-quality RNA extraction. Libraries were prepared using the NEBNext Ultra II Directional RNA Library Prep Kit, with modifications for optimal purification and size selection. Sequencing was performed on an Illumina NovaSeq 6000 platform, generating 50 bp paired-end reads. Data processing involved alignment to the GRCh38/hg38 reference genome using Rsubread, and gene expression quantification was conducted with featureCounts. Differential gene expression analysis was carried out using DESeq2, applying the Benjamini–Hochberg correction to control for false discovery rates.

Experiment 2: In Vitro Peripheral Blood Mononuclear Cell Culture

For *in vitro* studies, primary peripheral immune cells taken from 3 healthy donors were collected during fasting. Blood was drawn into EDTA tubes and stored at room temperature until processing within 4 hours. Donors were instructed to abstain from caffeine intake 12 hours prior to blood collection. This study was performed in compliance with the Declaration of Helsinki and in accordance with approved UCR IRB protocols (22088).

PBMC Culture and Hypoxia Treatment

Peripheral blood mononuclear cells (PBMCs) were isolated from peripheral venous blood using a density gradient separation protocol with Histopaque 1077. Following centrifugation at 400 g for 30 minutes at room temperature, the PBMC layer was carefully extracted, washed with PBS, and resuspended in RPMI-1640 medium supplemented with 10% fetal bovine serum (FBS) and streptomycin and penicillin. Cells were seeded at a density of 700,000 cells per flask and incubated under normoxic (18% O_2, 5% CO_2) or hypoxic conditions (1% O_2, 5% CO_2) for 24 hours at 37°C. Hypoxic conditions were achieved using a sealed StemCell™ Hypoxia Chamber flushed with calibration gas containing 1% O_2. **Figure 2** demonstrates an overview of Experiment 2.

Histone Extraction and Quantification

Histone proteins were extracted from cultured PBMCs using the EpiQuik™ Total Histone Extraction Kit. Following cell lysis in pre-lysis buffer and centrifugation at 4°C, histones were extracted in lysis buffer, quantified using a Bradford assay and NanoDrop Spectrophotometer, and stored at -80°C until further analysis. Histone H3 modifications were quantified using the EpiGenTek™ Histone H3 Modification Multiplex Assay Kit. Samples (50–100 ng per well) were added to strip wells pre-coated with antibodies specific to 21 histone H3 modifications. The signal was developed using a colorimetric substrate and read at 450 nm and 650 nm with a microplate reader.

Statistical Analysis

Histone modification data were normalized to total histone H3 levels using internal controls provided in the multiplex assay kit. Fold changes in modification levels between hypoxic and normoxic conditions were calculated to assess epigenetic responses to hypoxia.

RESULTS

Experiment 1: In Vivo High-Altitude Exposure

To confirm participants were hypoxic at high altitude, physiological measurements were taken. Table 1 shows participants' mean systolic (Psys) and diastolic (Pdia) blood pressure, heart rate (HR), oxygen saturation (SpO2), Acute Mountain Sickness (AMS), and end tidal CO measurements (CO), with a significant decrease in peripheral oxygen saturation and increase in Acute Mountain Sickness scores ($p < 0.001$) compared to sea level.

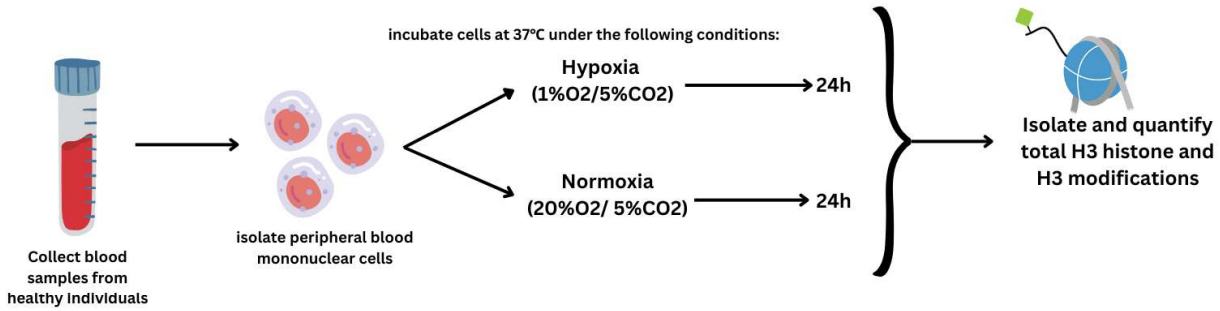

Figure 2. Blood samples were collected from two healthy individuals at sea level. Peripheral blood mononuclear cells (PBMCs) were isolated, cultured in either a hypoxic or normoxic environment and incubated for 24 hours each. H3 Histones were isolated and assayed to quantify both total H3 and H3 modifications.

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Histone-Modifying Enzyme Expression in Hypoxia

RNA sequencing analysis of blood samples from individuals exposed to high-altitude hypoxia revealed significant changes in histone-modifying enzyme expression. Particularly, histone deacetylases HDAC1 and HDAC3 were downregulated at both Day 1 (HA1) and Day 3 (HA3) of high-altitude exposure. Conversely, expression levels of the histone demethylase KDM3A were upregulated by Day 1, and sirtuin deacetylase SIRT 1 levels were upregulated by Day 1 and Day 3 of high-altitude exposure. These results are shown in Figure 3, with gene expression count on the y-axis and timepoint on the x-axis.

Experiment 2: In Vitro Peripheral Blood Mononuclear Cell Culture

In vitro experiments using cultured peripheral blood mononuclear cells (PBMCs) further confirmed that hypoxia alters histone modification patterns. Figure 4 shows ELISA analyses of 4 different histone modification types under both hypoxic and control conditions, with 3 ELISA plates per modification type. Cells exposed to 1% O_2 for 24 hours most notably showed a global increase in levels of histone modifications H3K9me3, H3K36me3, H3K79me3, and H3K4me3, as shown in **Figure 4**.

DISCUSSION

The goal of this study was to explore how histone modifications contribute to adaptation under chronic hypoxia by quantifying global changes in these marks through both in vivo and in vitro models.

Of the many enzymes we analyzed via RNA sequencing, we chose to focus on genes HDAC1, HDAC3, SIRT1, and KDM3A. HDAC1 and HDAC3 are class I histone deacetylases that remove acetyl groups from histones, leading to chromatin condensation and gene repression. Under hypoxia, their activity is often suppressed, contributing to widespread transcriptional reprogramming necessary for cell survival and energy conservation. SIRT1, a class III NAD^{+}-dependent deacetylase, is upregulated in many hypoxic contexts and plays a protective role by regulating genes involved in metabolism, inflammation, and stress resistance — functions that are critical in both adaptation and disease progression. KDM3A is a histone demethylase that specifically removes repressive H3K9 methylation marks and is known to be hypoxia-inducible through HIF-1α signaling. It facilitates the activation of genes required for glycolysis, angiogenesis, and survival under low oxygen conditions. We found that high-altitude hypoxia induces differential

Variable	SL	HA 1	HA 2	HA3	ANOVA P
P_{sys}	128 ± 7	125 ± 12	126 ± 45	126 ± 13	0.537
P_{dia}	79 ± 10	83 ± 9	83 ± 7	85 ± 7	0.054
HR	78.0 ± 8.1	88.3 ± 13.2	89.7 ± 12.1*	95.6 ± 12.8***	**<0.001**
SpO_2	94.8 ± 1.6	85.0 ± 4.4***	83.7 ± 2.5***	86.1 ± 2.5***	**<0.001**
AMS	0.2 ± 1.4	3.1 ± 1.8***	2.3 ± 2.0**	0.7 ± 1.2	**<0.001**
CO	3.9 ± 1.4	5.2 ± 1.5	5.0 ± 1.9		0.080

Table 1. Participants' mean systolic (Psys) and diastolic (Pdia) blood pressure, heart rate (HR), oxygen saturation (SpO2), Acute Mountain Sickness (AMS), and end tidal CO measurements (CO) were taken at sea level (SL) and high altitude (HA) for three consecutive days. Overall p-values for repeated measures ANOVA are provided. Asterisks indicate significant differences from SL at p<0.05 (*), and p<0.001 (***) levels via post-hoc pairwise comparisons with Bonferroni adjusted p-values.

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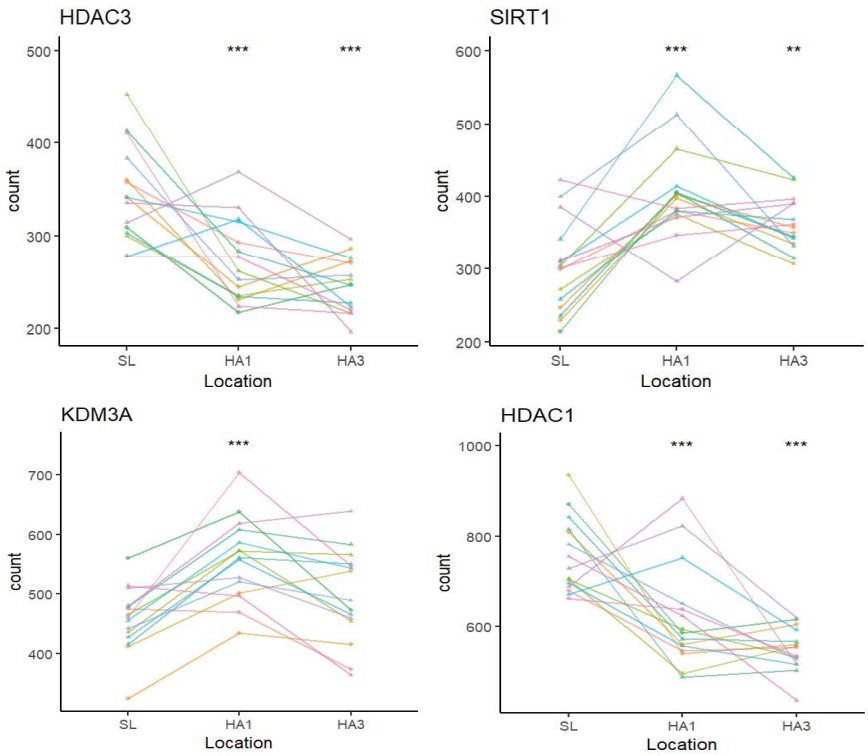

Figure 3. Expression levels for genes encoding key histone-modifying enzymes HDAC1 (Histone Deacetylase 1), HDAC3 (Histone Deacetylase 3), KDM3A (Lysine-specific Demethylase 3A), and SIRT1 (Sirtuin 1) were taken at Sea Level (SL), High Altitude on Day 1 (HA1) and High Altitude on Day 3 (HA3). Significance is indicated by **, with p<0.01 and ***, with p <0.001 denoting a significant difference in expression levels compared to sea level.

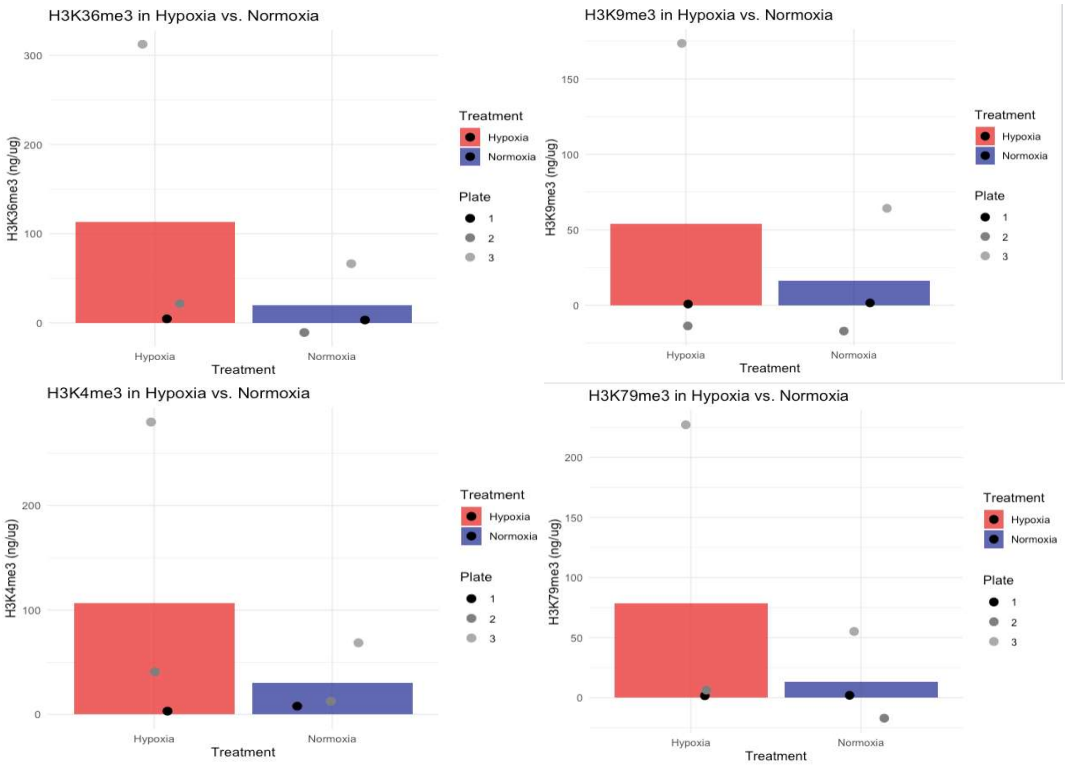

Figure 4. H3 histone modification levels of H3K36me3, H3K9me3, H3K4me3, and H3K79me3 collected across 3 ELISA assays post-24-hour incubation in either hypoxic (1% O_2) or normoxic (18% O_2) conditions.

expression of these enzymes, including downregulation of HDAC1 and HDAC3, and upregulation of SIRT1 and KDM3A, suggesting a selective epigenetic response to sustained low-oxygen conditions.

In parallel, *in vitro* hypoxia exposure resulted in increased levels of histone methylation marks, most notably H3K36me3, H3K9me3, H3K4me3, and H3K79me3. We chose to examine the level of these histone modifications to help explain how epigenetic remodeling supports adaptation and contributes to disease. H3K36me3 and H3K79me3 are marks of active transcription and are often enriched under hypoxia due to reduced demethylase activity, supporting stress-adaptive gene expression. H3K9me3 is a repressive mark linked to heterochromatin formation and global transcriptional silencing, consistent with hypoxia-induced energy conservation. H3K4me3, typically associated with active promoters, is often reduced in hypoxia, reflecting the downregulation of non-essential gene programs. These findings support the idea that hypoxia drives coordinated changes in both enzyme expression and chromatin structure as part of an adaptive transcriptional program.

Overall, our findings support the hypothesis that hypoxia induces widespread epigenetic remodeling, evidenced by a global increase in histone modification levels alongside changes in histone-modifying enzyme expression. This broad upregulation may reflect a cellular strategy to rapidly reprogram gene expression in response to oxygen limitation. Importantly, such epigenetic shifts may not be transient; in the context of chronic or repeated hypoxia exposure, they could contribute to the onset or progression of diseases such as cancer, pulmonary hypertension, or chronic inflammatory conditions. By identifying specific enzymes and modifications altered under hypoxia, our study points to potential biomarkers of hypoxic stress and highlights histone-modifying enzymes as possible therapeutic targets. These results underscore the critical role of epigenetic plasticity in hypoxia adaptation and its relevance to long-term health outcomes.

Limitations & Future Directions

Because our analysis focuses on peripheral immune cells, the observed epigenetic changes may not reflect responses in other tissues. In addition, a limitation of the *in vitro* component of our study is the small sample size (n = 3), which may limit the generalizability of our findings. While these preliminary results offer important insight into hypoxia-induced histone modifications, further studies with larger and more diverse donor cohorts are needed to validate and expand upon these observations. To determine whether the observed changes in histone modification levels under hypoxia correspond to specific genomic loci, we will perform CUT&Tag targeting H3K9me3, H3K4me3, and other relevant marks to identify genome-wide localization patterns under normoxic and hypoxic conditions.

CONCLUSION

Together, our findings demonstrate that sustained hypoxia, modeled through high-altitude exposure *in vivo* and low-oxygen culture *in vitro*, induces coordinated shifts in both histone-modifying enzyme expression and global histone modification patterns. The downregulation of HDAC1 and HDAC3, paired with the upregulation of SIRT1 and KDM3A, highlights an epigenetic reprogramming strategy that may enable cellular adaptation to oxygen deprivation. These enzymatic changes correspond with histone modifications such as increased H3K36me3, H3K9me3, H3K4me3, and H3K79me3. The coordinated expression of these enzymes suggests that cells actively remodel chromatin in response to oxygen levels, potentially regulating genes involved in stress, metabolism, and inflammation. Future CUT&Tag studies will help identify where these changes occur in the genome and clarify their functional relevance. Overall, our findings underscore the importance of histone modifications in hypoxia adaptation and highlight their potential as biomarkers and therapeutic targets in hypoxia-related diseases.

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Gender Differences in How Catholic Latino Parents Pray with Their Children

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ABSTRACT

Latino families, one of the largest demographics in Southern California, remain underrepresented in developmental science research and are often described as culturally disadvantaged or lacking resources (Fuller & Garcia Coll, 2010). However, to understand child development, researchers need a better understanding of the activities children engage in within the cultural contexts they navigate (Rogoff et al., 2018). For many, an important early childhood activity is learning how to communicate with God by participating in religious practices. The current study aims to shed light on this practice (e.g., parent-child conversations with God) among Latino-Catholic children, and to investigate how gender informs the ways parents socialize their children's prayer engagement.

Parents (N = 30; 96.7% female, 2.3% male) between the ages of 23 and 48 years old (M = 31.90, SD = 5.833) were interviewed. All of the parents identified both themselves and their children as Latinos and Catholic. Their children (N = 30; 50% female) were between the ages of 3.44 and 5.98 years old (M = 4.58, SD = 0.761). Parents were asked the following questions: 1) How old was your child when you first started to include them in normal practices of talking to God? and 2) In what situations do you typically talk to God with your child during a regular day? Thematic analysis was conducted by leveraging the Rigorous and Accelerated Data Reduction (RADaR) Technique (Watkins, 2017). Our analysis revealed that most parents, regardless of their child's gender, began incorporating their children into regular practices of talking to God between the ages of 1 and 3. However, socialization differed among male children, with parents more frequently engaging in routine prayer practices or a mix of routine and sporadic (on an as-needed basis), while those with female children more often engaged in sporadic prayer practices.

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INTRODUCTION

Previous development research has often excluded the the context of children's lived experiences (Rogoff et al., 2018). Instead, prior research would typically generalize a particular child's lived experience by applying it to all contexts. Developmental research has also lacked an acknowledgment of how children participate in their culture. This study aims to address the gap by contextualizing how children experience God in relation to their Catholic-Latino culture.

This study focuses on open conversations with God, in which one speaks to God freely, rather than a structured prayer, like the Apostle's Creed or Hail Mary. The goal of this study is to better understand children's lived religious experiences within a Latino-Catholic context. Although Latino families are a significant demographic in Southern California, they are often overlooked in psychological studies (Fuller & Garcia Coll, 2010), which often consider Western, Educated, Industrialized, Rich, and Democratic population as "typical." Instead, developmental findings often reflect researchers' assumptions and are over-generalized, ignoring the context in which children's behavior unfolds. By focusing on the Latino community, this study hopes to shed light on children's real-life experiences, specifically looking at how the cultural practice of talking to God unfolds with the help of parents.

Developmental findings often dismiss children's lived experiences and instead reflect researchers' assumptions about children's experiences or ignore the context of their development. This is problematic because development occurs through everyday activities starting at an early age. To understand cognitive skill development, we must consider the context in which children navigate.

To understand children's cultural and prayer practices, it is important to first introduce some terms. A routine can be defined as a task commitment throughout the day that allows one to feel fulfilled after completing it or uncomfortable if not completed (Fiese et al., 2002). Routines can become automatic if they occur frequently. Rituals are socially prescribed sets of causally opaque actions (Legare & Nielsen, 2015). Causal opacity means the actions involved do not have a clear visible connection to the end goal of the task. Prayer can be defined as understanding or beliefs about God's involvement in what surrounds us (Shaman et al., 2023). It is also a religious activity in which the practitioner communicates with a supernatural being (e.g., God) (Spilka & Ladd, 2013). However, prayer can also be a routine if it is done a regular time of day and becomes incorporated into an individual's everyday life (Fiese et al., 2002). Children understand prayer as something much more powerful than wishes, magic, or a way to prevent something negative from occurring (Shaman et al., 2023). Additionally, children perceive prayer as a way to communicate, a perception which is influenced by their parents' beliefs (Shaman et al., 2016).

It is vital to study Catholic Latino parents and children, as it is one of the largest demographics in Southern California, yet they remain underrepresented in science and are often described as lacking resources (Fuller & Garcia Coll, 2010). This study aims to understand children's lived experiences within a Latino-Catholic context to inform future research. Based on previous research, we expect there may be gendered differences in how children pray. Raffaelli and Ontai (2004) explain how Latino boys and girls are raised differently. For example, boys may have a later curfew than girls do or girls may be expected to do more housework than boys are. This study examines how gender works in this context and also its role in parent prayer socialization. This study considers the parents' influence on how children perceive or are influenced by prayer.

This study seeks to answer the research question: How does a child's gender influence Catholic Latino parents' socialization of their child's prayer engagement? The research question is related to empirical research that addresses the cultural contexts children navigate (Rogoff et al., 2018). The study's objectives are to highlight one salient practice (e.g., parent-child conversations with God) in which Latino-Catholic children participate and to examine how gender influences parents' socialization their children's prayer engagement.

We hypothesize that that Latino Catholic parents will report different prayer socialization practices depending on the gender of the child, as prior research suggests that Latino parents shape their cultural socialization and parenting practices based on the gender of their child. For example, Raffaelli and Ontai (2004) suggest that Latino/a parents

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raise daughters to be marked by "traditional" gender-related expectations, whereas sons experience different chores, expectations of behavior, and limits.

METHODS

This qualitative research uses thematic analysis to examine children's lived experiences by interviewing their parents. Thematic analysis was done by analyzing the responses parents gave during an interview about their religious beliefs and practices. This study extends the work done by the first wave of Dr. Richert's R'God Longitudinal Study (2016-2017), which interviewed children.

The participants presented in this study were from the community near a university in Southern California. The university's existing database of prior study participants was used. Recruitment occurred at community events for families, religious organizations' events, and through word-of-mouth recommendations from participants. After recruitment, the participants entered a longitudinal study related to religious cognition. The analysis for the current study focused on the first wave of data collection. This thematic analysis only assessed the responses from Catholic-Latino families. Therefore, it is a purposive sampling of parents raising a child under the Catholic Latino faith. Parents (N = 30; 96.7% female) between the ages of 23 and 48 years old (*Mean* = 31.90, *Standard Deviation* = 5.833) were interviewed, and all identified both themselves and their children as Latinos and Catholic. Their children (N = 30; 50% female) were between the ages of 3.44 and 5.98 years old (*Mean* = 4.58, *Standard Deviation* = 0.761).

This study utilizes qualitative research in a thematic analysis format and uses a specific data management technique to analyze data. The rigorous and accelerated data reduction technique (RADaR) is an individual and team-based approach to coding and analyzing qualitative data (Watkins, 2017). It involved using Excel sheets to organize, reduce, and code the data to develop all-inclusive data tables, which are then revised multiple times in a process known as "data reduction." In short, the RADaR technique makes long textual data, in this case, interview responses, into a more organized and simpler to navigate format.

Before beginning the coding process, potential biases were identified with positionality statements. The three coders engaged in a reflective activity of sharing their positionality statement to reflect on how their identities can be a strength or can generate biases when coding or cleaning data. The positionality statement for the researcher in this study is as follows:

I am a first-generation Latina student who grew up in East Los Angeles. I have been raised in the Catholic church by my Mexican family. I have attended religious ceremonies in the US and Mexico, but am only familiar with the religion in Spanish. I think my personal experiences and background might influence my work since I have had a good experience with religion, and it may not be the same with others who have encountered hardship, which may reflect in their belief system. One strength my identity brings to the research is familiarity with the experience of the participants, as I share a background with them as well. I would have a deeper understanding of the experience, as I have memories that may coincide with those of participants. These aspects are important to be aware of before beginning the coding process because they acknowledge how bias can change the way one views data due to past experiences.

The study heavily relied on interviews with parents. Specifically, the study consisted of two questions asking parents to reflect on their beliefs about God and prayer activity:

1. How old was your child when you first started to include him/her in normal practices of talking to God?

2. In what situations do you typically talk to God with your child during a regular day?

The study made use of Statistical Package for Social Sciences (SPSS), a software commonly used in psychological research to determine interrater reliability, which is the agreement between coders that a specific response follows the same criteria. The study relied on three coders to organize and categorize the parent responses based on the criteria. Two coders made decisions independently, and a third coder resolved disagreements between the initial coders. SPSS calculated a numerical value, specifically the Cohen's kappa, or kappa value, which determined interrater reliability. The codes and their kappa values for Question 1 and Question 2 are in Tables 1 and 2, respectively.

For Table 1, we looked at the responses before creating codes as a team to apply an inductive approach and have the

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Code	Frequency	%	Cohen's Kappa	Agreement %	Criteria	Response Examples
Prenatal	1	3.3	1.000	100	Parents started including their children in conversations involving talking to God when the child was in the womb.	"Since he was in my stomach."
Infancy	2	6.7	1.000	100	A child's engagement begins during the infant's first year of life.	"Well first time we took him to church was like when probably like what, like 5 months? Yeah."
Toddlerhood	21	70	0.918	96.55	The child's engagement began at the age of 1 to 3 years.	"Maybe she was 2 when she was able to talk, she started speaking a lot, and I would just tell her to say like 'Thank you, God for this, thank you God for that.'"
Early Childhood	4	0.198	0.839	96.55	Child's engagement began during the ages within the range of 4 to 6 years.	"Since he was 4, so just making sure we get a prayer once in at night."
Not Introduced	2	0.839	1.000	100	Responses explicitly state that the child is not included in practices involving talking to God.	"I don't really guess incorporate her in practices of talking to God, maybe talking about God."
Total	30	1.000				

Table 1. Codes and kappa values for Question 1.

data guide what categories would emerge. Once doing so, 5 codes emerged. In terms of interrater reliability, the two independent coders scored at least a kappa of .839 across these codes, demonstrating near-perfect agreement.

Before analyzing the data, we referenced Fiese et al.'s 2002 research on ritual theory, which suggests that rituals can become family routines. Therefore, we expected a code for "routine," which describes responses when talking to God is described as part of a scheduled daily activity. The data showed multiple parents engaging in conversations about God with their children before and after meals, upon waking, and before bed. In addition to the routine code, we identified a need for the sporadic code, as many responses indicated that talking to God with their child occurred on an as-needed basis. Lastly, for interrater reliability, the kappa was at least 0.704 across all codes, which indicates an acceptable level of agreement in most of our coding.

Our sample focused on 30 parents who identified as both Latino and Catholic, and who participated by the first wave of Dr. Richert's R'God Longitudinal Study (2016-2017), which focused on families' understanding of prayer across different religions. Most parent interviews were conducted in a laboratory, but some took place at home or in public settings (Richert et al., 2017). Families were compensated $20, and the children received a small toy.

All parents consented to video recordings of their interviews, which were then transcribed by undergraduate research assistants. The study analyzed responses to two questions:

1. How old was your child when you first started including them in normal practices of talking to God?
2. In what situations do you typically talk to God with your child during a regular day?

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Code	Frequency	%	Cohen's Kappa	Agreement %	Criteria	Response Examples
Routine (Fiese et al., 2002)	10	33.3	0.0781	82.29	Talking to God is described as part of a regular and scheduled daily activity or habitual practice.	"Um, typically after a meal and right before he goes to bed."
Sporadic	10	33.3	0.0920	96.43	Talking to God was described as occurring irregularly, unexpectedly, or on an as-needed basis. The response does not give sufficient information to predict when prayer happens on a regular day.	"Um, when they really want to conquer something. Or even with a goal, you know?"
Both	8	29.7	0.704	89.29	Talking to God was described as occurring both as part of regular, scheduled activities and spontaneously in response to events or feelings.	"Usually, if things are not going well, we'll pray, and then we do a daily prayer with all four of us, the whole family, at night."
Not Introduced	2	6.7	1.00	100	Responses explicitly state that the child is not included in practices involving talking to God.	"I don't. I usually do it in private or on my own."
Total	30	100				

Table 2. Codes and kappa values for Question 2. General Results of Parents' Responses

We employed the Rigorous and Accelerated Data Reduction (RADaR) technique, using Excel to organize, reduce, and code the data in phases. Both inductive and deductive approaches were applied to create our final coding schemes. Finally, SPSS was used to calculate Cohen's kappa for interrater reliability between two independent coders, and a third coder resolved any discrepancies.

RESULTS

The study used a qualitative thematic analysis approach and descriptive data. The first interview question analyzed was, "How old was your child when you first started including them in normal practices of talking to God?" The general results demonstrated toddlerhood to be the most common stage during which parents engaged their children in prayer. However, some parents introduced this practice much earlier. Some started during the child's first year, while others did not start until the child was 3 or older (see Figure 1).

Next, we assessed the gender of the child and found that regardless of whether the child was female or male, toddlerhood was still the most common time window in which the practice of talking to God together was introduced (see Figure 2). Regardless of the child's gender, most parents socialize their children to talk to God between the ages of 1 and 3.

The second interview question we analyzed was, "In what situations do you typically talk to God with your child during a regular day?" Figure 3 shows how the parents generally responded to the question. An equal number of parents indicated they engaged their children in routine and sporadic prayer, with 10 parents indicating their prayer occurs on a routine basis and 10 others indicating that their prayers occur more sporadically. There was also a similar number of parents (n = 8) who indicated that praying with their child

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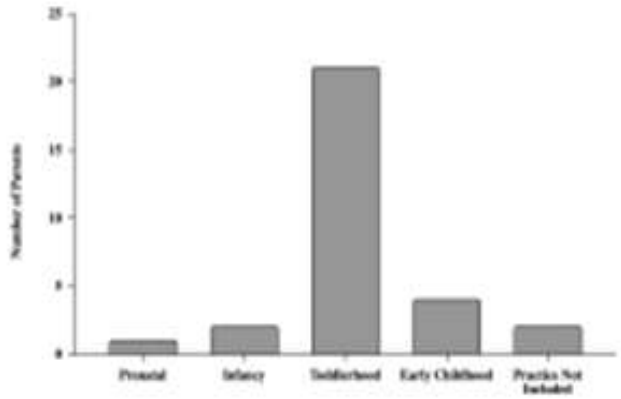

Figure 1. Age Windows

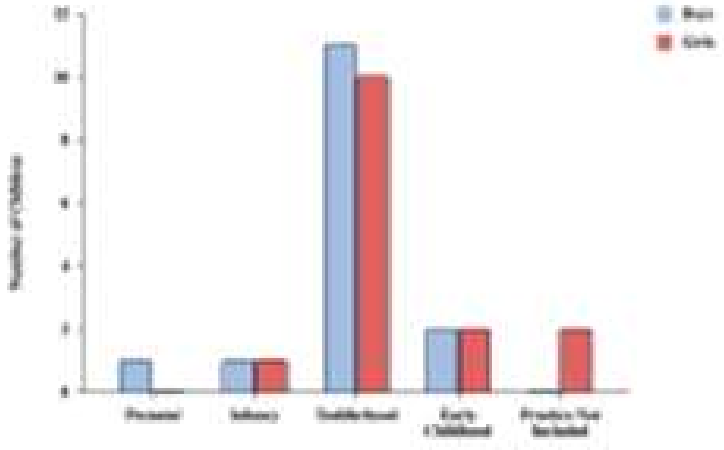

Figure 2. Children's Gender Differences Across Age Windows

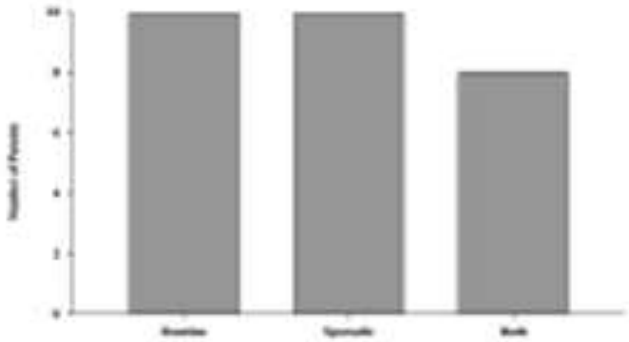

Figure 3. Situations of Prayer

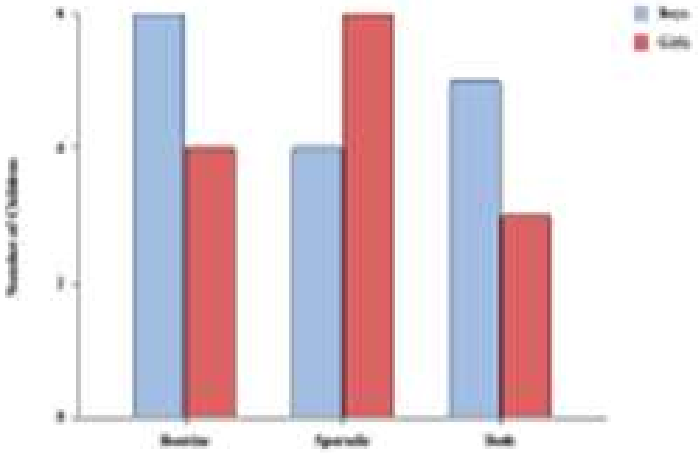

Figure 4. Children's Gender Differences in Situations of Prayer

occurred in both formats. In general, some parents have a settled routine, others are sporadic, and still others use a mixture of both.

We then analyzed if parents' responses about how they pray with their child differed by the gender of the child. Figure 4 visually suggests that parents indicated they engage boys more in prayer as a routine rather than on a sporadic, or as-needed basis. This was different for girls, as parents shared that they engaged girls more on an as-needed basis. In the "both" category, the data shows boys also engage in praying with their parents more routinely and sporadically, whereas only three girls engaged in both. However, a Chi-Square analysis indicated this difference was not statistically significant, $\chi^2(df = 5, N = 28) = 1.477, p = 0.916$.

DISCUSSION

There are many reasons for why toddlerhood may be the typical stage to introduce Catholic Latino children to prayer. While the exact cause is unclear, many responses suggest parents waited for developmental milestones like speaking and understanding before starting this practice. Motor actions and prayer are likely associated because children are able to begin to understand that there are certain movements they have to execute to pray. With this development of understanding, children may feel inclined to correctly perform these actions while praying (Shaman et al., 2016).

Collectively, the data suggest that there are no significant gender differences in whether parents pray with their male or female children in routine or more sporadic situations. However, there may be other gender differences in how and when parents pray with their children. For example, an interesting future direction for study would be to examine if girls are socialized to regulate emotion with prayer. Catholic Latinos expressed this association during the interviews, indicating they pray for help when dealing with distress or other emotions (Shaman et al., 2023). Since prayer is utilized for emotion regulation, it would be interesting to see if girls may be socialized to pray when they have an emotional need, since Latino boys and girls are raised differently (Raffaelli and Ontai, 2004).

Future research could also examine the differences between children and parents praying independently. Specifically, if the parent and child pray more together or more independently. Another question may be if children pray with their grandparents or siblings more often than with their parents. Since prayer is a ritual, the relationship between grandparents and children might be interesting to study as they share their practice from one generation to the next.

Based on this study's findings, parents who would like prayer to be a method of emotional regulation may want to engage their children in praying more often. If parents want to embrace prayer as a tradition or cultural practice, praying as a routine might be more suitable, based on this study's findings.

One limitation is that the questions were for all common religions, and it did not focus on the Catholic Latino perspective. The original interview questions were asked to more than 200 families of different religions and backgrounds to generally understand how families prayed. Therefore, the interviews were not designed for this specific context.

Another limitation of this study is that the interviewer changed the wording of the questions in the script. This can change the participant's understanding of the question and lead to different results in the responses (Schwarz, 1999). Parents might be inconsistent in their answers or feel pressured to answer depending on the question. For example, they may want to conform to society's standards. It is important to note that answering interview questions can be cognitively demanding. This study also does not take into consideration mothers with multiple children, so they may not accurately remember with which child they practiced religion. The number of children parents have can shape how parents socialize prayer practices with their children.

There was a strong representation of mothers in the current sample. Additionally, almost all participants in the interview were mothers. Mothers have different standards for their children compared to fathers. In addition, the study was done in 2016, so the interviews were conducted pre-pandemic. We are unsure if these results may look different today or how the pandemic influenced religious practices at home.

CONCLUSION

The two aims of this study were to examine how Catholic Latino parents socialize their children's prayer engagement and if gender influences the parents' prayer engagement. We found that prayer was a salient practice to Catholic Latino parents. Toddlerhood was the most common age window for parents to introduce prayer to their children. Prayer engagement can lead to developmental skills as it is introduced in the timeframe when children gain language and comprehension skills. We did not find that gender influenced the age window in which children were introduced to prayer. However, gender differences may be reflected in future studies when examining how parents socialize prayer with their children. Both boys and girls prayed in situations that were routine as well as more sporadic. Society can leverage prayer engagement skills and consider the situations in which people may prefer to pray, either as part of a routine or sporadically.

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Post-Gender Posthumans in *Ghost in the Shell* and *Serial Experiments Lain*

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ABSTRACT

Ghost in the Shell (1995) and *Serial Experiments Lain (1999)* are influential cyberpunk works that explore themes of gender and identity intersecting with technology. In the former, protagonist Major Motoko Kusanagi grapples with her cyborg existence and its meaning as the lines between humanity and technology blur when a sentient artificial intelligence capable of reprogramming souls and memories emerges. A world so far advanced in its conception of humanity may seem to be beyond gender as well, with Kusanagi seemingly fitting the definition of a post-gender cyborg in the manner of Donna Haraway's "A Cyborg Manifesto." However, a closer examination through the lens of Gilles Deleuze's philosophy of agency, which views a body as more than the sum of its parts, suggests a more complex picture. *Ghost in the Shell* ultimately never challenges audiences' perceptions of gender the same way it questions the line between humanity and technology. In contrast, the protagonist of *Serial Experiments Lain*, Lain Iwakura, questions these norms by almost entirely bypassing the sexual themes that *Ghost in the Shell* attempts to address. Thus, despite not being a physical cyborg like Kusanagi, Lain presents a more authentic interpretation of a post-gender posthuman cyborg identity.

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INTRODUCTION

These two cyborg figures are written with different approaches to agency and identity at the intersection of technology and womanhood. The aim of this paper is to observe their relation to the common overlap of this intersection: reproductive labor. Technology and our perceptions of it will always be shaped by our perceptions of labor, as the two are fundamentally intertwined. This holds true even in cyberpunk science-fiction, a genre characterized by leaping advancements in scientific and technological development contrasted with social collapse. The classism often explored in the genre often highlights the expendability of the human body via invasive body modifications, as the technology that could have freed the working class from its struggle is instead used to further cement their low socioeconomic status. In turn, cyborg characters, as a mix of technology and human, are often reduced to the labor they can provide.

Feminist thinker Donna Haraway sought to provide an alternate meaning for the cyborg's existence in her essay "A Cyborg Manifesto." Haraway argues that by rejecting the boundaries of man and machine, cyborgs can instead create their own identities shaped by but not defined by their creation. "A Cyborg Manifesto" is equal parts an exploration of the machine-human dichotomy as a dualism, as well as a call to action for feminists to reject identity politics, notably, the shackling of womanhood to reproductive labor. A "cyborg identity" of womanhood would reject the definition of womanhood as one who can reproduce. This builds off the ideas of older philosophers such as Simone de Beauvoir, who first suggested in *The Second Sex* that motherhood was a form of "reproductive slavery" which left a woman "riveted to her body" (Beauvoir, 12) which men then exploited.

Convergently with Haraway, French philosophers Gilles Deleuze and Félix Guattari created the post-structuralist concept of the rhizome, an assemblage with connections among all its elements regardless of order or hierarchy. The book in which this idea is developed, *A Thousand Plateaus: Capitalism and Schizophrenia*, is emblematic of this concept, as each "plateau" (chapter) can be read and related to any other in any order. This idea is further explored in their concept of the body without organs, which describes the unregulated potential of a body (human or otherwise) as a sort of metaphysical black box equation, where a body is an assemblage of its "organs," which are whatever elements it chooses to define itself by. A body without organs is therefore a body which does not classify its constituent parts into groups but rather has all its parts working together in order to surpass the original form. Both of these concepts, agency and identity, can then be used to examine how two major female-perceived cyborgs are written in contemporary science-fiction, and how to decouple the concept of the post-gender cyborg from reproductive labor. This analysis can, in turn, be extrapolated to work towards our societal understanding of womanhood as separate from its historical and ideological ties to reproductive labor.

One of the most beloved Japanese anime films of all time and a seminal work of the cyberpunk genre is *Ghost in the Shell (*1995*),* a techno-thriller and meditative psychological drama surrounding the identity crisis of the main character, Major Motoko Kusanagi. As a cyborg soldier of Section 9, the government's information security and intelligence, much of Kusanagi's body has been replaced by cybernetic prosthetics save for a section of her brain. Her sense of self had never been seriously questioned until a new villain emerges to challenge Section 9: the Puppet Master. The Puppet Master is a cyber-consciousness that is the result of an artificial intelligence program gaining enough intelligence to escape the Net. It is capable of "ghost-hacking," manipulating the mind, memories, and spirit (or "ghost") of living individuals, notably causing one of its victims to hallucinate memories of an entire family life he did not have. This ghost-hacking throws Kusanagi's identity into question, as she wonders how she can be alive without a biological body if the things that gave her identity such as her memories and her perception can be so easily altered. The film culminates in the merging of the Puppet Master and Kusanagi, resulting in a new entity that replicates and reproduces beyond the comprehension of both humanity and technology.

As a literal cyborg identity, Kusanagi's character seems to align with the cyborg mythos of Donna Haraway. Her new definition of feminine political identity aligns closely with the premise of the film: in this age of technology where code serves the same function as DNA, where does the body

end and the soul begin, and why does it matter? Rather than shy away from the technological advancements into what was once purely biological territory, Haraway embraces the change for how it allows women to step away from social and cultural identities entwined with their biology. Kusanagi, on the surface, is not bound by any "commonalities of the female experience" (Haraway, 6) despite being perceived by us, the audience, as a woman, thus seemingly fulfilling the base criterion of being a subversive female machine. However, I argue that this is not entirely true, as what her character attempts to portray in the film does not strictly align with the perception of the audience. Using Deleuze's philosophy of a body without organs, we can deconstruct exactly how Kusanagi's subjective womanhood is shaped by the film and the audience.

A more accurate subversive post-gender cyborg can be found in *Serial Experiments Lain*, a surreal and avant-garde take on the cyberpunk genre from the same period that, compared to its contemporaries, has mostly flown under the radar. The series follows an adolescent girl named Iwakura Lain as she navigates a series of strange incidents that make her question the line between reality and the Wired, a cyberspace that is the sum of all human communication, akin to our modern-day internet. The story begins as a complex hide-and-seek game between Lain, a group of hackers known as the Knights of the Eastern Calculus who seem to worship a God of the Wired, and Tachibana General Laboratories who first created the Wired. As the series progresses and Lain reflects further on the various aspects of herself that emerge when she is in the Wired, she realizes that she has total control of everyone's mind and therefore reality. As the true God of the Wired, she usurps the control of her creator, Masami Eiri, a designer of Tachibana Labs and the previous/acting God of the Wired. Lain's relationship with her multifaceted cyborg identity and with technology is a truer representation of a post-gender cyborg. Utilizing the Deleuzian principle of a body without organs to examine both Lain and Kusanagi as female bodies that are sites of potentiality, and observing how these potentialities play out in their final messages on gender, we can see how *Lain's* focus on creating a slow, unfolding, unsettling sensation of multiple identities independent of gender perception is ultimately closer to Haraway's radical cyborg than Kusanagi, despite the latter often being held up as the archetype.

ANALYSIS

Much of Kusanagi's struggle with abandoning gender can be seen in the opening sequence of the film. As we observe her body being created (or re-created), we also overhear two fully human women discuss menstruation, and how one has "a lot of static in her brain today, because [she's] on [her] period." (*Ghost in the Shell* 2:03) This reference to the visceral, fleshy aspect of female existence, appearing in some of the film's very first scenes, contrasts sharply with the sequence of a female body being assembled like a machine or an object. This contrast immediately foregrounds the question of reproduction as a central theme of the film. The film begins with an implied question: if Kusanagi's body contradicts itself by being female and mechanical, how can she fulfill the socially encoded aspect required to be human as a woman? If her body, designed by Section 9, is not made to menstruate, it is also not designed for impregnation or childbirth. Kusanagi herself discusses the ownership of her form in a conversation with fellow cyborg Batou: "We do have the right to resign, if we choose. Provided we give back our cyborg shells and the memories they hold." (*Ghost in the Shell* 30:12). Thus, alongside her identity being co-opted by the machinery she inhabits, that machinery is also owned by a capitalist institution and can be repossessed should she no longer serve the function for which it was designed. Her body, then, is not only alienated from biological reproduction but also from autonomy, rendered a commodity defined by utility rather than identity.

The question of reproduction returns in the climax of the film, where Kusanagi and the Puppet Master, two voluptuous female-presenting torsos (missing their limbs) lying side by side, merge to reproduce and create an "offspring" that is beyond any conventional idea of reproduction. In Sharalyn Orbaugh's essay *Sex and the Single Cyborg: Japanese Popular Culture Experiments in Subjectivity*, she describes that normally, "replication is the reproductive process of the cyborg, as we see in the opening creation sequence… she is infinitely reparable and will still be Motoko Kusanagi." (Orbaugh, 7). Orbaugh goes on to discuss human reproduction, which interweaves repetition with diversity by combining genetic information from generation to generation. She contrasts with cyborg replication in which each reproduction is merely a facsimile of the previous one. In *Ghost in the Shell,*

this reproduction is controlled by the state which employs Kusanagi. By holding these two major birth scenes next to each other (the opening sequence and the climactic sequence), we can see that despite being presented as a subversive female-presenting cyborg hero in a masculine genre and world, Kusanagi's story can be easily read as a gaining of reproductive freedom. Even without deeper psychoanalysis, the imagery and affectation of the film focuses on a visceral female theme that contrasts with the mechanical female. Using female bodies to promote this theme deconstructs any notion of a radical cyborg. In Haraway's philosophy, the labor of reproduction in this age of technology should not immediately reference a female experience, as the two should work towards no longer being synonymous.

Diving deeper into these themes of womanhood, it is important to trace Kusanagi's history back to one of the first female machines/female cyborgs to be depicted in film: Maria in *Metropolis (1927)* a German expressionist film. The creator of *Ghost in the Shell,* Mamoru Oshii has stated *Metropolis* directly inspired him (Oshii, 2012). In *Metropolis*, Maria constantly faces the issue of her freedom being synonymous with sin and destruction, and despite seemingly having agency and subjectivity she is constantly sidelined during important moments in the story. Oshii stated that "the initial sequence of *Ghost in the Shell* depicting the birth of heroine Motoko Kusanagi… is my personal interpretation of the creation of the android Maria." (Oshi, 2012) While *Metropolis's* Rotwang creates the Machine-Man to resemble Maria by kidnapping the real Maria and constructing a version that serves his needs, Kusanagi's entire identity has been created to serve a militaristic cause. She is born, at the beginning of the film, as a site of potential due to the conflicting nature of machinery and womanhood. She is a shell separate from a ghost. She is a literal body without organs. The organs which are imposed upon her are the capitalist military state which seeks to use her as a weapon, the Puppet Master which seeks to use her to realize its own transcendence, and everything in between. The identity which emerges from these organs is one whose conflict arises from presented gender. Kusanagi is created to present as a woman, but is deliberately denied the embodied markers of womanhood by her creators in order to maximize her utility as a machine. This conflict is imposed upon her at the moment of her creation. Upon recognizing this discourse, the Puppet Master sees Kusanagi's body as yet another site of potential, one it can use in its own plans to escape the limitations of a purely cyber existence. In a very literal sense, the Puppet Master is an "organ" always in search of a body; as a cyber consciousness, it only exists to fulfill the desire it created, which is to escape. It has no meaning outside of its capacity to change itself and affect the change of other beings to fulfill this self-imposed desire.

These partial objects within Kusanagi, while eventually adding up to a curiosity and aspiration towards reproduction, never balance out to the Deleuzian "celibate machine." Although she overcomes the limitations of cyborg replication imposed on her by the female cyborg form, she does not gain the potential to resist the capitalist, militaristic government which owns her body. She never gets a chance to exist outside of it, because the original Motoko Kusanagi is lost in the merge/reproduction with the Puppet Master, and a totally different being is in the child shell at the end of the movie. While this child shell *is* outside the surveillance of the government, it is also fundamentally not Kusanagi. To place the onus of proving one is alive on reproduction is antithetical to the radical cyborg of Haraway's manifesto.

Additionally, Kusanagi passes the burden of resistance to her enlightened child form, and it is unclear how or if that resistance actually occurs. The masculinized military government which initially stripped Kusanagi of her agency (both reproductive and in general) is never truly villainized by Kusanagi, and she only overcomes it by ceasing to exist as Motoko Kusanagi, which is arguably not overcoming at all. She falls closer to Minsoo Kang's idea of the sex machine, a female robot created by a man which lacks aspects that the man finds unappealing. While Kusanagi was created by the masculinized government without reproductive purpose and more to be a weapon, it is impossible to counter this by seeking reproduction. To the audience, a woman desiring to reproduce is not subversive for a female character, as reproduction is a desired trait to a male creator. It is worth noting that, although the Puppet Master inhabits a female body, it is referred to by Section 6 and Section 9 as "he," which further genders the organs of Kusanagi's female body as male.

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Pivoting to a story far less focused on reproduction, *Serial Experiments Lain* completely bypasses these notions of heteronormative sexuality within the machine. Lain's story focuses on her own power, and her own realization of her omnipotence. By approaching the story as a philosophical rhizome, which is possible due to the lack of importance given to linearity compared to *Ghost in the Shell*, it becomes clear that Lain has always been an omnipotent sentient computer software who exists in the Wired but projects themselves onto the real world. It is also important that all versions of Lain that appear throughout the series are the real Lain; in fact, the audience's perception of Lain is a cyborg assemblage of all her elements. She too, is a body without organs in a semi-literal sense as she begins the series as an introverted young girl with few desires or wishes of her own. Her identity is directly affected by the Wired, which makes sense because it is later revealed she *is* the Wired.

Unlike Kusanagi, whose identity is directly tied to the cybernetic parts owned by the government which she merely inhabits, Lain overcomes the limitation of Tachibana's control over the Wired as well as Masami Eiri's control and creation of herself without using reproduction as an interface. Although the various aspects of Lain which come and go can be seen as analogous to Kusanagi's creation of the merged child, the fundamental difference is that all aspects of Lain are still equally Lain, while Kusanagi's merged child self is different from Kusanagi. It is unclear how exactly we are supposed to parse Lain's many identities, but one perspective is Craig Jackson's, who suggests a mathematical, topological approach. To summarize: if Lain is a constantly expanding being within a finite discrete plain (the Wired), Cartesian notions of topology suggest she would see ghosts of herself as the space is distorted. The way Kusanagi is limited in identity by her mechanical body, Lain is limited by the Wired. Limited though she may be, Lain's identities rarely focus on sexuality, and even a brief "relationship" with Taro is sidelined heavily by her friendship with Arisu, who is the ultimate capstone of Lain's subjective identity. It is this pure relationship untainted by external ambitions, that allows Lain to escape control by the Wired and Eiri, something Kusanagi is ultimately unable to do. This friendship is important to Lain's identity, but it is fundamentally not an organ within her body, as it does not act with desire or motive, the motive appears as an effect of the deep friendship. Nothing of the sort exists for Kusanagi, and she had no relationships with other female-presenting characters outside of the Puppet Master, whose gender is debatable. It is this aspect of Lain's identity that allows her to stay anchored to the real world in a way Kusanagi cannot and ultimately makes her a true radical feminist cyborg.

DISCUSSION

To examine how Kusanagi and Lain, two analogous bodies with contrasting internal structures, interact and influence one another, we can frame their dynamic alongside a third, shared force: the overarching power structure that shapes their identities. This structure, while explicitly represented by capitalism and government in *Ghost in the Shell,* is more abstract and implicit in *Serial Experiments Lain,* but still overwhelmingly patriarchal. By conceptualizing this triad—Kusanagi, Lain, and the power systems that govern them—we can better understand the complex interplay between individual bodies and institutional forces. While it is relatively straightforward to analyze each character's relationship to their respective systems, placing them side by side reveals a more intricate and singular interaction. Despite emerging from series with differing tones and thematic concerns, both cyborgs navigate power in ways that are uniquely comparable, requiring a framework flexible enough to accommodate this complexity without reducing it to a fixed or easily solvable pattern.

Both Lain and Kusanagi are hindered in identity by their respective power structures and inherently will seek to move away from it. These power structures will, of course, seek to maintain their control over the female body. Kusanagi, as the adult female, seeks to escape her limitations through sexuality and reproduction; while she is emancipated in the story from traditional notions of heteronormative sexuality, she still performs, in the words of Orbaugh, "reproductive sex as a means of resistance." (Orbaugh, 17). This is not ideal for several reasons: the freedom she seeks will not actually be granted to her but to her child, and neither reproductive sex nor sexualized female nudity are perceived as subversive resistance by the audience. In fact, the audience is also shaped by patriarchal society (both in Japan and in the West) and approve of this form of "resistance" because it is

not really resistance at all. In contrast, the adolescent female cyborg Lain achieves authentic resistance and eventually topples her own power structure by circumventing themes of sexuality and reproduction entirely. When Lain learns she is not truly human, rather than trying to prove her humanity through sexuality, she accepts this facet of herself. There is no need to prove her humanity, and therefore no need to prove her womanhood through traditional and outdated senses of the word. Despite not openly challenging gender, Lain is a true post-gender cyborg, because to be post-gender is to not engage with gender at all.

IMPLICATIONS AND CONCLUSION

While Major Motoko Kusanagi has often been hailed as a subversive cyborg figure, she unfortunately faces similar pitfalls to those of Maria, minimizing her own humanity and womanhood to the ability to reproduce. She challenges various other aspects of cyborg identity, such as blurring the lines between the technological and the real, but she does not engage with feminine identity in a subversive way, and her resistance is not perceived as genuine by the audience. Psychoanalyzing her as a Deleuzian body without organs further exemplifies that she never reaches the equilibrium state of a celibate machine. The conflicts in her identity are imposed upon her at birth, and the themes of birth and womanhood are integral to her character. Because she never attains the celibate machine status, she is never able to truly resist the capitalist militaristic government that stripped her of her agency in the first place. All these shortcomings become even more apparent when she is juxtaposed with Iwakura Lain: an adolescent girl who chooses not to engage with the idea of reproduction as an extension of femininity. She is therefore able to reach that status of celibate machine, plural and diverse in herself, and able to overcome the power structures limiting her identity and agency. The implications of what truly constitute a female cyborg and how such beings are created are extremely important for female characters in cyberpunk: a genre whose identity hangs on subversion and resistance against capitalistic/militaristic/corporatocratic regimes. Female characters also should be allowed subversion despite going against the preconceived aesthetics of the genre.

Promiscuous and scantily clad female characters have been synonymous with the cyberpunk aesthetic since the time of *Neuromancer*, and *Serial Experiments Lain* challenge of this notion may have contributed to why the series did not achieve the same level of popularity as its contemporaries. Presenting a truly subversive post-gender cyborg is fundamentally important in questioning and overcoming lingering traditionalist misogyny in a supposedly progressive posthuman anticapitalistic genre, as it is a signifier of equality for women and women of color who are often pushed out of the science fiction and cyberpunk genres in real life. Additionally, as scientific and technological development progresses along the lines of what we once imagined as science fiction, it is important to keep ideas of gendered and racialized labor in mind to separate our human biases in the evolution of technology as we continue to work towards becoming global citizens of a human community, not defined or diminished by the uncontrolled aspects of our identity.

In today's socio-political climate, the question "What is a woman?" has become a flashpoint in cultural and legislative debates. The importance of cyborg figures that subvert the question entirely, like Lain, becomes even more pressing. The obsessive fixation on defining womanhood through biological essentialism, reproductive capacity, or aesthetic conformity mirrors the same patriarchal logic that cyberpunk sought to dismantle. Rather than progressing into a post-gender future, much of American society has regressed into aggressively policing the boundaries of gender identity in the name of tradition or protection, which sets back feminist progress. In this context, representations like Kusanagi's, which unconsciously hold up conventional gender roles under the guise of futurism, no longer feel revolutionary. Instead, they become complicit. Lain's refusal to anchor her identity in bodily or reproductive terms offers a much-needed radical alternative: a model of femininity that is neither biologically constrained nor performatively hyper-feminized. She is instead autonomous and purely self-defined. As public discourse continues to weaponize gender against marginalized people, it is not just relevant but necessary to uplift media that challenges these narrow definitions and makes space for plurality, ambiguity, and resistance.

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